COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The mission of CIT is to impart high quality education and training to its students to make them World-Class Engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

DEPARTMENT OF CHEMICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

VISION AND MISSION

VISION

The Department of Chemical Engineering strives for excellence in all aspects of teaching and research, to produce Chemical Engineers of quality required in Industries/ academic/ research organizations and serves the society at national and international standards.

MISSION

The Department is committed to continue building on its tradition of excellence and innovation by preparing the engineers of tomorrow and by meeting the challenges of a changing world through education, research, and service to its profession and the community.

DEPARTMENT OF CHEMICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To acquire working knowledge of applied Mathematics, Physics, Chemistry and basic Engineering Sciences that lay the solid foundation for understanding the core Chemical Engineering and specializations.

II. To develop an understanding of engineering principles related to the major aspects of Chemical Engineering phenomena, processes, materials and products.

III. To develop ability to obtain data and information necessary to formulate and to solve problems related to Chemical Engineering Equipment/ unit operations / unit processes with or without the support of software.

IV. To analyze and synthesize the knowledge of various courses to design / innovate on the existing equipment/ processes.

V. To integrate knowledge of core and allied courses to comprehend the multi-disciplinary nature of technological and organizational problems.

VI. To develop inter-personal skills, managerial skills, communication skills, professional ethics & values and entrepreneurship needed for professional success and growth of the organization and individual.

VII. To recognize the need for higher studies and lifelong learning to adopt oneself in the face of ever changing technologies and practices and be alive to the needs of industry and society.

DEPARTMENT OF CHEMICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAMME OUTCOMES (POs)

a. The graduates have an ability to apply knowledge of advanced mathematics, physical sciences and engineering principles to practical problems in their respective professions.

b. The graduates have an ability to improve the efficiency of processes and quality of products in chemical industry.

c. The graduates have an ability to identify, formulate and solve chemical engineering problems.

d. The graduates have an ability to design innovative processes and equipment suitable to the contemporary needs of the chemical industry and to promote the qualities of leadership and employability.

e. The graduates have an ability to work in multidisciplinary teams consisting of professionals from various disciplines of Engineering, Physical Sciences and Humanities supported by continuous Industry - Institution Interaction.

f. The graduates have an ability to be employed in software based jobs related to chemical engineering equipment design and process simulation.

g. The graduates have an ability to communicate effectively in multicultural environment and work with professional ethics and responsibility.

h. The graduates have an ability to gather information and procreate effective technical reports and oral presentations.

i. The graduates have an ability to design systems, components or processes to meet specified objectives within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability in the field of chemical engineering.

j. The graduates have an ability to engage in lifelong learning and to update technical know-how by self learning besides learning a great deal by associating with professional bodies and alumni.

k. The graduates have an ability to succeed in the graduate competitive examinations and pursue higher studies in chemical engineering or lateral disciplines

POs / PEOs	a	b	c	d	e	f	g	h	i	j	k
i.	X				X						X
ii.		X	X	X							X
iii.		X	X								
iv.				X		X					
v.		X	X	X				X	X	X	
vi.					X		X			X	
vii.					X		X			X	

COIMBATORE INSTITUTE OF TECHNOLOGY

(Autonomous Institution Affiliated To Anna University Chennai)

DEPARTMENT OF CHEMICAL ENGINEERING

Curriculum from the Academic Year 2013 - 2014

SUBJECTS OF STUDY

Semester III

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1	13CE31	Mathematics III	3	1	0	4
2	13CH32	Organic Chemistry	3	0	0	3
3	13CH33	Mechanics of Solids	3	0	0	3
4	13CH34	Heat Power Engineering	3	0	0	3
5	13CH35	Electrical Engineering	3	0	0	3
6	13CH36	Chemical Process Calculations	3	1	0	4
7	13CH47	Science of Creativity and Professional Ethics	2	0	0	-
		PRACTICALS				
8	13CH48A	Organic Chemistry Lab	0	0	3	-
9	13CH48B	Physical Chemistry Lab	0	0	3	-
10	13CH49A	Electrical Engineering Lab	0	0	3	-
11	13CH49B	Mechanical Engineering Lab	0	0	3	-
		Total				**20**

Semester IV

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1.	13CH41	Mathematics IV	3	1	0	4
2.	13CH42	Physical Chemistry	3	0	0	3
3.	13CH43	Chemical Process Industries I	3	0	0	3
4.	13CH44	Fluid Mechanics	3	0	0	3
5.	13CH45	Mechanical Operations	3	1	0	4
6.	13CH46	Process Instrumentation	3	0	0	3
7.	13CH47	Science of Creativity and Professional Ethics	2	0	0	2
		PRACTICALS				
8.	13CH48A	Organic Chemistry Lab	0	0	3	2
9.	13CH48B	Physical Chemistry Lab	0	0	3	2
10.	13CH49A	Electrical Engineering Lab	0	0	3	2
11.	13CH49B	Mechanical Engineering Lab	0	0	3	2
		Total				**30**

Semester V

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1	13CH51	Chemical Process Industries II	3	0	0	3
2	13CH52	Chemical Engineering Thermodynamics	3	1	0	4
3	13CH53	Heat Transfer	3	1	0	4
4	13CH54	Mass Transfer - I	3	1	0	4
5	13CH55	Environmental Engineering	3	0	0	3
6	13CH56	Instrumental Methods of Analysis	3	0	0	3
		PRACTICALS				
7	13CH57	Technical and Instrumental Analysis Lab-I	0	0	3	2
8	13CH58	Fluid Mechanics Lab	0	0	3	2
9	13CH69	Mini Project	0	0	3	-
		Total				**25**

Semester VI

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1	13CH61	Process Dynamics and Control	3	1	0	4
2	13CH62	Chemical Reaction Engineering	3	1	0	4
3	13CH63	Mass Transfer-II	3	1	0	4
4	13CH64	Energy Technology	3	0	0	3
5	13CH65	Chemical Process Plant Safety	3	0	0	3
6	13CH66	Process Equipment Design and Drawing -I	0	0	6	4
		PRACTICALS				
7	13CH67	Technical and Instrumental Analysis Lab-II	0	0	3	2
8	13CH68	Mechanical Operations Lab	0	0	3	2
9	13CH69	Mini Project	0	0	3	2
		Total				**28**

Semester VII

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1	13CH71	Transport Phenomena	3	1	0	4
2	13CH72	Process Economics and Industrial Management	3	0	0	3
3	13CH73	Elective I	3	0	0	3
4	13CH74	Elective II	3	0	0	3
5	13CH75	Process Equipment Design and Drawing -II	0	0	6	4
		PRACTICALS				
6	13CH76	Heat Transfer Lab	0	0	3	2
7	13CH77	Reaction Engineering Lab	0	0	3	2
8	13CH88	Project Work and Viva-voce	0	0	6	-
		Total				**21**

Semester VIII

S.No.	Code	Course	Credit			
			L	T	P	C
		THEORY				
1	13CH81	Total Quality Management	3	0	0	3
2	13CH82	Process Utilities and Engineering	3	0	0	3
3	13CH83	Process Modeling and Simulation	3	0	0	3
4	13CH84	Elective III	3	0	0	3
5	13CH85	Elective IV	3	0	0	3
		PRACTICALS				
6	13CH86	Mass Transfer Lab	0	0	3	2
7	13CH87	Process Control and Simulation Lab	0	0	3	2
8	13CH88	Project Work and Viva-voce	0	0	6	6
		Total				**25**

LIST OF ELECTIVES

S.No.	Code	Course	Credit			
			L	T	P	C
1	13E01	Sugar Technology	3	0	0	3
2	13E02	Polymer Science and Technology	3	0	0	3
3	13E03	Petrochemicals Technology	3	0	0	3
4	13E04	Fertilizer Technology	3	0	0	3
5	13E05	Food Technology	3	0	0	3
6	13E06	Pulp and Paper Technology	3	0	0	3
7	13E07	Industrial Waste Water Treatment	3	0	0	3
8	13E08	Surface Coating Technology	3	0	0	3
9	13E09	Petroleum Refinery Engineering	3	0	0	3
10	13E10	Electrochemical Engineering	3	0	0	3
11	13E11	Modern Separation Techniques	3	0	0	3
12	13E12	Mineral Processing Technology	3	0	0	3
13	13E13	Operations Research	3	0	0	3
14	13E14	Fluidization Engineering	3	0	0	3
15	13E15	Drugs and Pharmaceuticals Technology	3	0	0	3
16	13E16	Energy Management in Chemical Industries	3	0	0	3
17	13E17	Corrosion Science and Engineering	3	0	0	3
18	13E18	Environmental Impact Assessment and Clean Technology	3	0	0	3
19	13E19	Risk Analysis and Hazop	3	0	0	3
20	13E20	Process Automation	3	0	0	3
21	13E21	Optimization of Chemical Processes	3	0	0	3
22	13E22	Computer Aided Design	2	1	0	3
23	13E23	Biochemical Engineering	3	0	0	3
24	13E24	Material Science and Technology	3	0	0	3
25	13E25	Integrated Design of Chemical Processes	3	0	0	3
26	13E26	Piping and Instrumentation	3	0	0	3

TOTAL CREDITS

S. No.	SEMESTER	CREDITS
1	I	20
2	II	31
3	III	20
4	IV	30
5	V	25
6	VI	28
7	VII	21
8	VIII	25
	TOTAL	**200**

Sub. Code : **13CH66 - Process Equipment design and Drawing - I** in Sixth semester and Sub. Code : 13CH75 - **Process Equipment design and Drawing - II** in Seventh Semester B.Tech (Chemical Engineering) shall be evaluated under Continuous Assessment Scheme (CAS).

13CE31 MATHEMATICS III

(Common to third semester B.E., /B.Tech, all branches)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *This course provides quick overview of the concepts and results in complex number analysis*
- *To provide basic concepts for Fourier series and harmonic analysis*
- *To learn various transform techniques used to solve boundary value problems*

COURSE OUTCOMES :

CO1 *: The ability to derive and apply solutions from knowledge of Mathematics in real world problems.*

CO2 *: The ability to solve boundary values problems with the help of Fourier and Laplace transforms.*

COMPLEX DIFFERENTIATION

Analytic functions-Definitions and properties-Cauchy Riemann equations in cartesian and polar coordinates-construction of analytic functions- Conformal mappings-Bilinear Transformation -the mappings of the form w= z+a, az, 1/z, z^2, e^z, sinz, cosz, -Simple problems. **(12)**

COMPLEX INTEGRATION

Cauchy's integral theorem-Integral formula-Taylor's and Laurent's series (without proof)-Types of singularities, Poles and residues-Cauchy's residue theorem-Applications-Contour integration using circular and semicircular contours. **(12)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and functions-solution by direct method-solution of first order non-linear PDE-standard types-Lagrange's linear equation-Linear higher order homogeneous PDE with constant coefficients. **(12)**

FOURIER TRANSFORMS

Fourier integral theorem (without proof)-Infinite Fourier transform-infinite Fourier sine and cosine transforms-properties and problems-Convolution theorem-Parseval's identity-Finite Fourier sine and cosine Transforms- properties and problems. **(12)**

BOUNDARY VALUE PROBLEMS

Vibration of strings-one dimensional wave equations, one dimensional heat flow- unsteady state and steady state -Two dimensional heat flow steady state in Cartesian coordinates-Separation of variables-Fourier series solution. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS :

1. *Kandasamy.P, Thilagavathy.K and Gunavathy.K, Engineering Mathematics series, S.Chand and Co. Ltd, New Delhi, 2004.*
2. *Veerarajan .T, Engineering Mathematics, (for Semester III), Third Edition (Fifth Reprint) Tata .Mc Graw-Hill publishing company Ltd, 2008.*
3. *Venkataraman.M.K, Engineering Mathematics III, (Revised and Enlarged Fourteenth Edition, The National Publishing Company, Chennai, 2008.*
4. *Venkataraman.M.K. Engineering Mathematics III-A, Eleventh Edition, The National Publishing Company, Chennai, 2008.*

REFERENCE BOOKS:

1. *Erwin Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons (Asia) Private Limited, 2008.*
2. *Grewal, B.S, Higher Engineering Mathematics, Fortieth Edition, Khanna Publishers, 2007.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X									X
CO2	X	X									X

13CH32 - ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To instill students with an appreciation of knowledge in various organic compounds to solve practical problems*
- *To provide knowledge in petrochemicals manufacturing and analysis.*
- *To provide knowledge in qualitative analysis and estimation of glucose and sugar.*
- *To provide knowledge in analysis of simple organic compounds.*

COURSE OUTCOMES :

CO1 *: Student is able to detect elements, functional groups and structure of unknown organic compounds.*

CO2 *: Student acquires knowledge which is useful in the preparation of different organic compounds.*

CO3 *: Student is able to purify a given organic compound.*

NOMENCLATURE AND HYDROCARBONS

Nature and structure of organic molecules-Homologous series-functional groups-IUPAC nomenclature. Electron Displacement Effects-Inductive, Electromeric, Mesomeric and Hyperconjugative effects and their applications.

Cycloalkanes: preparation, properties and stability of cycloalkanes - Baeyer's strain theory- Sachse - Mohr concept of strainless ring systems. Recovery of benzene and their homologues from coal tar and petroleum.

Aromaticity - electrophilic substitution reactions of benzene and toluene. Orientation and reactivity - Disubstituion in benzene - theories of orientation. **(9)**

STREOCHEMISTRY

Geometrical isomerism - Beckmann rearrangement- optical isomerism - configurational isomerism - D and L and R-S Systems - Racemization- Resolution _ Asymmetric synthesis _ Walden inversion. Conformational isomerism -Conformers of ethane, propane, butane and cycloalkanes. **(9)**

CARBOHYDRATES

Classification- Conversions of monosaccharides - chemical properties of glucose and fructose- open chain and ring structures of glucose and fructose.

Disaccharides: Sources, structure (no elucidation) and uses. Polysaccharies: sources and structures (no elucidation) of starch and cellulose- Applications of cellulose derivatives. **(9)**

HETEROCYCLICS AND ALKALOIDS

Five-membered and six-membered ring compounds - sources, isolation, preparation, structure (no elucidation) and properties of Furan, Pyrrole, Thiopene and Pyridine condensed ring compounds-source,

proportion, structure (no elucidation) and chemical properties of Indole, Quinoline and Isoquinoline. Alkaloids: Sources, isolation, structures (no elucidation) and uses of Coniine, Nicotine, Quinine, Cocaine and Atopine. **(9)**

SYNTHETIC APPLICATIONS OF ORGANIC COMPOUNDS AND DYES

Synthetic applications of Grignard reagents, Organolithium, Organolead and Organozine- syntheitic applications of active methylene compounds like malonic ester and acetoacetic ester.

Dyes: Colour and constitution - classification of dyes based on their chemical structure and their applications. Important dyes like Maritus yellow, Congo red, Bismarck brown, Auramine - O, Crystal violet, Magenta, Uranine, Indigo, Thioindigo and Alizarin (preparation and uses only). **(9)**

Total : 45

TEXT BOOKS :

1. *Bhupinder Mehta & Manju Mehta, "Organic Chemistry" Prentice- Hall of India (P) Ltd, New Delhi, 2005.*
2. *Thomas N.Sorrel, "Organic Chemistry", First Edition, Viva Books Private Limited, New Delhi, 2004.*
3. *Robert Thornton Morrison and Robert Neilson Boyd, " Organic Chemistry", 6th Edition, Prentice-Hall of India (P) Ltd New Delhi (2002)*

REFERENCE BOOKS :

1. *Jerry March Advanced Organic Chemistry - Reactions, Mechanisms and Structure 4th Edition, John Wiley & Sons, New York, 2004.*
2. *I.L.Finar, "Organic Chemistry Vol1. The Fundamental Principles" 6th Edition ELBS Edition, England, 2002.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X									X
CO2	X		X					X			
CO3	X		X						X		X

13CH33 - MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide adequate knowledge pertaining to conceptualization, realization and evaluation of appropriate behavior of elastic and / or other relevant engineering materials sustained to resist various categories of forces occurring in realistic structural systems.*
- *To effectively supplement the necessary and basic properties of the metals, alloys and polymers for the analysis and techno-economic feasibility of engineered products.*

COURSE OUTCOMES :

CO1 *: Able to select compatible materials for product development and design, visualization of stresses in various systems and pave foundation for applied chemical engineering based structural mechanics.*

PERSPECTIVES OF STRESS AND STRAIN

Concept and development of stresses and strains - Normal (tension and compression) and shear stresses - Hock's laws : simple, modified and generalized - Poission's ratio - Young's modulus, modulus of rigidly and bulk modulus - Relationships between three moduli (no derivation) - Simple problems - Simple statically indeterminate systems like compound bars or assembly - Thermal stresses and relevant problems. **(9)**

ANALYSIS OF BEAMS

Support conditions and types of beams - Types of static loads; point, uniformly distributed, uniformly varying and couple - Development of shear force (SF) and bending moment (BM) in beams - Analysis of simply - supported, over-hanging and cantilever beams for SF and BM - Construction of SF and BMDs - Relationships between load on beam, SF and Bm in beams and their applications. **(9)**

BENDING AND SHEAR STRESSES IN BEAMS

Concept of simple symmetrical bending - Derivation of simple bending equation with assumptions - Development of bending stresses in beams - Bending stress distribution - Assessment of load carrying capacity of beams - Beam of uniform strength (concept only). leaf springs - Flitched beams - Development and analysis of shear stresses in beams - Shear stress distributions in square and rectangular beam sections only. **(9)**

TORSION OF CIRCULAR SHAFTS

Concept of torsion in solid and hollow shafts - Derivation of simple torsion equation with assumptions - Power transmission through shafts - Compound shafts and simple applications - Thin closed and open - coiled helical springs (without any corrections) - Spring systems : series and parallel. **(9)**

COLUMNS AND PLANE TRUSSES

Types of axial - loaded columns: long, intermediate and short - Different end conditions - Analysis of long columns by Euler's theory (derivation with assumptions) - Assessment of critical and safe loads - Analysis of columns by Rankine-Jordan's theory - Assessment of load carrying capacity of prismatic and built-up sections - Types of plane trusses: imperfect, perfect and redundant - Analysis of statically determinated plane trusses with assumptions - Method of joints and method of sections. **(9)**

Total : 45

TEXT BOOKS :

1. *Popov. E.P., "Mechanics of Materials", 2nd Edn., Prentice Hall Pub., N.Y., (1990).*
2. *Sadhu Singh, "Strength of materials" 3rd Edn., Khanna Publications, New Delhi (2003).*

REFERENCE BOOKS :

1. *Bansal, R.K. "Strength of Materials" 4th Edn., Laxmi Publications (P) Ltd., Bombay (2007).*
2. *Kazmi, S.M.A., "Solid Mechanics", 1st Edn., Tata McGraw Pub., New Delhi., (2001).*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X	X	X						X

13CH34 - HEAT POWER ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To understand the variations in different type of axial forces and coplanar forces and their reactions support, identify the difference between centriod, center of mass and gravity to determine them*
- *To estimate the thermal stress in a circular bar in normal and tapering diameters and their variations with temperature, determine poisons ratio, bulk modulus and elastic modulus on thick and thon cylinders.*
- *To understand about the properties of steam and its behavior at different pressures and specific volumes, the knowledge regarding the steam generators like boilers, their classification with accessories and mountings.*
- *The object is to impact about the drive systems, their classification according to their applications, maximum power transmitted by the belt drives, gears and bearings.*

COURSE OUTCOMES :

CO1 *: To understand the principle and applications of refrigeration and air-conditioning processes.*

CO2 *: To understand the working principle of IC engines and to analyze port-timing and valve timing diagram for four stroke engines.*

CO3 *: Ability to analyze various process cycles and to solve problems for various cycles.*

CO4 *: Understand the working principles of steam Boilers steam and gas Turbines.*

INTERNAL COMBUSTION (IC) ENGINE

Classification - working of four stroke and two stroke engines - Petrol and Diesel engines - Ignition systems - working of simple carburetor - cooling and lubrication systems - Testing of IC Engines - various efficiencies - Heat balance test. **(12)**

AIR POWER CYCLES AND JET PROPULSION

Otto cycles, Diesel cycle, Dual cycle, comparison. Mean Effective Pressure (MEP) - Brayton cycle - Simple problems, Turbo jet - thrust - thrust power - propulsion efficiency - Rocket propulsion **(9)**

GAS AND STEAM TURBINES

Open and closed cycle gas turbine system - practical gas turbines - Regeneration - Intercooling and Reheating - Simple Problems, Principle of impulse and reaction turbines - compounding of turbines - Simple problems. **(10)**

STEAM POWER CYCLE AND BOILERS

Ranking cycle, Properties of steam - steam tables and charts, Study of boilers - fire tube, water tube boilers- Mounting - Accessories. **(8)**

REFRIGERATION AND AIR CONDITIONING

Vapour compression refrigeration cycle on p-h diagram - COP - heat pump, Psychrometry - Air-Conditioning processes - application. **(6)**

Total : 45

TEXT BOOKS :

1. *Rudramoorthy. R, Thermal Engineering, Fifteenth Edition, Tata McGraw Hill, New Delhi, 2012.*
2. *Kothandaraman C.P., Domkundwar S., Engineering Thermodynamics , Second Edition, Dhanpath Rai and Sons, New Delhi, 2003.*

REFERENCE BOOKS :

1. *Rajput.R .K., Thermal Engineering, Ninenth Edition, Laxmi Publication Pvt. Ltd, New Delhi ,2013.*
2. *Ballaney.P.L., Thermal Engineering, Fifth Edition, Khanna publishers, New Delhi, 2010.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X						
CO2	X			X	X						
CO3	X		X						X		
CO4	X			X				X			X

13CH35 - ELECTRICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To learn how voltages and currents will be in each and every elements in the circuits for DC as well as AC excitations.*
- *To explain basic concepts of electrical machines with operation, control, testing and application.*
- *To understand the principle of operation and characteristics of all electronic devices and small signal analysis of transistors.*
- *To understand the working principle of various oscillators and electronic devices.*

COURSE OUTCOMES :

CO1 *: To understand the basic concepts and working principle of DC/AC circuits.*

CO2 *: To improve the ability analyzes performance of electrical machines in terms of efficiency and their utilizations in different applications.*

CO3 *: To know various electronic devices and their operations with their characteristics.*

CO4 *: To know the principles of operation of oscillator and electronic measuring devices.*

DC MACHINES AND TRANSFORMERS

DC Generator: Constructional details-EMF equations-types and characteristics-D.C motors: Principle of operation- torque equation-types and characteristics -speed control-applications.

Transformers: Construction and principle of operation -EMF equation -equivalent circuit -OC and SC test-regulation and efficiency-auto transformer. **(9)**

AC MACHINES

Alternator: types of construction-operation-EMF equation-regulation by load test-synchronous motor: Principles of operation-starting -applications.

Three phase induction motor: types of construction -principle of operation-torque-slip characteristics-speed control-applications. Single phase induction motor: Capacitor start and run, shaded pole induction motor-universal motor. **(9)**

INDUSTRIAL DRIVES AND CONTROL (Qualitative Treatment)

Characteristics of electric drives and loads-selection of motor rating-solid state DC drive-solid state AC drive (Qualitative treatment)-V/F control. Selection of drives for chemical industries: paper mills, process control industries, cement mills, printing press. **(9)**

INSTRUMENTATION

Strain gauges, linear variable differential transformers, piezo-electric transducers, digital displacement transducers, sound level meter, electromagnetic flow meters, thermocouples, thermistors, resistance potentiometers, capacitive transducers, speed measurement. **(9)**

MICRO CONTROLLERS

ARM: General block diagram- mbed nxp lpc1768-simple programs-Interfacing: Two segment LED, seven segment LED, LCD, stepper motor, push button operations-switching, swapping, rotating operations.

(9)

Total : 45

TEXT BOOKS :

1. *Mittle, V.N., Basic Electrical Engineering, Second Edition, Tata McGraw Hill, New Delhi, 2005.*
2. *D. P. Kothari, I. J. Nagrath, "Electrical Machines", Tata McGraw-Hill Education, New Delhi, 2004.*
3. *Dubey, G.K , Fundamentals of Electrical Drives, Second Edition, Narosa Publishing House, New Delhi, 2002.*
4. *Sawhney A.K, Puneet Sawhney, A Course in Electrical and Electronics Measurements, Eighteenth Edition, Dhanpat Rai and Sons, New Delhi, 2010.*

REFERENCE BOOKS :

1. *Singh, S.K, Industrial Instrumentation and Control, Third Edition, Tata McGraw Hill Publishers, New Delhi, 2009.*
2. *Steve B. Furber, Stephen B. Furber, ARM System-on-Chip Architecture, Second Edition, Addison Wesley Longman Limited, 2011.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X				X						
CO2	X			X	X						
CO3	X		X		X						
CO4	X		X		X		X				

13CH36 - CHEMICAL PROCESS CALCULATIONS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To be exposed to ideas in dimensional analysis and to be familiar with different unit systems and conversion from one set of system to another.*
- *To understand the various unit operations and unit processes performed in a Chemical industry.*
- *To understand the various ways of express the composition and behaviour of the three phases of the materials handled in a chemical industry.*
- *To learn fundamentals of stoichiometry apply the material balance concept and precisely calculate the amount of materials required to carry out the suitable unit operation or process.*
- *To be familiar with laws and rules governing enthalpies of systems associated with unit operations and processes in the manufacture of a chemical.*
- *To learn the application of the general energy balance equation and precisely calculate the energy requirements of the unit operation or process involved.*

COURSE OUTCOMES :

CO1 : *To calculate the composition of the materials*

CO2 : *To apply the various laws governing solid, liquid and gas phases.*

CO3 : *To perform material balance and precisely calculate the material required for various unit operations or processes in chemical engineering.*

CO4 : *To understand the unit conversion problems and different way of expressing the units.*

CO5 : *To perform Energy balance and precisely calculate the energy requirement for various unit operations or processes in chemical engineering.*

MATHEMATICAL PRINCIPLES

Units and dimensions: Basic and derived units - Different ways of expressing units and quantities, Graphical and Numerical methods of data fitting - Extrapolation and Interpolation techniques.

Conversion of units. Properties of pure substances - PVT behaviour - Ideal and Real gas laws. **(12)**

PROPERTIES OF MIXTURES AND SOLUTIONS

Mole fractions and partial pressures - Application of Dalton's, Amagat's, Henry's laws. Concept of Vapour pressure, Raoult's law and its applications, vapour pressure plots and effect of temperature on vapour pressure. **(12)**

MATERIAL BALANCE

Concept of limiting and excess reactants, Concepts of tie elements, recycle, by-pass and purge. Batch, stage wise and continuous operations. Material balance in systems without chemical reactions, Combustion Calculations. Material balance in systems with chemical reactions. **(12)**

ENERGY BALANCE

Definition of Heat capacity and Specific heat, Heat capacity of gases as a function of temperature, Mean heat capacity, heat capacity of mixture of gases. Heat capacities of solids and liquids - Kopp's rule and Trouton's rule. Standard heat of reaction, formation and combustion, Hess's law of heat summation and its application to determine heat of reaction, heat of neutralization, integral heat of solution, heat of mixing. Effect of pressure and temperature on heat of reaction. Theoretical and actual flame temperature in combustion calculations. **(12)**

HUMIDITY AND SATURATION

Definition of dry, wet bulb temperature - relative and percentage saturation, Dew point - humid heat, adiabatic saturation curve - Humidity Charts.

Solubility and Crystallization - Recovery of crystals from solutions by crystallization - Calculations based on material balance. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS :

1. *Bhatt, B.I. and Vora, S.M., Stoichiometry, Second Edition, Tata-McGraw Hill, New Delhi, 2004.*
2. *Narayanan. K.V. and Lakshmikutty.B., Stoichiometry and Process Calculations, First Edition, Prentice-Hall of India, New Delhi, 2006.*

REFERENCE BOOKS :

1. *David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Eighth Edition, Prentice -Hall of India, New Delhi, 2012.*
2. *Hougen, O.A., Watson, R.M. and Ragatz, R.A., Chemical Process Principles - Part I, Second Edition, John Wiley (ISE), 1976.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X				X	X		X
CO2	X		X	X							X
CO3	X		X		X			X	X		X
CO4	X		X		X				X		X

13CH41 - MATHEMATICS IV

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To incorporate the basic Numerical methods required for solving engineering problems.*
- *To study the basic statistical ideas that is imperative for effective understanding of engineering subjects.*
- *The topics introduced will serve as basic tools for specialized studies in many engineering fields.*

COURSE OUTCOMES :

CO1 *: The students will be familiar in applying Numerical methods for solving the system of algebraic equations, Ordinary differential equations and Partial differential equations.*

CO2 *: They will also be familiar in two dimensional random variables and curve fitting and sampling theory.*

CO3 *: To understand the Z-Transform ideas to analyze and solve communication oriented problems.*

NUMERICAL METHODS-I

Linear simultaneous equations: Gauss elimination method-Gauss Jordan method- Crout's method -Gauss Seidal method-Relaxation method.

Ordinary differential equations: Taylor s series-Modified Euler's-Runge-kutta fourth order methods - Milne's Predictor-Corrector method. **(12)**

NUMERICAL METHODS-II

Finite difference approximations-solution of PDE-Laplace equation-Liebmann's iteration process-Poisson equation-Parabolic equations -Bender Schmidt and Crank -Nicholson methods-Hyperbolic equation. **(12)**

TWO DIMENSIONAL RANDOM VARIABLES

Probability mass function - Probability distribution function - Cumulative distribution function - Marginal probability functions - Conditional distribution - Expectation of two dimensional random variables - Covariance - Correlation - regression - curve fitting - least square technique - only curve of the form or reducible to the form $y = ax + b$ or $y = ax^2 + bx + c$ **(12)**

SAMPLING THEORY

Elements of sampling - Large sample - Test for mean - proportion - standard deviation. Small sample test - t , F and Chi - square tests - Contingency table -Test for independence. **(12)**

Z -TRANSFORMS

Definition and properties - in verse Z transforms - initial and final value Theorems - Convolution - Solution of difference equations with constant coefficients. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Kandasamy .P, Thilagavathy.K and Gunavathy.K, Numerical methods, Twelfth Edition, S. Chand and Co Ltd., New Delhi, 2010.*
2. *Kandasamy.P, Probability Random variables and Random Processes, S Chand and Company 2008.*
3. *Veerarajan .T, Engineering Mathematics: For III Semester (Ascent series), Third Edition Tata McGraw-Hill Publishing Company Limited, 2008.*
4. *Veerarajan.T, Probability Statistics and Random Process, Third edition, Tata McGraw Hill Publishing Company Limited, 2007*

REFERENCE BOOKS

1. *Kapur.J.N, Saxena. H.C, Mathematical Statistics, Twelfth Edition, S Chand and Company 2005.*
2. *Grewal B.S, Higher Engineering Mathematics, Forty Second Edition, Khanna Publishers, 2013.*
3. *Grewal B.S, Numerical Methods in Science and Engineering, Fortieth Edition, Khanna Publishers, New Delhi, 2007.*
4. *Venkataraman.M.K, Numerical Methods in Science and Engineering, Fifth Edition, National Publishing Company, 2008.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X		X					X
CO2	X				X			X			X
CO3	X		X		X						X

13CH42 - PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To impart the basic knowledge on different theories of chemical reaction.*
- *To expose the students to understand the basic concepts of different isotherms and surface theories.*

COURSE OUTCOMES :

CO1 *: The students will be able to understand all the basic laws and equations involved in any type of chemical reactions*

PHASE EQUILIBRIA AND PHASE RULE

Phase rule and its applications to one component system (water, sulphur and carbon dioxide). Two component solid - solid (Eutectic, and Compound formation) and Liquid - Liquid systems. Simple three component systems. Interpretation of phase diagrams. Thermal analysis. Nernst distribution law. Partition coefficient principles. Thermodynamics of ideal solutions - Raoult's law. **(10)**

SURFACE CHEMISTRY

Solid - Gas interface - Langmuir and BET Isotherms. Surface area of solids. Adsorption from solutions. Gibb's equation. Freundlich isotherm. Surface activity of solids - role of chemisorption in heterogeneous catalysis. **(8)**

PHOTOCHEMISTRY

Elinstein's law of photochemical equivalence - photochemical reactions - Examples - decomposition of hydrogen iodide - Reaction between hydrogen and chlorine - Quantum efficiency - photosensitization, fluorescence, phosphorescence and chemiluminescence. **(7)**

CHEMICAL KINETICS

Rate of chemical reactions. Determination of order and molecularity of a reaction. Calculation of rate constants. Theories of reaction rates. Consecutive, Parallel and opposing reactions - reactions in solutions - catalysis - homogeneous and heterogeneous catalysis, enzyme catalysis, applications of catalysis. **(10)**

THERMODYNAMICS

Thermodynamic functions-their significance and interdependence-partial molar properties-chemical potential-Gibb's Duhem equation. Kirchoff's equation - C as a function of temperature - Bond energies-Maxwell's relation, Joule Thomson Coefficient. Thermodynamic criteria of spontaneity and equilibrium - Gibbs Helmholtz equation - Vant Hoff's isotherm and isochore equation, Clausius - Clapeyron equation. Third law of Thermodynamics - Nernst heat theorem - applications of third law. **(10)**

Total : 45

TEXT BOOKS

1. *Puri .B.R., Sharma. L.R., Pathania M.S., Elements of Physical Chemistry, Second Edition, Vishal Publishing company, Jalandhar, 2008*
2. *Peter Atkins, Julio De Paula, Atkins' Physical Chemistry, Ninth Edition, Oxford University Press, London, 2011.*
3. *Bahl.B.S., Tuli. G.D., Arun Bahl, Essentials of Physical Chemistry, S Chand Publisher, New Delhi 2009.*

REFERENCE BOOKS

1. *Soni .P.L., Charmarha.O.P, Dash.U.N, Textbook of Physical Chemistry, Twenty Second Edition, S.Chand and Sons, New Delhi, 2006.*
2. *Raj.G Advanced Physical Chemistry, Twenty Seventh Edition, Goel Publishing Company, New Delhi, 2011.*
3. *Kundu.M, Jain. S.K., Physical Chemistry, S Chand and Sons, New Delhi, 2004.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X								X

13CH43 - CHEMICAL PROCESS INDUSTRIES - I

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To Know various inorganic chemical manufacturing processes.*
- *To provide the knowledge of important unit operations of some major inorganic chemical processes.*
- *To understand problem solving in chemical processes.*
- *To learn how to analyze and evaluate complex industrial processes.*

COURSE OUTCOMES :

CO1 *: To demonstrate basic knowledge of chemical concepts and skills in handling chemical materials and equipment.*

CO2 *: To demonstrate conceptual knowledge and laboratory proficiency in the area of chemical analysis.*

CO3 *: To demonstrate proficiency in the use of analytical instrumentation generally found in the chemical industry.*

CO4 *: To exercise safety in the laboratory and adhere to safety, health and environmental regulation.*

WATER, SALT AND SULPHUR BASED INDUSTRIES

Sources and uses of water. Requisites of water for various purposes. Water treatment methods - Lime-Soda, Zeolite and Ion - exchange methods. Methods of obtaining fresh water from sea water. Salt, Sodium carbonate, salt cake, hydrochloric acid, sodium hydroxide, chlorine, bleaching powder, hypochlorites and chlorates. Manufacture of Sulphur and Sulphuric acid. Materials for handling, storage and transportation. **(11)**

INDUSTRIAL GASES, NITROGEN AND PHOSPHOROUS BASED INDUSTRIES

Oxygen, Nitrogen, Carbon dioxide, Acetylene and Synthesis gas. Ammonia, Nitric acid, Ammonium nitrate, Ammonium sulphate and Urea. Phosphorus, Phosphoric acid, Calcium phosphates, Ammonium phosphates, Sodium phosphates, Nitrophosphate and Phosphate esters. Mixed fertilizers (NPK Mixtures). Materials for handling, storage and transportation. **(9)**

PAINTS AND VARNISHES - CONSTITUENTS

Manufacture of paints and paint mixing process. Manufacture of White lead, Zinc oxide, Lithopone and Titanium dioxide. Manufacture of varnishes and Lacquers. Materials for handling, storage and transportation. **(9)**

CEMENT, LIME AND CERAMIC INDUSTRIES

Types of cements, their properties and applications. Manufacture of Portland cement. Production of Hydrated lime. Raw materials for Glass and Ceramic Industries. Production of glass by tank furnace - shaping and forming of articles from glass. Manufacture of optical glass, coloured glass, and safety glass and Pyrex glass. Manufacture of porcelain, enamel and chemical stoneware. Materials for handling, storage and transportation. **(9)**

REFRACTORY MATERIALS

Refractories -Properties, manufacture and varieties - Fire clay brick, Silica brick, High alumina refractories, Basic refractories, Forsterite, Magnesia refractories, Insulating brick, Silicon carbide and Electrocast refractories. **(7)**

Total : 45

TEXT BOOKS

1. *Gopala Rao M., Marshall Sittig, Dryden's Outlines of Chemical Technology-For 21st Century, Third Edition, EWP-East-West Press, New Delhi, 2010.*
2. *George T. Austin, Shreve's Chemical Process Industries, Fifth Edition, McGraw Hill (ISE), 2012.*
3. *Pandey. G.N, A Text Book of Chemical Technology, Vol. II, Second Edition, Vikas Publishing House Pvt.Ltd, New Delhi, 2000.*

REFERENCE BOOKS

1. *Venkateswaralu. D., Upadrashta. K.R., Chandrasekaran.K.D., CHEMTECH - I, S. Chand, New Delhi, 1975*
2. *CHEMTECH - II, Chemical Engineering Education Development Centre, I.I.T., Madras, 1977.*
3. *Kent. A.J., Riegel's Handbook of Industrial Chemistry, Van Nostrand - Reinhold, New York, 1992.*
4. *Stephenson. R.M, Introduction to Chemical Process Industries, Van Nostrand, New Jersy, 1966.*
5. *Furnas. C.C., Roger's Manual of Industrial Chemistry, Vol. I, Sixth Edition, Van Nostrand, New Jersy, 1942.*
6. *Lowenheim. F.A., Moran. M.K., Faith, Keyes and Clark's INDUSTRIAL CHEMICALS, Fourth Edition, John Wiley, New York, 1975.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X	X							X
CO2	X						X				X
CO3	X		X					X			
CO4	X					X	X				

13CH44 - FLUID MECHANICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To introduce basics of fluid mechanics*
- *To provide basis for mass, momentum and energy balances*
- *To provide an understanding of fluid statics, principles of fluid motion and flow measurements*
- *To understand dimensional analysis and similitude, analysis of pipe flow*

COURSE OUTCOMES :

CO1 : *Understands the basic terms and concepts of fluid mechanics*

CO2 : *Understands basis of mass, momentum and energy balances.*

CO3 : *Students will be able to explain about fluid statics, fluid motion and flow measurements.*

CO4 : *Students will be able to explain dimensional analysis and similitude, analysis of pipe flow and solve problems based on it.*

BASIC CONCEPTS

Definition of a fluid - Shear stress in a moving fluid - difference between liquids and gases -compressible and incompressible fluids - Newtonian and non- newtonian fluids - continuum concept of a fluid - properties of fluids - viscosity - compressibility - bulk modulus. Dimensional analysis and its applications in fluid flow. Statics of fluid systems-pressure - variation of pressure vertically in a fluid under gravity -General equation for the variation of pressure due to gravity in a static fluid - manometers: U-tube, differential and inclined manometers **(11)**

FLUID DYNAMICS

Fluid flow - basic concepts - Reynolds experiment - laminar and turbulent flows - nature of turbulence. Basic concepts of Boundary layer. Equation of continuity and its applications -momentum equations - Euler's equation of motion -Bernoulli's theorem and its applications. **(9)**

INCOMPRESSIBLE FLUID FLOW

Flow in conduits -Shear stress distribution in a cylindrical tube -Friction factor-Fanning's equation - Applications -Laminar flow in pipes -Hagen Poiseuille equation -Velocity distribution for laminar and turbulent flows -Losses due to sudden expansion and sudden contraction -Losses in pipe fittings **(9)**

FLUIDISED AND PACKED BEDS

Flow through packed beds - Ergun equation and kozney - Carman equation. Equation for one dimensional motion - Fluidisation-Mechanism of fluidisation - Types of fluidisation-Pressure drop in fluidised beds - Minimum fluidisation velocity. **(8)**

HYDRAULIC PUMPS AND PIPE FITTINGS

Pipes, Fittings and valves - Pumps, Fans, Compressors and Blowers - Positive displacement pumps - Centrifugal pumps - NPSH and cavitation - Pump calculations - Constant and variable head flow meters **(8)**

Total : 45

TEXT BOOKS

1. *McCabe. W.L., Smith. J C., Harriot. P., Unit operations of Chemical Engineering, McGraw Hill, Seventh Edition, 2005*
2. *Douglas.J.F., Gasiorek. J.M., Swaffield. J.A., Fluid Mechanics, Prentice Hall, Fourth Edition, 2000.*

REFERENCE BOOKS

1. *Hughes. F., John A Brighton and Nicholas Winowich, Schaum's Outline of Fluid Dynamics, McGraw-Hill; Third Edition, 1999.*
2. *Ranald.V.Giles, Cheng Liu and Jack Evett, Schaum's outline of Fluid Mechanics and Hydraulics, McGraw-Hill, Third Edition 2009.*
3. *Sulzer Pumps, Centrifugal pump Handbook, Butterworth - Heinemann, Third edition, 2010.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X							X
CO2	X		X	X							X
CO3	X		X		X						
CO4	X		X		X						X

13CH45 - MECHANICAL OPERATIONS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide knowledge on properties of solids, handling, screen analysis and its equipment about transportation and storage of solids.*
- *To provide the fundamentals of the size reduction techniques and its equipment*
- *To provide basic knowledge on mixers and agitators required in chemical process industries*
- *To provide the necessary tools to obtain quantitative solutions for filtration and learn the different types of filtration equipment.*

COURSE OUTCOMES :

CO1 *: Understand the properties of solids and analyses the best screening equipment necessary in chemical industries.*

CO2 *: Understand different types of size reduction principles and various types of equipment used in it.*

CO3 *: Identify the best mixers and agitators in a chemical industry depending on their specific requirements. Identify the best suitable filtration equipment and design of the filter equipment.*

PROPERTIES OF PARTICULATE SOLID AND SIZE REDUCTION

Forces employed for size reduction of solids. Types of crushers, grinders and disintegrators for coarse, intermediate, fine and ultrafine grinding. Cutting machines. Size reduction operation - Power requirements - Laws of comminution. Open and closed circuit grinding. Industrial applications of Size reduction equipments. Shape factor of particulate solids. Standard sieves and sieve scales. Differential and cumulative analysis - Plotting of sieve analysis data. Specific surface determination - Calculation of particle size from sieve analysis data. Size distribution of fine particles. Industrial screening equipments. Screen effectiveness. **(12)**

TRANSPORTATION, STORAGE AND RECOVERY OF FINE PARTICLES

Mechanical and pneumatic conveying equipments. Storage of solids - Angle of repose and angle of internal friction. Pressures in bins - Janssen equation. Gas cleaning methods - Cyclone separators, Bag filters, Scrubbers and electrostatic precipitators. Dense Media Separation (DMS), Flotation process - Separation by Magnetic and Impingement methods. **(12)**

MIXING AND AGITATION

Types of Mixers and mixing equipments for liquids, pastes, rubber and plastic materials and for dry powders. Power consumption in mixers. Criteria for mixing of Solids - Mixing Index. Scale up of agitator design. **(12)**

SIZE SEPARTION BY SETTLING AND SEDIMENTATION METHODS

Drag on spherical and non-spherical particles, Terminal settling velocity under laminar and turbulent conditions (Stokes' law and Newton's law). Size separation by settling methods - Free settling and

Hindered settling. Equipments - Settling chambers, classifiers, jigging and Tabling. Theory of Sedimentation. Types of Thickeners - Batch and Continuous. Applications of batch sedimentation tests for design of continuous thickeners. **(12)**

FILTRATION AND CENTRIFUGAL SEPARATION

Batch and continuous filtration equipments. Theories of filtration and washing. Compressibility of filter cakes. Filter media and Filter aids. Industrial filtration practice. Centrifugal filtration, Centrifugal settling, Centrifugal sedimentation and centrifugal clarification. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *McCabe. W. L., Smith. J. C., Harriot. P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw-Hill, New York, 2005.*
2. *Badger. W.L., Banchero. J.T., Introduction to Chemical Engineering, McGraw Hill (ISE), 1997.*

REFERENCE BOOKS

1. *Perry. R. H., Green. D. W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw-Hill, New York, 2007.*
2. *Narayanan. C.M., Bhattacharyya. B.C., Mechanical Operation for Chemical Engineers (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 2005.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X				X				X		X
CO2	X						X				X
CO3	X			X	X			X			X
CO4	X		X	X							X

13CH46 - PROCESS INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The main objective of this subject is to present the basic Measuring Instrument used in the Chemical process industries.*
- *To deliver widened spectrum of Chemical Engineering knowledge in various measuring instruments usually used in plants for Temperature, Pressure, Flow level, and other Miscellaneous Measurements.*

COURSE OUTCOMES :

CO1 *: The Students would have the Confident in knowing the principles and theory behind the various instrumentation parts very useful in Chemical Engineering plants in the area of Temperature Measurement, Pressure Measurement, Level Measurement, and Viscosity and also they would give exposure in P and I Diagrams.*

PRINCIPES OF MEASUREMENT

Analysis : Measurement of Force, Strain and Torque- Use of strain gauges. Transducers - Resistive, capacitive, Inductive and piezoelectric pickups. Static and Dynamic response of Instruments. Errors in measurements. **(9)**

TEMPERATURE MEASUREMENT

Liquid filled, Gas filled and Vapour pressure Thermometers. Bimetallic and Resistance thermometers. Thermocouples and Thermistors. Optical and Radiation pyrometers. **(9)**

PRESSURE MEASUREMENT

Manometers, Bourdon gauge and Bellows gauge. Measurement of pressure and Vacuum. Use of Transducers. **(9)**

FLOW, DENSITY AND LEVEL MEASUREMENTS

Variable head flow meters. Area flow meters. Positive displacement meters. Pressure Probes. Level measurements - Direct and Inertial types. Measurement of density and specific gravity. Instruments for weighing and feeding. **(9)**

MISCELLANEOUS MEASUREMENTS

Analysis of gas mixtures. Thermal conductivity, Viscosity and Electrical conductivity. Supporting instrumentation - Standard cells, Balancing circuits and Terminating devices. Principles of Telemetering. P and I diagrams. **(9)**

Total : 45

TEXT BOOKS

1. *Eckman, D.P, Industrial Instrumentation, Wiley Eastern, New Delhi, 2006.*
2. *Jain, R.K, Mechanical and Industrial Measurements, Ninth Edition Khanna Publishers, New Delhi 2011.*

REFERENCE BOOKS

1. *Perry, R.H., Green, D.W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw Hill (ISE), 2007.*
2. *Considine, D.N., Process Instruments and Controls Handbook, Third Edition, McGraw Hill. New York, 1997.*
3. *Benedict, R.P, Fundamentals of temperature, Pressure and Flow measurements, Third Edition, John Wiley, New York. 1984.*
4. *Notlingk. B.E., Jones' Instrument Technology, Vol. I and II, Fourth Edition, ELBS, 1987.*
5. *Patranabis. D., Principles of Instrumentation, Second Edition, Tata-McGraw Hill, New Delhi, 2007.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X					X			

13CH47 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
2	0	0	2

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To inculcate among students the need for creative thinking and personality development.*
- *To acquire knowledge about evolution of the Universe and evolution of living beings.*
- *To understand the benefits of yoga and introspection for better living.*
- *To understand about human values, value of time, developing self confidence and team work spirit.*
- *To acquire knowledge about professional ethics and responsibility for career growth in National and Multinational Companies.*

COURSE OUTCOMES :

CO1 *: An understanding about the need for creative thinking and personality development.*

CO2 *: Knowledge about evolution of Universe and evolution of living beings.*

CO3 *: An understanding of benefits of yoga and introspection for better living.*

CO4 *: An understanding of human values, value of time, self confidence and team work spirit.*

CO5 *: Knowledge about professional ethics and responsibility for career growth in National and Multinational Companies.*

LIFE FORCE, MIND AND CONCIOUSNESS

Science of Creativity and Personality Development - Objectives - Principles of Karma Yoga - Duty Consciousness - Communism and Capitalism - Law of Nature - Life Force - Origin - Potentiality of the Life Force - Primordial State - Wave Theory - Consciousness - Pancha Thanmatras - Secret of Revelations - Mind - Biomagnetism - Physical Transformation of Biomagnetism - Attachment, Detachment and Moderation in Enjoyment. **(9)**

EVOLUTION OF THE UNIVERSE AND LIVING BEINGS

Evolution of the Universe: Creation Theory - Evolution Theory - Theory of Permanence - Theory of Mithya - Big-Bang Theory - Evolution of Living Beings: Absolute Space and Force - Plants Experience Pain - Two Eyes and Two Ears - Seven Constituent Layers in the Body - Totality and Man - Six Temperaments - Realization of Truth - Space is The Almighty - Science and Spiritualism. **(9)**

YOGA AND INTROSPECTION

Simple and Safe Yoga - Physical Exercise - Meditation - Seven Centres of Meditation - Benefits - Effect of Good Vibrations - Cause and Effect System - Imaginary Expectations - Harmony in Life: Self, Family, Society and Nature - Introspection: Analysis of Thought, Moralization of Desire, Neutralization of Anger, Eradication of Worries and Self Realization. **(9)**

HUMAN VALUES

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Virtues - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - Commitment- Empathy - Self Confidence - Challenges in Work Place - Cyberspace - Impact of Cyberspace on Individuals. **(9)**

ENGINEERING ETHICS, RESPONSIBILITIES AND RIGHTS

Senses of Engineering Ethics - Moral Issues - Inquiries - Moral Dilemma - Moral Autonomy - Profession and Responsible Professionalism - Social Responsibility - Collegiality, Loyalty and Confidentiality - Human and Employee Rights - Intellectual Property Rights. **(9)**

Total : 45

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications, 4th Edition, 2009.*
2. *R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011.*

REFERENCES

1. *Sadhguru, "Body the Greatest Gadget and Mind is your Business", Diamond Pocket Books Pvt. Ltd, Isha Foundations, 2013.*
2. *Swami Vivekananda and Swami Nikhilananda, "Karma Yoga and Bhakti Yoga", 2nd Edition, Ramakrishna Vivekananda Publications, 2008.*
3. *Henry Dreyfuss, "The Measure of Man and Woman: Human Factors in Design", John Wiley and Sons Publications, 2012.*
4. *Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", 4th Edition McGraw Hill, NewYork, 2005.*
5. *M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 1st Edition, Prentice Hall of India, 2009.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1							X			X	
CO2							X		X	X	
CO3							X			X	
CO4				X			X		X	X	
CO5					X		X			X	

13CH48A - ORGANIC CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *To instill students with an appreciation of knowledge in various organic compounds to solve practical problems.*

COURSE OUTCOMES :

CO1 *: Student is able to detect elements, functional groups and structure of unknown organic compound.*

CO2 *: Student acquires knowledge which is useful in preparation of different organic compounds.*

EXPERIMENTS

Preparation of Organic Compounds

- Preparation of Acetanilide from Aniline
- Preparation of Benzoic acid from Ethyl benzoate
- Preparation of Salicylic acid from Methyl salicylate
- Preparation of Sym. Tribromoaniline from Aniline
- Preparation of Nitrobenzene from Benzene
- Preparation of m - Dinitrobenzene from Nitrobenzene
- Preparation of Benzoic acid from Benzaldehyde
- Preparation of Benzanilide from Aniline
- Preparation of Phthalimide from Phthalic acid
- Preparation of Aspirin from Salicyclic acid.

Qualitative analysis of simple organic substances with one and two functional groups only

- Aldehydes and Ketones
- Amides and Imides
- Amines
- Carbohydrates
- Carboxylic acids
- Esters
- Nitrocompounds
- Phenols.

Total : 45

TEXT BOOKS

1. *Venkateshwaran.V., Veeraswamy.R., Kulandaivelu.A.R., Basic Principles of Practical Chemistry, Second Edition, S. Chand and Sons, New Delhi. 2004.*

REFERENCE BOOKS

1. *Dey.B.B., Sitaraman.M.V., Govindachari.T.R., Laboratory Manual of Organic Chemistry, Fourth Edition, Allied Publishers, New Delhi, 1992.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X	X						X
CO2	X				X						X

13CH48B - PHYSICAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide knowledge in soap manufacturing, analysis and estimation*
- *To provide knowledge in oil (testing), analysis and estimation of glucose in sugar*
- *To provide knowledge in analysis of ores and alloys.*

COURSE OUTCOMES :

CO1 *: Student is able to purify a given organic compound*

EXPERIMENTS

- Determination of transition point of the given salt hydrate.
- Determination of partition coefficient of iodine between water and Carbon tetrachloride
- Determination of association factor of benzoic acid between benzene and water
- Determination of equilibrium constant for the triiodide formation by partition method.
- Determination of heat of neutralization of hydrochloric acid and sodium hydroxide.
- Determination of heat of solution of ammonium chloride, ammonium nitrate and potassium nitrate.
- Determination of specific rate constant for the reaction between potassium persulphate and potassium iodide.
- Determination of velocity constant of acid hydrolysis of methyl acetate.
- Determination of CST for phenol-water system.
- Study of effect of impurity on CST of phenol water system.
- Construction of binodal curve for water, nitrobenzene, and acetic acid.
- Determination of the strength of an acid by conductometric method.
- Determination of the strength of ferrous sulphate potentiometrically.
- Determination of Freundlich and Langmuir adsorption isotherms of acetic acid in aqueous solution by activated charcoal.

Total : 45

TEXT BOOKS

1. *Puri .B.R., Sharma. L.R., Pathania M.S., Elements of Physical Chemistry, Second Edition, Vishal Publishing company, Jalandhar, 2008*

REFERENCE BOOKS :

1. *Bahl.B.S., Tuli. G.D., Arun Bahl, Essentials of Physical Chemistry, S Chand Publisher, New Delhi 2009.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X			X	X			

13CH49A - ELECTRICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To make the students to understand the various electrical connections.*
- *To study the basic power calculations and calibrations of basic electrical devices.*

COURSE OUTCOMES :

CO1 *: The students understanding on usage of ammeter, voltmeter and other calibration techniques would be enhanced.*

EXPERIMENTS

- Calibration of Ammeter, Voltmeter and Wattmeter
- Calibration of Single Phase Energy meter
- Swinburne's Test
- No load Speed Control of DC Shunt Motor
- Open Circuit Characteristics of a separately excited DC generator
- Critical speed of DC shunt generator
- Load Test on DC shunt Motor
- Load Test on DC shunt Generator
- Open circuit and short circuit test on single phase Transformer
- Predetermination of efficiency and regulation characteristics of single phase transformer
- Load test on single phase transformer
- Load test on three phase squirrel cage induction motor
- Load test on slip ring induction motor
- Load test on single phase capacitor start induction motor
- Load test on single phase Alternator
- Study of capacitive transducers
- Study of inductive transducers
- Speed torque characteristics of single phase Fan motor
- Simple programs in ARM
- Interfacing programs in ARM.

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X	X			X			

13CH49B - MECHANICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To impart the basic knowledge on mechanical engineering operations.*
- *To learn the efficiency calculations of different engines.*

COURSE OUTCOMES :

CO1 *: The students understood how diesel engine, petrol engine and other mechanical devices works through performance analysis study.*

EXPERIMENTS

- Viscosity of lubrication oil by Say Bolt Universal viscometer.
- Viscosity of lubrication oil by Red Wood viscometer.
- Flash and Fire point test by open cup Cleveland apparatus.
- Flash and Fire point test by Pensky- Martin apparatus.
- Calibration of pressure and vacuum gauges.
- Load test on Kirloskar Engine.
- Port timing diagram on Two-Stroke Engine.
- Valve timing diagram on Four-Stroke Engine.
- Volumetric efficiency of reciprocating compressor.
- Heat balance test on Field Marshal Engine.
- Economic speed test on DPF Engine.
- Performance of Stefan-Boltzmann Constant.
- Calorific valve by Junker's Gas Calorimeter.
- Study of Internal Combustion (IC) Engine and Boiler.
- Performance test on vapour compression refrigeration system.
- Performance test on Heat Pump.
- Study of air- conditioning system test rig.

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X	X						

13CH51 - CHEMICAL PROCESS INDUSTRIES - II

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To make the students appreciate the fundamental principles and concepts of chemistry to solve practical problems.*
- *To provide students with the fundamental aspects of chemical process technology and professional knowledge in selected areas of chemical technology.*
- *To develop students' appreciation of the environmental, techno-economics and management problems associated with the chemical industry.*
- *To induce the development of students' independent, analytical and creative thinking.*

COURSE OUTCOMES :

CO1 : *Students will be able to demonstrate knowledge and understanding on fundamental principles of chemistry and chemical technology and on contemporary applications.*

CO2 : *Students will be able to design and conduct experiments, as well as critically analyze and interpret experiment results.*

CO3 : *Students will be able to identify, formulate and solve problems in chemical technology and related fields.*

CO4 : *Students will be able to specify, modify and design a component, processor system to meet the needs of trade.*

OIL AND ALLIED INDUSTRIES

Vegetable oil extraction methods. Refining of vegetable oils. Hydrogenation of Oils. Soaps, Candle, Detergents and Glycerine. Materials for handling, storage and transportation. **(9)**

CARBOHYDRATES AND FERMENTATION INDUSTRIES

Manufacture of Starch, Dextrin, Glucose and sucrose. Manufacture of Ethyl alcohol, Acetic acid and Vinegar, Citric acid, Oxalic acid and Antibiotics (Penicillin). Materials for handling, storage and transportation. **(9)**

PULP AND LEATHER INDUSTRIES

Production of Pulp. Conversion to paper. Production of Viscose, Acetate and Cuprammonium rayons and Cellulose acetate. Production of Dimethyl sulphite and Dimethyl sulphoxide from wood liquor. Manufacture of leather from hides and skins. Manufacture of Glue and Gelatin. Materials for handling, storage and transportation. **(9)**

PETROCHEMICAL INDUSTRIES

Manufacture of the following chemicals from petroleum sources only: Methanol, Formaldehyde, Chloromethanes, Freons, Trichloro-ethylene, Vinyl chloride, Ethylene oxide, Acetone, Acrylonitrile, Isoprene and Phenol. Materials for handling, storage and transportation. **(7)**

RUBBER, PLASTICS AND DYE INDUSTRIES

Natural and synthetic rubbers. Rubber processing. Manufacture of Styrene - Butadiene rubbers (SBR). Outline of polymerization process. Manufacture of Polyethylene, PVC, Polystyrene and Co-polymers, Nylon, Perspex, Teflon, Phenolic resins and Fibre Reinforced Plastics (FRP). Constituent of dyes - cause of colour. Classification and Testing. Manufacture of Azodyes (Chrome Blue Black I) and Indigo only. Materials for handling, storage and transportation. **(11)**

Total : 45

TEXT BOOKS

1. *Gopala Rao, M., Marshall Sittig. Dryden's Outlines of Chemical Technology- For 21 century, Third Edition, Affiliated East-West Press, New Delhi, 2004.*
2. *Austin.G.T., Shreve's Chemical Process Industries, Fifth Edition, McGraw Hill International Student Edition, 1984.*
3. *Pandey, G.N., A Text Book of Chemical Technology, Vol.2, Vikas Publishing House Pvt. Ltd, New Delhi,1994.*

REFERENCE BOOKS

1. *CHEMTECH - III, Chemical Engineering Education Development Centre, I.I.T., Madras, 1977.*
2. *CHEMTECH - IV, Chemical Engineering Education Development Centre, I.I.T., Madras, 1979.*
3. *Kent A.J., Riegel's Handbook of Industrial Chemistry, Van Nostrand - Reinhold, New York, 1974.*
4. *Stephenson R.M., Introduction to Chemical Process Industries, Van Nostrand, New Jersy, 1966.*
5. *Furnas, C.C., Roger's Manual of Industrial Chemistry, Vol.2, Sixth Edition, Van Nostrand, New Jersy, 1942.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X					X			
CO2	X			X				X			
CO3	X		X	X	X						
CO4	X			X							X

13CH52 - CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the first law of thermodynamics.*
- *To learn how to obtain or to estimate the thermal and volumetric properties of real fluids, the limitations imposed by the second law of thermodynamics on the conversion of heat to work.*
- *To learn chemical reaction thermodynamics and its application to homogenous and heterogeneous chemical reactions with multiple components.*
- *To learn the applications of energy balances in the analysis of batch, flow, and cyclical processes, including power cycles, refrigeration.*

COURSE OUTCOMES :

CO1 *: Students will be able to understand the role and relevance of Chemical Engineering Thermodynamics.*

CO2 *: Students will be able to Understand and analyze processes such as isothermal*

CO3 *: Students will be able to explain the property relation of homogeneous phases*

CO4 *: Students will be able to understand and Analyze steam power cycles; refrigeration cycles*

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. PVT behaviour gases. Equation of state. Entropy change in reversible and irreversible process, Internal energy and entropy as a function of Temperature and pressure **(10)**

THERMODYNAMIC PROPERTIES

Thermodynamics relations, Maxwell relations. Fugacity and fugacity coefficients. Estimation of thermodynamic properties. Types of thermodynamic diagrams. **(14)**

PHASE EQUILIBRIA AND VAPOUR LIQUID EQUILIBRIA

Phase equilibria - Activity and activity coefficients. Gibbs-Duhem equations. Van laar, Margules equation. Consistency test. Prediction of VLE. **(12)**

CHEMICAL REACTION EQUILIBRIA

Criteria of equilibrium. Standard free energy change and equilibrium constants. Effect of temperature. Evaluation of equilibrium constants. **(12)**

APPLICATION OF LAWS OF THERMODYNAMICS

Compression and expansion of fluids. Theory of multistage compression. Refrigeration principles and applications. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOK

1. *Smith J.M., Van Ness H.C., Abbott M.M., Introduction to Chemical Engineering Thermodynamics, Seventh Edition, Tata McGraw Hill International Student Edition, 2007.*

REFERENCE BOOKS

1. *Dodge, B.F., Chemical Engineering Thermodynamics, McGraw Hill International Student Edition, 1960.*
2. *Sandler, S.I., Chemical and Engineering Thermodynamics, Second Edition, John Wiley International Student Edition, 1989.*
3. *Rao .Y.V.C., Chemical Engineering Thermodynamics, united press (India) ltd.1997.*
4. *Narayanan K.V., A Text Book of Chemical Engineering Thermodynamics, Prentice- Hall Of India Private Limited, New Delhi,2001.*
5. *Merle Potter , Craig Somerton., Schaum's outline of Thermodynamics for Engineers, Second Edition, McGraw Hill ,2009*
6. *Hendrick.C.Vanness, Michael M.Abbott., Schaum's outline of Thermodynamics with Chemical Applications, McGraw Hill Professional, 1989.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X						X
CO2	X		X	X				X			
CO3	X			X	X						X
CO4	X		X	X		X					

13CH53 - HEAT TRANSFER

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

To introduce basic modes of heat transfer and its role for various heat transfer applications.

- *To introduce the physics of thermal conduction in solids and composites such as insulation and define thermal conduction resistance*
- *To learn the Basic concepts of convection and radiation mechanisms.*
- *To learn both the LMTD and effectiveness-NTU methods of heat exchanger analysis.*
- *To present numerous and diverse real world engineering examples to give students a feel for how heat transfer is applied in engineering practice.*

COURSE OUTCOMES :

CO1 : *Understands the basic terms and concepts involved in heat transfer.*

CO2 : *Ability to determine resistances for conduction, radiation, and convection heat transfer, using the fundamental relationships and correlations.*

CO3 : *Ability to evaluate a fin or a fin array using fin performance parameters.*

CO4 : *Each student can use empirical correlations to analyze external and internal, forced and free convection problems.*

CO5 : *Ability to solve heat exchanger design problems by using LMTD and NTU-effectiveness method*

CONDUCTION

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, - Heat conduction through a series of resistances - Thermal conductivity measurement; effect of temperature on thermal conductivity; Heat transfer in extended surfaces. **(12)**

CONVECTION

Concepts of heat transfer by convection - Natural and forced convection, Analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, Correlations for the calculation of heat transfer coefficients, heat transfer coefficient for flow through a pipe, flow through a non circular conduit, flow past flat plate, flow through packed beds. Heat transfer by natural convection. **(12)**

HEAT EXCHANGERS

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors - Design of various types of heat exchangers and condensers. **(12)**

CONDENSATION AND BOILING

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling. **(12)**

EVAPORATION AND RADIATION

Theory of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation. Radiation heat transfer - Emissive power, Black body radiation, Emissivity, Stefen - Boltzman law, Planck's law, radiation between surfaces. **(12)**

Total : 45

TEXT BOOKS

1. *Binay K. Dutta., Heat Transfer: Principles and Applications, Fifth Printing, Prentice Hall of India Private Limited, 2006.*
2. *Holman, J. P., Heat Transfer, Eighth Edition, McGraw Hill, 1997.*

REFERENCE BOOKS

1. *McCabe W.L., Smith J.C., Harriott. P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.*
2. *Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1999.*
3. *Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol-1, Fourth Edition, Asian Books Private Limited, India, 1998.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X								X
CO2	X		X					X			X
CO3	X		X	X					X		
CO4	X		X	X							X
CO5	X	X	X						X		

13CH54 - MASS TRANSFER - I

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit the properties according to the changed environment.*
- *Shall be able to compute or determine the applicable diffusion and mass transfer coefficients for a given system.*
- *To explain the students with the basic principles of various mass transfer operations with examples.*
- *To describe and illustrate to the students the equipment used in operations involving mass transfer with their advantages and disadvantages.*

COURSE OUTCOMES :

CO1 : *Students will be capable of defining the basic principles of mass transfer operations and other separation processes.*

CO2 : *Ability to apply knowledge of maths and science to problems in mass transfer.*

CO3 : *Identify the major parts of various mass transfer equipment, conduct experiments and prepare tables and graphs that effectively present experimental results.*

CO4 : *Determine the size and cost of the mass transfer equipment.*

CO5 : *Able to select suitable type of cooling tower, dryer and crystallizer for specific applications.*

DIFFUSION IN FLUIDS

Molecular diffusion and eddy diffusion. Steady state molecular diffusion in fluids at rest and in laminar flow. Molecular diffusion in gases, steady state diffusion of gas A through non-diffusing gas B, steady state equimolal counter diffusion. Effective diffusivity, steady state diffusion in multicomponent mixtures. Measurement of diffusivity. Molecular diffusion in liquids. **(12)**

INTERPHASE MASS TRANSFER

Mass transfer coefficients, F and K type mass transfer coefficients, relation between mass transfer coefficients, Film theory, Penetration theory, Danckwerts surface renewal theory. Two film theory. Wetted wall towers. Concept of NTU and HTU. Equilibrium curve and operating line. Analogy between momentum, heat and mass transfer. **(14)**

HUMIDIFICATION

Humidification operation of air-water system. Psychometric chart. Methods of humidification and dehumidification. Lewis relation. Theory and principles of cooling towers. Types of cooling towers. **(12)**

DRYING

Theory and mechanism of drying. Batch drying, drying tests, drying curve, time of drying. Mechanism of moisture movement, drying rate during constant rate period, unsaturated surface drying, drying with internal diffusion. Continuous drying operations and equipment. Classification of dryers. Application of dryers in process industries. **(11)**

CRYSTALLIZATION

Factors governing nucleation and crystal growth, theory of crystallization. Batch and continuous crystallizers. Performance and applications of industrial crystallizers. **(11)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.*
2. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill International Student Edition, 1980.*

REFERENCE BOOKS

1. *Badger W.L., Banchero J.T., Introduction to Chemical Engineering, McGraw Hill International Student Edition, 1997.*
2. *Geankoplis C. J., Transport Processes and Unit Operations, Third Edition, Prentice Hall of India Private Limited, New Delhi, 2003.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X		X						X	X
CO2	X		X						X		X
CO3	X	X			X		X	X			
CO4	X					X		X	X		
CO5	X	X							X		X

13CH55 - ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide knowledge about air pollution standards, impacts assessment, analysis and various control methods.*
- *To provide knowledge about water pollutants standards, their effects, sampling methods and treatment methods.*
- *To provide knowledge about solid pollutants and their collection and disposal methods.*

COURSE OUTCOMES :

CO1 : *Understands the air pollution standards, impacts assessment, analysis and various control methods for air pollutants.*

CO2 : *Understands the water pollutants standards, their effects, sampling methods and treatment methods.*

CO3 : *Understands the solid pollutants and their collection and disposal methods.*

ENVIRONMENTAL POLLUTION: AN OVERVIEW

Impact of man on the environment, various cycles, effect of environment due to pollution, pollution of air, water and soil, classification and properties of air pollutants, various emission sources, photochemical smog, effects of air pollution on human health, vegetation, etc., Air pollution laws and standards. Impact Assessment and analysis. **(9)**

AIR POLLUTION - SAMPLING, MEASUREMENT AND CONTROL METHODS

Various types of sampling and measurements, analysis of air pollutants - SO_2, NO_2, CO and particulate matter etc. Various control methods, particulate emission control methods, gaseous emission control methods. **(9)**

WATER POLLUTION - SAMPLING AND ANALYSIS

Water resources, various types of water pollutants and their effects, waste water sampling. Grab sample and composite sample, various methods of analysis - BOD, COD, dissolved oxygen, TOC, determination of inorganic substance and water quality standards. **(9)**

WASTE WATER TREATMENT METHODS

Basic processes of water treatment - primary, secondary and advanced treatment methods. Water pollution in pulp and paper industries, food industries, petroleum, fertilizer and power generation industries. **(9)**

SOLID WASTE TREATMENT AND DISPOSAL METHODS

Sources and classification, public health aspects, methods of collection, disposal methods - nuclear waste disposal and solid waste disposal from other industries. **(9)**

Total : 45

TEXT BOOKS

1. *Rao, C.S, Environmental Pollution Control Engineering, Wiley Eastern, New Delhi, 1991.*
2. *Met Calf and Eddy., Waste Water Engineering, Treatment and Disposal, Tata McGraw Hill, New Delhi, 1987.*

REFERENCE BOOKS

1. *Pandey, G.N. and Carney, G.C, Environmental Engineering, Tata McGraw Hill, New Delhi, 1998.*
2. *Kapoor B.S., Environmental Engineering, Third Edition, Khanna Publishers, Delhi, 1989.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X						X	X
CO2	X		X	X						X	X
CO3									X	X	

13CH56 - INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *This course is intended to provide the students with the fundamental knowledge of various analytical techniques like UV, IR, NMR, and mass spectroscopic techniques and thermal methods like TGA and DTA.*

COURSE OUTCOMES :

CO1 *: After successful completion of course, the students shall be familiar with characterization of inorganic and organic molecules using spectroscopic and other instrumental methods and analytical skills*

UV SPECTROSCOPY AND NMR SPECTROSCOPY

UV SPECTROSCOPY

Characteristics of Electromagnetic radiations-Definition-wave length, wave number, frequency, energy. The absorption laws - theory of electronic spectroscopy - double beam spectrophotometer. Chromophore - Auxochrome - types of absorption bands - Absorption and intensity shifts - applications. **(5)**

NMR SPECTROSCOPY

Theory - number of signals - Instrumentation - chemical shift - factors influencing chemical shift - spin - spin coupling - applications. **(4)**

IR SPECTROSCOPY AND MASS SPECTROSCOPY

IR SPECTROSCOPY

Theory - vibrational frequency - number of fundamental vibrations - Hook's law - scanning of IR spectrum - applications. **(5)**

MASS SPECTROSCOPY

Basic principles - theory - instrumentation - Nitrogen rule - Molecular ion - McLafferty rearrangement - applications. **(4)**

SEPERATION METHODS

Principles of solvent extraction - extraction techniques - analytical applications. **(3)**

Principles of chromatography - different types - Thin layer, Column and Gas chromatography. **(4)**

Radio chemical methods - activation analysis - isotopic dilution methods. **(2)**

THERMAL METHODS AND ELECTROCHEMICAL METHOD

THERMAL METHODS

Thermogravimetry - factors influencing the thermogram - TGA instrument - applications of TGA - DTA - definition - instrumentation - thermal analysis of calcium oxalate monohydrate and calcium acetate monohydrate - applications of DTA. **(4)**

FLUORIMETRIC METHOD - fluorescence - phosphorescence - theory - fluorimeter **(2)**

ELECTROCHEMICAL METHOD

Principles of polarography - half wave potential - factors affecting the limiting current - applications of Polarography. **(3)**

PRINCIPLES OF GRAVIMETRIC ANALYSIS

Methods of obtaining the Precipitate - Conditions for Precipitation - Choice of Precipitants - Advantages of using Organic Precipitants - Disadvantages - Types of organic Precipitants - Specific and Selective Precipitants - Sequestering Agents. **(4)**

Theories of Precipitation - Co-precipitation - Post-precipitation. **(2)**

Effects of Digestion - General rules for precipitation - Precipitation from homogeneous Medium - Washing of precipitates - Drying of Precipitates - Types, Care and Use of Crucibles. **(3)**

Total : 45

TEXT BOOKS

1. *Sharma B.K., Instrumental methods of chemical analysis , Eighteenth Edition, GOEL publishing House. 2002.*
2. *Ewing G.W., Instrumental methods of Chemical Analysis, Fifth Edition, McGraw Hill,New York, 1992.*
3. *Chatwal, Anand, Instrumental Methods of Chemical Analysis, Seventh Edition, Himalaya Publishing House. 2005.*
4. *Vogel's textbook of Quantitative Chemical Analysis, Fifth Edition. ELBS Publications,2007.*

REFERENCE BOOKS

1. *Skoog D.A., Principles of Instrumental Analysis, Sixth Edition, Saunders College Publication, 2007.*
2. *Williard H.H., Meritt L.C and Dean J.H., - Instrumental Methods of Analysis, Sixth Edition,1990.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X				X			X

13CH57 - TECHNICAL AND INSTRUMENTAL ANALYSIS LABORATORY - I

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *The course concentrates on the various chemical and analytical techniques utilized for analysis in the chemical industries.*
- *To gain the knowledge to analyze various samples and to calibrate the instruments used in chemical industries.*
- *To provide knowledge on fundamental principles, design and functions of the most commonly used instruments in Chemical Industries.*

COURSE OUTCOMES :

CO1 : *Able to attain skills in analyzing various samples and handling of instruments.*

CO2 : *Understand and analyze the samples by both quantitative and qualitative methods.*

CO3 : *Able to gain practical knowledge to carry out meaningful interpretation of data from analytical chemical measurements.*

EXPERIMENTS

- Analysis of water
- Estimation of calcium oxide in quick lime
- Estimation of manganese oxide in pyrolisite
- Determination of total fatty matter in soap
- Estimation of glucose
- Estimation of loss on ignition, silica, iron and aluminum oxide in bauxite
- Evaluation of purity in calcium carbonate
- Estimation of magnesium silicate in talcum powder
- Determination of acidity or alkalinity of a solution using P^H meter
- UV - Spectrophotometer - verify the Beer-Lambert's law
- Determination of sodium by Flame photometer
- Determination of Biochemical Oxygen Demand

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X				X				X	X
CO2		X	X		X		X	X	X		
CO3		X		X	X	X			X		

13CH58 - FLUID MECHANICS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide experience on various basic fluid mechanics experiments.*
- *To impart hands on experience on different unit operation equipment.*
- *Apply principles developed in chemical engineering courses to the analysis of chemical engineering processes and unit operations*

COURSE OUTCOMES :

CO1 *: The students will be able to run all the fluid machinery equipments independently and able to find study their performance characteristics.*

CO2 *: The student's ability to operate different unit operations and their calculations involved has improved.*

EXPERIMENTS

- Venturimeter / Orifice Meter
- Helical Coil / Spiral Coil
- Pipe Friction/ Expansion Losses
- Reciprocating Pump
- Globe Valve/ Loses in Bends
- Centrifugal Pumps
- Open orifice and V notch
- Fluidized Bed
- Packed Bed
- Annular pipes
- Bernoulli's Theorem
- Drag on Sphere
- Pitot Tube
- Elutriator

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X							X
CO2	X		X		X			X			X

13CH61 - PROCESS DYNAMICS AND CONTROL

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the students the working knowledge of Laplace transforms to express the dynamics of linear control system in terms of transfer functions, a method which allows the categorization of a range of dynamic responses commonly encounter in practice.*
- *To provide the students with fundamental background of process control theory and working knowledge of automatic control systems for chemical process.*
- *To provide the students the knowledge of stability analysis, frequency response analysis and control system design approaches.*
- *To provide the students working knowledge in analysis, design and turning of feedback, feed forward controllers in the context of various control strategies used to control chemical processes.*

COURSE OUTCOMES :

CO1 : *Students will have the working knowledge of Laplace transforms and analyze typical process dynamics with and without feedback control using both time domain and Laplace domain.*

CO2 : *To be able to analyze open loop and closed loop systems such as stability and performance.*

CO3 : *Develop working knowledge to analysis tuning of feedback/feed forward controllers and also various advanced control strategies used to control chemical process equipments.*

OPEN LOOP SYSTEMS

Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics. **(12)**

CLOSED LOOP SYSTEMS

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems, Routh-Hurwitz and Root-locus stability of a control system. **(12)**

FREQUENCY RESPONSE

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion, tuning of controller settings. **(12)**

ADVANCED CONTROL SYSTEMS

Introduction to advanced control systems, cascade control, feed forward control, model predictive control, control of distillation Column and heat exchanger. Adaptive controller, Supervisory controller and Ratio controller. **(12)**

DIGITAL CONTROLLERS

Introduction to Computer control loops, Digital computer, computer process Interface, digital to analog and analog to digital converters, sampling continuous signal, Hardware components of a DDC loop, New control Design problems. **(12)**

Total : 60

TEXT BOOKS

1. *Donald R. Cough anowr, Process Systems Analysis and Control, Third Edition, McGraw Hill, New York, 2008.*
2. *Vyas R.P.,Process Control and Instrumentation, Second Edition, Central Technology Publications, Nagpur.*
3. *Stephanopoulos G., Chemical Process Control: An Introduction To Theory And Practice, Sixth Edition, Prentice Hall of India Pvt.Ltd, New Delhi, 2006.*

REFERENCE BOOKS

1. *Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Process Dynamics and Control, Third Edition, John Wiley and sons, New York, 2010.*
2. *Carlos A Smith, Armando B Corripio, Principles and Practice of Automation process control, Third Edition, John Wiley, New York, 2005.*
3. *Harriot P., Process Control, Tata McGraw Hill, New Delhi, 1997.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X						X
CO2			X		X		X				
CO3		X		X					X		X

13CH62 - CHEMICAL REACTION ENGINEERING

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide knowledge on different types of reactions, reaction rate, collection and analysis of reaction rate data to derive rate expressions.*
- *To provide knowledge on different kinetic models to analyze the batch reactor data.*
- *To provide knowledge of different types of reactors (Batch, semi batch, CSTR, PFR) and to derive the design equations of ideal reactors from mole balance.*
- *To provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions.*
- *To understand about the multiple reactors systems.*
- *To have a clear understanding of the non ideality creeping into the real systems, analyse the extent of deviation from ideal conditions and apply the same for calculating the conversion or size of a real system.*
- *To understand about the heterogeneous non catalytic and catalytic reactions, develop appropriate rate expressions and application in the design of heterogeneous reactors.*

COURSE OUTCOMES :

The students will be able

CO1 : *To analyze kinetic data and determine the rate expressions (reaction order and specific reaction rate) for a homogeneous single or multiple reactions.*

CO2 : *To derive and solve design equations for ideal batch, semi batch and steady state flow reactors.*

CO3 : *To understand the performance characteristics and the advantages and disadvantages of major reactor types and recommend the appropriate reactor required for a given duty.*

CO4 : *To precisely analyze the extent of non ideality in the real system.*

CO5 : *To develop the kinetics for a heterogeneous system and design the reactor required for the given heterogeneous system.*

CHEMICAL KINETICS

Classification of reactions, Types of rate expressions, Elementary and Non elementary reactions, Types of intermediates and testing a mechanism in non elementary reactions, Temperature dependency of the rate constant based on Arrhenius, collision and Transition State Theories. **(12)**

DATA ANALYSIS AND INTERPRETATION

Differential and integral Methods of analysis of rate data, Interpretation of rate data in constant and variable volume systems, Kinetics of irreversible, Parallel and Series reactions in constant volume batch reactor. **(12)**

DESIGN OF IDEAL REACTORS

Development of design expressions for batch, plug flow and continuous Stirred tank reactors. Comparison, advantages and limitations. Concept of space time and velocity. Size comparison of single reactors. Plug flow reactors in series and parallel, Mixed flow reactors of equal and different sizes in series. Reactors of different types in series. Recycle reactor. Qualitative and quantitative treatment of parallel, series reactions. **(12)**

NON IDEAL FLOW

Residence time distribution Function. Relationship among E, F and C curves. Moments of RTD. Models for non ideal flow - Segregation, Tanks in series and Dispersion models. Reactor modeling with RTD. **(12)**

HETEROGENEOUS REACTIONS

Non catalytic fluid-solid systems: Kinetic models for non catalytic fluid-solid systems - Progressive conversion and Unreacted core Models. Development of rate expressions for various controlling regimes.

Heterogeneous Catalysis: Kinetics and rate expressions for fluid-solid catalytic reactions. Langmuir Hinshelwood and Eley Rideal mechanisms for surface Reactions. Reaction and diffusion within porous catalysts. Concept of effectiveness factor. Design outline of fixed and fluidized bed reactors. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Octave Levenspiel, Chemical Reaction Engineering, Third Edition., John Wiley and sons, New Delhi,2007.*
2. *Smith J.M., Chemical Engineering kinetics, Third Edition, McGraw Hill, 1981.*

REFERENCE BOOKS

1. *Scott Fogler H., Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, Eastern Economy Edition, New Delhi, 2006.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X							X		X
CO2	X	X							X		X
CO3	X		X	X							X
CO4	X	X							X		
CO5	X	X							X		X

13CH63 - MASS TRANSFER - II

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *Understand the concept of various stage operations.*
- *Given the specifications for a feed and desired product streams, select a separation method and design a process utilizing that method to achieve the desired products.*
- *For a proposed separation process, apply the fundamentals of mass transfer and engineering correlations to design process equipment.*
- *To choose an appropriate separation technology for a particular application.*

COURSE OUTCOMES :

CO1 *: Students are able to select appropriate process using specific criteria among alternative separation technologies available.*

CO2 *: Understand the basic concepts of different mass transfer operations and its governing laws.*

CO3 *: Understand the importance of mass transfer phenomena in the design of process equipment.*

CO4 *: Able to apply mass transfer fundamentals to calculate rates of mass transfer for practical situations and to identify rate-limiting processes.*

DISTILLATION

Vapour - Liquid - Equilibrium (VLE). Ideal solutions and Raoult's law, non ideal solutions and Henry's law, relative volatility, azeotropes - minimum and maximum boiling. Flash distillation, differential distillation - Rayleigh's equation, steam distillation. **(12)**

EXTRACTION

Application of liquid-liquid extraction. Liquid-liquid equilibria, general features of triangular co-ordinate systems. Choice of solvent for extraction. Solid-liquid extraction. Typical industrial applications. Factors affecting leaching - agitation, particle size, temperature and solvent properties. Operation of stagewise and differential contact extractors. **(12)**

ABSORPTION

Equilibrium solubility of gases in liquids. Choice of solvents for absorption. Single component absorption. Operating and equilibrium lines for absorber and stripper. Minimum liquid - gas ratio for absorption. Countercurrent multistage operation, one component transferred continuous contact equipment, absorption of one component in packed tower, overall coefficients, transfer units - graphical, analytical methods and overall height of transfer units. Absorption with chemical reaction. Tower packings and packed tower. **(12)**

ADSORPTION AND ION EXCHANGE

Types of adsorption - physical adsorption and chemical adsorption. Factors influencing adsorption. Nature of adsorbents. Industrial adsorbents. Freundlich adsorption isotherm and its application. Adsorption

operation - single stage, crosscurrent and countercurrent operations. Recovery of solvent vapours. Ion exchange - principles, techniques, applications, eqilibria and rate of ion exchange. **(12)**

EQUIPMENT FOR CONTINUOUS DISTILLATION

Plate columns, packed columns. Determination of number of theoretical plates using McCabe - Thiele and Ponchon - Savarit methods. Location of feed plate. Reflux ratio - optimum reflux. Plate efficiency - overall and Murphree efficiencies. Azeotropic and extractive distillations. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *McCabe W. L., Smith J.C., and Harriott P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill (ISE),2005.*
2. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill (ISE), 1980.*
3. *Geankoplis C. J., Transport Processes and Unit Operations, Third Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2003.*

REFERENCE BOOKS

1. *Coulson J.M., Richardson J.F., Backhurst J.R Harker J.M., Coulson and Richardson's., Chemical Engineering, Vol II, 6th Edition,Butter Worth Heinemann, Oxford, 2002.*
2. *Alan S. Foust, Leonard A Wenzel, Curlis W.Clump, Louis Maus, L.Bryce Andersen., Principles of Unit operations, Second Edition, John Wiley and Sons, 2008.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X							X	X
CO2			X		X	X	X				
CO3		X						X	X		
CO4		X		X		X		X			X

13CH64 - ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the knowledge about formation, classification, ranking, analysis, testing, carbonization, gasification and liquefaction of coal, manufacture of cock.*
- *To provide the knowledge about design, occurrence, composition, classification, exploration and production of petroleum, refining, testing and analysis of petroleum products.*
- *To provide knowledge about the non conventional energy sources and its storage*
- *To provide knowledge about the energy related problems in the world and its solutions.*

COURSE OUTCOMES :

CO1 *: An ability to understand the importance of environment and conservation of natural resources.*

CO2 *: An ability to succeed in the competitive exams of energy industry.*

CO3 *: An ability to utilize the non conventional energies in place of conventional energies and its manufacture.*

CO4 *: An ability to maintain the sustainability in the environment.*

SOLID FUELS

Principal solid fuels, Coal- Preparation, Storage, Carbonization, Bio Fuels, Briquetting. **(9)**

LIQUID FUELS

Liquid fuels from crude oil, Synthetic and other liquid fuels. Storage and handling of liquid fuels. **(9)**

GASEOUS FUELS

Natural gas, Manufacture of gaseous fuels. Gas purification. Combustion. Furnaces. Waste heat recovery. **(9)**

NUCLEAR ENERGY SOURCES

Nuclear energy - Nuclear reactions. Fuel materials, Moderators and Structural materials. Nuclear reactors. Reprocessing of spent nuclear fuel. **(9)**

RENEWABLE ENERGY SOURCES

Solar energy - Utilization for room and water heating. Silicon cells in storage of solar energy. Energy from Biomasses - Biogas plant. Wind energy, Tidal and Ocean thermal sources. **(9)**

Total : 45

TEXT BOOKS

1. *Gupta O.P., Elements of Fuels, Furnaces and Refractories, Khanna Publishers, New Delhi, 1990.*

2. *Rao S, Parulekar B.B Energy Technology, Non Convectional, Renewable and Convectional Khanna publication, New Delhi 1997.*

3. *Himus G.W., The Elements of Fuel Technology, second Edition, Leonard Hill, London, 1958.*

REFERENCE BOOK

1. *Considine D.M., Energy Technology Handbook, McGraw Hill, New York, 1977.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X						X			
CO2							X				X
CO3	X	X									
CO4							X		X		

13CH65 - CHEMICAL PROCESS PLANT SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The Students are able to understanding the predominating hazards associated with objects, facilities, equipment and work practices in the work environment and of appropriate control procedures and devices to be considered - to control the hazards*
- *The Students are able to participate actively in preparing a technical team safety project,analyzing a safety scenario and developing a program to correct the problem and prevent recurrences.*
- *The Students are able to study the effect of toxic and flammable materials and conduct the management of a fire prevention and abatement program.*
- *The Students are able to demonstrate knowledge of appropriate protective equipment, safety and health training procedures.*

COURSE OUTCOMES :

CO1 : *To attain the knowledge of human error and human factors principles and how they relate to Process Safety Management.*

CO2 : *To improve human performance by reducing human error-likely work situations through design, improved work instructions, training and the recognition of human factors hazards.*

CO3 : *To practice performing human factors and procedures analyses in realistic workshops and safety education training programme.*

CO4 : *Able to reduce the process hazards by using protective equipments and communicate the safety and hazard analysis reports.*

DEVELOPMENT OF INDUSTRIAL PLANT SAFETY

Introduction to safety: Concept and importance of industrial safety. Safety in erection and commissioning of chemical plants, Safety in the design process of chemical plants Fundamental safety Tenets. Safety in the site selection and lay out. Location and design parameters for chimney, Flares rupture discs, location of boiler houses, storage of hazardous chemicals etc. Safety in Operations and processes. Work permit system. Confined space safety practices. **(9)**

INDUSTRIAL SAFETY

Chemical hazards classification, hazards due to fire, explosion, toxic chemicals and radiation.Reduction of Process hazards by plant condition monitoring. Electrical exposures. Guarding Live electrical elements. Electrical wiring switches and fuses. Grounding. Ground Fault Interrupter. Classification of atmospheric contaminants. **(9)**

HANDLING AND STORAGE

TLV - classification and significance. Contamination reduction or removal methods. Handling and storage of Hazardous chemicals. Pressurized lines and containers (LPG, Compressed air, gases or fluids). Extreme temperatures - hot and cold. Reaction safety. Run away reactions. **(9)**

RISK ANALYSIS

Risk assessment - hazard vs risk, techniques for risk assessment, qualitative, reconnoitres, rapid and comprehensive risk assessment techniques: checklists, indices, HAZOP, maximum credible accident

analysis, fault tree analysis, past accident analysis, FMEA (Failure mode and effect analysis), quantitative risk assessment, domino effect and its assessment. **(9)**

PROTECTION SYSTEMS

Emergency Preparedness: Fire and Explosion. Fire hazards. Fire pyramid. Types of fires. Types of fire extinguishers and its handling. Types of built in extinguishing systems. Fixed Fire protection systems. Fire fighting techniques. Emergency procedures. Types of alarm systems. Study of fire protection systems and Emergency procedure of a leading chemical industry (preferably refinery/petrochemical) **(9)**

Total : 45

TEXT BOOKS

1. *David S. Gloss, Miriam Gayle Wardle., Introduction to Safety Engineering, Wiley, New York, 1984.*
2. *Fawcett H.H., Wood W.S., Safety and Accident Prevention in Chemical Operations, second Edition, John Wiley, New York, 1982.*
3. *Crowl D., Louver J., Chemical Process Safety - Fundamentals with Applications, second Edition, Prentice Hall, New Jersey, 2002.*
4. *Heinrich H.W., Roos N., Dan Peterson P.E., Industrial Accident Prevention, Fifth Edition, McGraw Hill, New York,1979.*
5. *Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.*
6. *Grialdi, J. V., and Simonds, R.H., Safety Management, AITBS Publishers and Distributors, New Delhi*

REFERENCE BOOKS

1. *Lees, F.P., Loss Prevention in Process Industries, Butterworths, NewDelhi, 3rd Edn., 2005.*
2. *Slote, L., Handbook of occupational safety and Health, John Wiley and Sons, New York.*
3. *Buschmann, Loss Prevention and Safety Promotion in the Process Industries, Elsevier Scientific, New York*
4. *K.V. Raghavan and A.A.Khan: Methodologies in Hazard Identification and Assessment Manual by CLRI, December 1990.*
5. *V.C Marshal : Major Chemical Hazards - Ellis Harwood Ltd., Chichester, U.K. 1987.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X					X		
CO2	X				X				X		
CO3	X	X	X								
CO4	X		X					X			X

13CH66 - PROCESS EQUIPMENT DESIGN AND DRAWING - I

L	T	P	C
0	0	6	4

ASSESSMENT : THEORY AND PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide how the chemical engineering principles applied to the design of chemical plants and process equipment.*
- *To practice the steps in creating a chemical process design from original concept to successful completion and operation.*
- *To interplay the economic and technical factors in process development, site selection, project design, and production management.*
- *To provide the procedures for carrying out unit operations commonly encountered in chemical process industries.*

COURSE OUTCOMES :

CO1 : *Understand the concepts in process design, equipment design and cost estimation.*

CO2 : *Understand process flow sheet development, material and energy balances; equipment specification.*

CO3 : *Understand the design of separation equipment and heat exchanger commonly used in process industries.*

CO4 : *Apply new techniques in filtration, drying and the strategies in process design and synthesis.*

INTRODUCTION

Engineering properties of various materials at different temperatures. Factor of safety - Working stresses. Piping and Instrumentation Diagrams. **(10)**

STORAGE TANKS

Design of mild steel and wooden storage tanks - optimum proportions. Foundations and supports for equipments and tank. **(10)**

PRESSURE VESSELS

Design of vessels subjected to internal and external pressures. Design of formed ends and covers. Design of flanges and bolts. Design of agitators. Manhole and inspection openings. Design of Tall Vertical Vessels. **(20)**

SEPARATION EQUIPMENT

Design of cyclone separator, Centrifuge, Filtration Equipment, Thickeners and Crystallizers. **(20)**

Theory : 30

Practical : 30

Total : 60

Note : This subject will be evaluated through Continuous Assessment Scheme (CAS).

TEXT BOOKS :

1. *Don W. Green, Robert H. Perry, Perry's Chemical Engineers 'Handbook, Eighth Edition, McGraw Hill, 2007.*
2. *Indian Standard Codes:*
   - *(a) IS : 2825 - 1969: Code for Unfired Pressure Vessels.*
   - *(b) IS : 4049 - 1979: Specifications for formed ends for Tanks and Pressure vessels.*
   - *(c) IS : 4179 - 1967: Sizes of Process Vessels and their Leading Dimensions.*
   - *(d) IS: 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.*
   - *(f) IS : 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild Steel Cylindrical Welded Oil Storage Tanks. (Published by Bureau of Indian Standards, New Delhi).*
   - *(g) ASME Section 8 and 9*
3. *Joshi M.V., Process Equipment Design, Third Edition, MacMillan, India, 2004.*
4. *Bhattacharya.B.C., Introduction to Chemical Equipment Design, CBS Publishers and Distributors, New Delhi, 1985.*
5. *Coulson J.M., Richardson J.F., Sinnott R.K., Chemical Engineering, Vol. VI, Maxwell-Macmillan, New York, 1989.*

REFERENCES :

1. *Brownell L.E., Young E.H., Process Equipment Design, Wiley Eastern, New Delhi, 1977.*
2. *Ludwig E.E.,Applied Process Design for Chemical and Petrochemical Plants, Vols. I, II and III, Second Edition, Gulf Publishing Company, Texas, 1977, 1979, 1983.*
3. *Strigle R.F., Random Packings and Packed Towers (Design and Application), Gulf Publishing Company, Texas, 1987.*
4. *Bednar H.H.,Pressure Vessel Design Handbook, Second Edition, CBS Publishers and Distributors, New Delhi, 1989.*
5. *Backhurst J.R., Harker J.H., Process Plant Design, Heinemann Books, London, 1973.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X									X
CO2	X			X					X		
CO3					X			X	X		
CO4				X			X		X		

13CH67 - TECHNICAL AND INSTRUMENTAL ANALYSIS LABORATORY - II

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the basic concepts and skills in advanced methods of separation and analysis.*
- *To develop the basic skills in instrumentation and to understand the role of the chemical engineers in analyzing, measuring the sample and problem solving in chemical analysis.*
- *To develop an understanding of the range and theories of instrumental methods of analysis.*

COURSE OUTCOMES :

CO1 *: At the end of this course, the students would have learnt about various instrumentation and analytical techniques.*

CO2 *: This will be a pre-requisite for certain specialized project work that a student undertakes.*

CO3 *: Able to expand skills in the scientific method of planning, developing, conducting reviewing and reporting experiments.*

EXPERIMENTS

- Analysis of cement
- Estimation of available chlorine in bleaching powder
- Estimation of nitrogen in inorganic fertilizer
- Estimation of tin, lead, copper and zinc in brass
- Determination of acid value of an oil
- Estimation of copper
- Determination of saponification value of an oil
- Estimation of the concentration of unknown samples using Nephelometer
- UV - Spectrophotometer - determination of concentration of unknown solution
- Estimation of potassium by Flame photometer
- Determination of Chemical Oxygen Demand

Practical : 30

Total : 30

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X			X			X		
CO2	X	X		X					X		X
CO3	X				X		X	X		X	X

13CH68 - MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide experience on various basic mechanical operations experiments.*
- *To impart hands on experience on different unit operation equipments.*
- *Apply principles developed in chemical engineering courses to the analysis of chemical engineering processes and unit operations*

COURSE OUTCOMES :

CO1 *: The students will be able to run all the mechanical operation equipments independently and able to find study their performance characteristics.*

CO2 *: The student's ability to operate different unit operations and their calculations involved has improved.*

EXPERIMENTS

- Ball Mill
- Roll Crusher
- Sedimentation
- Filtration
- Air Classifier
- Raymond mill
- Plate and Frame Filter Press
- Screen Effectiveness
- Hammer Mill
- Jaw Crusher

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X				X				
CO2		X		X		X			X		

13CH69 - MINI PROJECT

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide basic knowledge in chemical engineering research.*
- *To gain experience in organization and implementation of a project and thus acquire the necessary confidence to carry out the same.*

COURSE OUTCOMES :

CO1 *: Students will understand the concepts to how a project has to be started, their pre-requirements, flowchart preparation, and economic calculation and solution.*

The students are expected to carry out mini project connected with process development studies which will be assigned by the faculty in charge. Progress of the work will be assessed periodically in which the student will give an oral presentation on the work done. The student should maintain a record of the work done regularly and submit them for assessment periodically. At the end of the semester, the students should submit a report of the work done in standard format which will be evaluated by the faculty and subject experts.

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X			X		X			X

13CH71 - TRANSPORT PHENOMENA

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To develop and detailed understanding of the physics behind transport phenomena in chemical and biological engineered systems.*
- *To provide the fundamentals to solve problems involving transports of momentum, energy and mass in chemical systems using a unified approach.*
- *To learn the fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.*
- *To teach how to formulate conservation statements in heat, mass, and momentum at multiscales for microscopic steady modes. It enables to apply transport phenomena to real industrial problems*

COURSE OUTCOMES :

CO1 : Students will be able to simplify the general equations of change for specific applications.

CO2 : Set up shell balances for conservation of momentum, energy, and mass and employ shell balance equations to obtain desired profiles for velocity, temperature and concentration.

CO3 : Ability and set up to solve simple elementary microscopic momentum, heat and mass balances for steady and quasi steady state problems.

CO4 : Understand and analyze advanced transport problems in heat, mass, and momentum, both macroscopic and Utilize information obtained from solutions of the balance equations to obtain engineering quantities of interest.

BASIC CONCEPTS AND CONSERVATION THEOREMS IN MOMENTUM TRANSPORT

Derivation of the basic momentum transport equation - derivation using elementary volume concept and conservation theorems. Equation of continuity and motion - Navier-Stokes and Euler equations of motion in rectangular, cylindrical and spherical co-ordinate systems. Dimensional analysis of equations of change. Analysis of momentum transport using shell balance technique and basic transport equations - types of boundary conditions. **(12)**

APPLICATIONS OF EQUATIONS OF CHANGE IN MOMENTUM TRANSPORT

Flow of fluids in thin films, parallel plates, circular tubes and annulus, adjacent flow of two immiscible fluids, couette flow, rotating surface flow and radial flow. Flow near a wall suddenly set in motion. **(12)**

BASIC CONCEPTS AND CONSERVATION THEOREMS IN ENERGY TRANSPORT

Basic energy transport equations - derivations using elementary volume concept and conservation theorems in different co-ordinate systems. Dimensional analysis of equations of change. Analysis of energy transport using shell balance technique and basic transport equations - types of boundary conditions. **(12)**

APPLICATIONS OF EQUATIONS OF CHANGE IN MOMENTUM TRANSPORT

Conduction with energy sources in fixed bed catalytic reactors and in cooling fins. Forced convection in circular tubes - Natural convection from a heated plate. Unsteady state conduction of finite slab.**(12)**

MASS TRANSPORT

Continuity equation for a binary mixture and its derivation. Dimensional analysis of equations of change. Analysis of mass transport using shell balance technique and types of boundary conditions.

Steady and unsteady state one dimensional diffusion, diffusion in porous catalyst with and without chemical reaction and diffusion in falling liquid film. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Byron Bird.R, Warren E Stewart, Edwin N.Lightfoot, Transport Phenomena, Revised Second Edition., John Wiley(ISE), India, 2007.*
2. *Robert S. Brodkey, Harry C.Hershey, Transport Phenomena-A unified approach, McGraw Hill (ISE), 2003.*

REFERENCE BOOKS

1. *James Welty, Charles E. Wicks, Gregory L. Rorer, Robert E. Wilson, Fundamentals of Momentum, Heat and Mass Transfer, Sixth Edition, John Wiley, (ISE), 2013.*
2. *Carroll O.Bennet, John Earle Meyers, Momentum, Heat and Mass Transfer, Third Edition, Tata-McGraw Hill, New Delhi,1983.*
3. *Christie J. Geankoplis, Transport Processes and Separation Process principles, Fourth Edition, Prentice Hall Professional Technical Reference, 2003*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X			X			X		
CO2	X		X					X			
CO3	X		X	X							X
CO4	X		X	X					X		

13CH72 - PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the student with an insight on the various principles, concepts and functions of General Management and economics with thrust on Industrial Management, to enable him/her to take up employment or pursue higher education.*
- *To provide students with an ability to integrate knowledge about various production systems, functions and controlling techniques etc.*
- *To enable the student to demonstrate a good working knowledge about Industrial Management and various functional areas of management.*
- *To motivate the student for entrepreneurship activities.*

COURSE OUTCOMES :

CO1 : *Students will be able to understand the theory behind Inventory Control, Organization Types and PPC.*

CO2 : *Motivate the student for entrepreneurship and managerial skills.*

CO3 : *Provides the student with an ability to integrate knowledge about financial statements, Depreciation Accounting and other areas.*

INTEREST AND PLANT COST

Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery. **(10)**

PROJECT PROFITABILITY AND FINANCIAL RATIOS

Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems. **(10)**

ECONOMIC BALANCE IN EQUIPMENTS

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments. **(9)**

PRINCIPLES OF MANAGEMENT

Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS). **(8)**

PRODUCTION PLANNING CONTROL

Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control. **(8)**

Total : 45

TEXT BOOKS

1. *Max Peters, Klaus Timmerhaus, Ronald West, plant design and economics for chemical Engineers, Fifth Edition, McGraw Hill (ISE), 2004.*
2. *Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.*
3. *H.E. Schwyer, Process Engineering Economics, McGraw Hill Book, New York, 1970*

REFERNCE BOOKS

1. *FC Jelen, JH Black, Cost and Optimization Engineering, Second Edition, McGraw-Hill., New York, 1983.*
2. *Robin Smith, Chemical Process Design, McGraw Hill Book co., New York, 1995.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X								
CO2			X	X				X			
CO3		X				X				X	

13CH75 - PROCESS EQUIPMENT DESIGN AND DRAWING - II

L	T	P	C
0	0	6	4

ASSESSMENT : THEORY AND PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide how the chemical engineering principles applies to the design of chemical plants and process equipment.*
- *To practice the steps in creating a chemical process design from original concept to successful completion and operation.*
- *To interplay the economic and technical factors in process development, site selection, project design, and production management.*
- *To provide the procedures for sizing unit operations commonly encountered in the chemical process industries.*

COURSE OUTCOMES :

CO1 *: Understands the concepts in process design, equipment design and cost estimation.*

CO2 *: Understands process flow sheet development, material and energy balances; equipment specification.*

CO3 *: Understands the design of separation equipment and heat exchanger commonly used in process industries.*

CO4 *: Apply new techniques in drying and the strategies in process design and synthesis*

HEAT TRANSFER EQUIPMENT

Design of Heat Exchangers, Condensers, Evaporators and Reboilers. **(15)**

MASS TRANSFER EQUIPMENT

Design of Distillation Columns. **(15)**

Design of Extraction and Absorption Equipment. **(15)**

Design of Rotary Dryers and Cooling tower. **(15)**

Theory : 30

Practical : 30

Total : 60

TEXT BOOKS

1. *Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, Eighth Edition, McGraw Hill (ISE), October 2007.*
2. *Indian Standard Codes:*

   (a) IS : 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.

(b) *IS : 4506 - 1967: Specifications for Shell and Tube Heat Exchangers.*

(c) *IS : 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild Steel Cylindrical Welded Oil Storage Tanks. (Published by Bureau of Indian Standards, New Delhi).*

3. *Joshi M.V, V.V. Mahajani, S.B. Umarji, Process Equipment Design, fourth Edition, MacMillan, India, 2009.*
4. *Coulson J.M., Richardson, J.F., Sinnott, R.K., Chemical Engineering Design, Chemical Engineering series Vol.6, Elsevier, New York, 2005.*
5. *Donald Quentin Kern, Process Heat Transfer, First Edition, Tata McGraw - Hill Education, India, 2001.*
6. *Lloyd E. Brownell, Edwin H. Young, Process Equipment Design, Wiley Eastern, New Delhi, 1977.*

REFERENCE BOOKS

1. *Smith B.D, Design of Equilibrium Stage Processes, McGraw Hill, New York, 1983.*
2. *Ernest E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Volume I II and III, Fourth Edition, Gulf Publishing Company, Texas, 2007.*
3. *Ralph F. strigle, Random Packings and Packed Towers: Design and Applications, Gulf Publishing Company, Texas, 1988.*
4. *Fraas A.P., Ozisik M.N, Heat Exchanger Design, Second Edition, John Wiley, New York, 1989.*
5. *Henry H. Bednar, Pressure Vessel Design Handbook, Second Edition Van Nostrand Reinhold, University of michagan, 2007.*
6. *J. R. Backhurst, John Hadlett Harker, Process Plant Design, American Elsevier Publishers, London, 1973.*
7. *Shrikant D.Dawande, Process Design of Equipments, Fourth Edition, Central Techno Publications, Nagpur, 2005.*

Note : This subject will be evaluated through Continuous Assessment Scheme (CAS).

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X					X		
CO2	X				X				X		
CO3	X	X	X								
CO4			X				X			X	

13CH76 - HEAT TRANSFER LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To apply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.*
- *To develop practical understanding of common heat transfer equipments.*
- *To develop skills in experimental design and troubleshooting.*
- *To develop skills in data collection, analysis and interpretation.*

COURSE OUTCOMES :

CO1 *: Students should be able to collect quality raw data from an operation.*

CO2 *: Students should be able to compare observed with predicted performance.*

CO3 *: Students should be able to communicate the results of their analysis effectively in written and oral reports.*

CO4 *: Students should be able to function effectively in a lab team.*

CO5 *: Ability to design experiments to obtain heat transfer coefficients.*

EXPERIMENTS

- Thermal conductivity of solid materials
- Transient Heat conduction
- Electrical analogies
- Natural convection Heat Transfer
- Heat transfer in pool boiling and Nucleate boiling
- Condensation heat transfer
- Steady and Un-steady state heat transfer through submerged coils in Agitated vessels
- Radiation heat transfer
- Characteristics and Efficiency of Heat Transfer equipments such as Heat Exchangers

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X				X			
CO2		X			X				X		X
CO3			X		X			X			
CO4				X	X		X				
CO5	X	X				X					X

13CH77 - REACTION ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide a core foundation for the analysis and design of chemical reactors.*
- *To provide instruction in the analysis of experimental data to obtain rate equations and kinetic and thermodynamic data.*
- *To provide the information of parametric study of the various chemical reactions. To gain knowledge in the design of reactors*
- *To give students experience with a flexible bench scale experiment that can be used to study the processes.*

COURSE OUTCOMES :

CO1 *: Design ideal continuous reactors operating at isothermal conditions given kinetic data and conversion.*

CO2 *: Solve for conversion in a non-ideal reactor given a residence time distribution*

CO3 *: To understand how to measure reaction rates using integral and differential methods*

CO4 *: Students are aware that materials, construction, operability, safety and ethical issues must be considered in reactor.*

EXPERIMENTS

- Develop experience in handling small scale chemical reactors and better understand the kinetics of reactions.
- Performance characteristics and reaction rates of reactors including Batch, Plug Flow, Mixed Flow and Adiabatic type reactors.

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X							X
CO2	X		X	X					X		
CO3	X				X		X		X		
CO4	X							X			X

13CH81 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *The basic concepts of quality management make them learn about TQM principles, SPC, TQM tools and quality system.*

COURSE OUTCOME :

CO1 *: They can be able to implement TQM in an industry and thus, they can improve the quality and can increase the profit in that industry.*

INTRODUCTION

Definition of TQM, Basic approach, Gurus of TQM,TQM Frame work, Defining Quality, Obstacles, Benefits of TQM, Leadership- Concepts, The Deming Philosophy, The role of TQM leaders, Implementation, Quality council, Quality statements, Strategic Planning **(9)**

TQM PRINICIPLES

Customer Satisfaction-Customer Perception of Quality, Using Customer Complaints, service Quality, Customer retention; Employee involvement-Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits; Continuous process improvement- The Juran Trilogy, The PDSA cycle, Kaizen, Six sigma; Supplier partnership-Partnering, Sourcing, Supplier Selection, Supplier rating, Relationship Development; Performance Measures-Basic concepts, Strategy, Presentation, Cost of Quality. **(9)**

STATISTICAL PROCESS CONTROL

The Seven tools of Quality, Statistical Fundamentals, Process Capability, Control Charts for Variable and Attributes, New Seven Management tools. **(9)**

TQM TOOLS

Benchmarking - Reasons to Benchmark, Process, Pitfalls and Criticisms; Quality Function Deployment-Benefits, House of Quality, QFD Process; Taguchi's quality loss function; Total Productive Maintenance (TPM)-Concept, Improvement needs; FMEA - Stages of FMEA. **(9)**

QUALITY SYSTEMS

Benefits of ISO registration, ISO 9000 Series of Standards, Sector- specific Standards, ISO requirements, Implementation, Documentation, Internal Audits, Registration; Environmental Management System- ISO 14000 Series Standards, Concepts of ISO 14001, Requirements of ISO 14001, Benefits of EMS. **(9)**

Total : 45

TEXT BOOKS

1. *Besterfield, Dale H., Carol Besterfield-Michna, Glen Besterfield and Mary Besterfield-Sacre,:Total Quality Management, Third Edition, Second Impression, Pearson Education Inc, New Delhi, 2007.*
2. *Subburaj Ramasamy, :Total Quality Management, Second reprint , Tata McGraw Hill publishing Company Ltd, New Delhi, 2006.*

REFERENCE BOOKS

1. *Dr.Kumar S, :Total Quality Management , First Edition, Reprint, Laxmi Publications (P) Ltd., New Delhi , 2007.*
2. *Naagarazan R.S and Arivalagar A.A , :Total Quality Management, First Edition, Reprint, New Age International (P) Ltd., New Delhi , 2005.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X								X

13CH82 - PROCESS UTILITIES AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide knowledge and engineering aspects of plant utilities like water, compressed air and vacuum, refrigeration, air-conditioning and ventilation to the chemical engineering as well as basic knowledge about industry.*
- *To understand about the properties of steam and its behaviour at different pressures and specific volumes, the knowledge regarding the steam generators like boilers, their classification with accessories and mountings.*

COURSE OUTCOMES :

CO1 *: Ability to apply basic knowledge of mathematics, science and engineering.*

CO2 *: Ability to identify, formulate and solve chemical engineering problems.*

WATER

Water resources, Treatment and cooling. Storage and distribution of water. Re-use and conservation of water. **(9)**

COMPRESSED AIR AND VACUUM

Compressors and Vacuum pumps- Performance characteristics of Compressor and Vacuum pumps. Boosters. Air receivers. Piping systems. Air leaks. Lubrication. Oil and moisture removal. **(9)**

REFRIGERATION

Refrigeration systems and their characteristics. Production of cryogenic temperatures. **(8)**

AIR CONDITIONING AND VENTILATION

Characteristics of Air-water systems. Humidification and Dehumidification equipment. Exhaust ventilation. **(10)**

STEAM

Steam generation in chemical process plants. Properties of steam. Boilers and Power generation equipment. Steam engines and turbines. Steam handling and distribution. Steam economy. Electric power distribution in process plants. **(9)**

Total : 45

TEXT BOOKS

1. *Bhasin S D. : Project Engineering of Process Plants, Chemical Engineering Education Development Centre, IIT Madras, 1979.*
2. *Davidson, P J and West, T F.: Services for Chemical Industry, Pergamum Press, Oxford 1968*
3. *Process Utilities, Chemical Engineering Education Development Centre, IIT Madras, 1986.*

REFERENCE BOOKS

1. *Perry, R.H., and Green, D.W,: Perry's Chemical Engineers Handbook, Eighth Edition, McGraw Hill (ISE), 2008.*
2. *W.L McCabe J.C.Smith, and Harriot. P.: Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill, Publication, 2008.*
3. *Ludwig, E.E.: Applied Process Design for Chemical and Petrochemical Plants, Gulf Publishing Company, Texas, Vol.1, 4th Edition 2007, Vol.2, 4th Edition 2010, Vol.3, 3rd Edition 2011.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X								X
CO2	X		X	X				X			

13CH83 - PROCESS MODELLING AND SIMULATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To explain the benefits of simulation and modeling for important chemical engineering applications.*
- *To learn the systematic approach for model building, modeling framework, model verification and model validation*
- *To improve the student's ability to perform effective modeling and simulation processes for various separation process and distributed system used in chemical industries.*
- *To learn the application of commercial simulation software to solve ordinary differential equations*
- *To introduce to the use of mathematics and methods of engineering in analysis of chemical and physical processes.*

COURSE OUTCOMES :

CO1 : *Ability to obtain mathematical model for flow processes like gravity flow tank, hydraulic transients*

CO2 : *Acquired the fundamental principles of chemical engineering for the modeling and simulation of chemical reactions and of separation processes*

CO3 : *Ability to model any real system with the help of input-output data by using linear and non-linear regression analysis*

CO4 : *Ability to formulate and solve mathematical model problem with the help of various numerical methods*

CO5 : *Ability to apply those techniques to real time industrial problems*

INTRODUCTION

Uses of Mathematical Models - Principles of formulation. Fundamental laws: Continuity equations, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples. **(7)**

BASIC MODELLING

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous - Flow boiling system. **(7)**

FLUID FLOW AND REACTION KINETICS

Gas flow systems - Example: Three-Volume gas flow system, Hydraulic transients - between two reservoirs, pumping system. Reaction Kinetics: General modelling scheme, Liquid phase CSTR - Radical kinetics - Elementary reduction of Radical Mechanism - Rate limiting steps, Heterogeneous kinetics - Example: Autoclave. **(9)**

STAGED OPERATIONS AND DISTRIBUTED SYSTEMS

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat Exchanger, Pipeline Gas flow, Pipeline Flasher Process, Tubular Reactor. **(9)**

SIMULATION

Analog Simulation: Introduction, Basic components, Operational Blocks, Simple Examples - Three CSTR's in series, Gravity flow tank. Digital Simulation: Numerical Methods - Implicit function convergence, Numerical integration - Euler, Runge Kutta fourth-order methods. Simple Examples: Three CSTR's in series, Non isothermal CSTR, Binary distillation column, Batch reactor. **(13)**

Total : 45

TEXT BOOKS

1. *Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second edition, 1996.*
2. *Franks, R.G.E.: Modeling and Simulation in Chemical Engineering, Wiley-Interscience, New York, 1972.*

REFERENCE BOOKS

1. *Himmelblau, D.M. and Bischoff, K.B,: Process Analysis and Simulation, Wiley, 1968.*
2. *Ramirez,W.F.: Computational methods for Process Simulation, Butterworths, NewYork, 2nd Edition, 1998*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X	X		X					
CO2	X		X								X
CO3			X	X		X					
CO4	X	X	X								
CO5	X				X			X			

13CH86 - MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To apply the concepts of mass transfer and thermodynamics to the design and operation of mass transfer experiments.*
- *To develop practical understanding of common mass transfer equipments.*
- *To develop skills in experimental design and troubleshooting.*
- *To develop skills in data collection, analysis and interpretation.*
- *Determines experimentally the diffusion coefficient in binary systems of liquids and gases.*
- *Understands surface evaporation in stationary and moving surfaces.*
- *Studies dynamics of single drop hydrodynamics and perforated plate tower.*
- *Determines the kinetic and equilibrium parameters of drying of wet solids.*

COURSE OUTCOMES :

CO1 : *Students should be able to collect quality raw data from an operation.*

CO2 : *Students should be able to compare observed with predicted performance.*

CO3 : *Students should be able to communicate the results of their analysis effectively in written and oral reports.*

CO4 : *Students should be able to function effectively in a lab team.*

CO5 : *Ability to design experiments to obtain mass transfer coefficients like diffusion coefficient in liquids and gases.*

CO6 : *Ability to troubleshoot problems in liquid - liquid extraction perforated towers or spray towers.*

CO7 : *Ability to calculate drying rates of wet solids and volatile chemical spills.*

CO8 : *Ability to design gas - liquid absorption columns.*

EXPERIMENTS

- Measurement of Diffusion coefficient
- Concentration profile
- Wetted wall column
- Ternary Liquid-liquid Equilibrium
- Leaching
- Extraction in packed and plate columns
- Steam distillation
- Simple distillation

- Distillation in packed columns
- Adsorption Isotherms and Drying rate measurements
- Characteristics and Efficiency of Mass transfer equipments.

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X				X			
CO2	X	X	X						X		
CO3			X		X			X			
CO4				X	X		X				
CO5	X	X									X
CO6		X	X						X		
CO7	X		X						X		
CO8	X			X					X		

13CH87 - PROCESS CONTROL AND SIMULATION LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVES :

- *To provide a core foundation for the analysis and the control of chemical processes.*
- *To gain knowledge in the design and simulation of various chemical process systems.*
- *To give students experience with a flexible bench scale experiment that can be used to study the processes.*

COURSE OUTCOMES :

CO1 : *Design of chemical processes and control strategies with the help of controllers.*

CO2 : *To understand how to develop a model and simulate the chemical processes with the help of experimental data.*

CO3 : *Understands the response of systems including Second order system and Non-interacting system. Comprehend the use and response of the controllers.*

EXPERIMENTS

- Calibration of Pressure gauge
- Flow Characteristics of a Control Valve
- Dynamic Response of a First Order and Second Order Systems
- Response of Single Tank and Non-Interacting System
- Installed Characteristics of Control valve
- Determination of Control Valve Coefficient
- Transient Response of a P-Controller, PD-Controller, PI-Controller and PID-Controller. Simulation of chemical processes using Software packages like MatLab, Fluent etc.

Total : 45

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X							X	X		
CO2	X		X	X							
CO3	X				X						X

13CH88 - PROJECT WORK AND VIVA VOCE

L	T	P	C
0	0	6	6

ASSESSMENT : PRACTICAL

COURSE EDUCATIONAL OBJECTIVE :

- *The object of the project work is to test the ability of the students to co-ordinate the entire knowledge of Chemical Engineering principles to tackle a practical problem in a suitable manner and in the same way as might be expected of him if he were to be in the service of a large manufacturing/ consultation firm, and were required to report upon a new manufacturing/ diversification proposal.*

COURSE OUTCOMES :

CO1 *: On successful completion, students will be possible to design and provide a feasible solution for real time project scenario*

The students should carry out the project work allotted to them in the stipulated time duration. They should submit a detailed report prior to the final semester examinations. The dates for allocation of the questions and for the submission of the final report will be notified by the department. The following Instructions should be followed by the students regarding the project.

INSTRUCTIONS

1. The answers should be made on preferably 22 x 28.5 cm. size (A-4 Size) papers and the number of pages should be around fifty.
2. The written part should be type written.
3. Drawings must be as blue/ammonia prints or in Indian ink on good quality drawing paper.
4. Detailed flow sheets for the Process, Material and Energy should be given.
5. All symbols used in the flow diagrams should follow the norms prescribed as per IS. Code 3233-1965 (Recommendations on Graphical Symbols for Process Flow Diagrams).
6. All calculations should be made by application of fundamental principles and from available published data.
7. All Physical and Thermodynamic properties required for calculations should be obtained from standard Text books, Handbooks or International Critical Tables. In the absence of such data these properties must be calculated using other known techniques (like group contribution, etc.,). No data should be assumed.
8. Design of equipments should be from first principles as per Indian Standard Codes and other standard text and reference books.
9. A complete drawing of the designed equipment should be furnished.
10. All dimensions, mechanical details and materials of construction should be furnished as per norms prescribed in IS-696: 1972 (Code of Practice for Engineering Drawings). Wherever possible detailed or working drawings should be given.
11. Complete layout diagrams including conveying equipment must be furnished and the floor area should be evaluated for calculating building costs.

12. Cost estimation must be done as per methods followed by text and reference books in Cost Engineering. Current market prices should be obtained from Trade literature or periodicals.
13. References must be given in detail to all sources of published information made use of by the students. The names of the journals/periodicals should be abbreviated as in the Chemical Abstracts (Published by the American Chemical Society).
14. All calculations should be done in SI. Units only.

The evaluation of the project work will be done by the faculty of chemical engineering and the marks will be awarded based on continuous evaluation, review and presentations. There will also be a Viva Voce examination conducted jointly by an Internal Examiner and an External Examiner.

Total : 90

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X	X	X				X		X

13E01 - SUGAR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The main scope of this course is to provide the basic knowledge about the sugar industry.*
- *To provide idea about all the process, operations like evaporation, crystallization, purification, and their equipments and instruments which are being used in sugar industry.*

COURSE OUTCOMES :

CO1 *: The students would have gained the confidence by knowing the principals and theory behind the various parts of the sugar industry so that they can sort out any kind of problem which is possible to occur in the sugar industry.*

INTRODUCTION

Sugar industry in India. Chemical and Physical properties of Sucrose and reducing sugars. Source for Sucrose. Formation of sucrose plants. Non sugar compounds of sugar cane. Inorganic constituents of sugar cane juices and sugars. Analytical methods used in Sugar Industry. **(9)**

PURIFICATION

Chemical technology of the purification processes. Fundamental reactions and physical chemistry aspects of clarification. Liming, sulphitation and carbonation processes. Filtration of sugar juice. **(9)**

EVAPORATION

Evaporation of sugar juice. Heat transfer in evaporators. Evaporation equipment and auxiliaries. Methods of obtaining steam and quality of steam. Steam economy. Chemistry of the evaporation process. Scale formation and cleaning of evaporators. **(9)**

CRYSTALLOGRAPHY OF SUCROSE

Solubility of sucrose. Solubility of sucrose - nucleation in super saturated solutions - kinetics and growth of crystallization. Chemistry of crystallization. Control methods and equipment in sugar crystallization; Technology of sugar crystallization. Evaporation and circulation in vacuum pans. **(9)**

CENTRIFUGATION

Theory of the centrifugal processes. Centrifugal operation. Engineering principles of sugar centrifugals and the centrifugal process. Centrifugal equipment and auxiliaries. Production of final molasses and its utilizations. Grading of sugar. **(9)**

Total : 45

TEXT BOOKS

1. *Honig P., Principles of Sugar Technology, Vol.1,2 and 3, Elsevier Publishing Company, 1953.*
2. *Van der Poel P.W., Schwartz T.K., Schiweck H.M., Sugar Technology [Beet and Cane Sugar Manufacture], Beet Sugar Development Foundation (Fort Collins, Colo.), Fourth Edition, Verlag Dr Albert Bartens KG, 1998.*

REFERENCE BOOKS

1. *Payne J.H., Sugarcane factory Analytical control, Fifth Edition, Elsevier Publisher, London, 1968.*
2. *Jenkins G.H., Introduction to Sugarcane technology, Elsevier Publisher, London, 1966.*
3. *Hoing P., Principle of Sugar Cane Technology, Elsevier Publisher, London.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X	X	X							X

13E02 - POLYMER SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *Acquire the fundamental Chemical and Physical information on the Synthesis, Production and Characterization of Polymer material and to appreciate the breadth of Polymer properties, applications, and to learn about Polymer in a particular application area.*

COURSE OUTCOMES :

CO1 *: Able to survey the current usage of Polymer and Compounding ingredients.*

CO2 *: Able to compare the use and general properties of Polymers with traditional materials.*

CO3 *: Able to recognize the different types of polymers.*

POLYMER CHAINS AND THEIR CHARACTERIZATION

The science of large molecules - Basic concepts of polymer science. History of Macromolecular science, Molecular Forces and chemical Bonding in polymers. Polymer solutions. Criteria for polymer solubility, Conformations of Dissolved polymer chains, Thermodynamics of polymer solutions, Phase Separation in polymer solutions. **(9)**

STRUCTURE AND PROPERTIES OF BULK POLYMERS

Morphology and Order in Crystalline polymers - Configurations of polymer Chains, Crystal structure of polymers, Morphology of polymer Single Crystals.

Rheology and the Mechanical properties of polymers - Viscous Flow, Kinetic theory of Rubber Elasticity, Viscoelasticity.

Polymer structure and physical properties - The crystalline melting point, the Glass Transition, Properties involving Large Deformations, properties involving small Deformations, property requirement and polymer Utilization. **(9)**

POLYMERIZATION

Step-Reaction (Condensation) Polymerization - Classification of polymers and polymerization Mechanisms, chemistry of stepwise polymerization, Kinetics and Statistics of Linear stepwise polymerization.

Radical Chain (Addition) Polymerization - chemistry of vinyl polymerization, Laboratory Methods in Vinyl polymerization, Steady state kinetics of vinyl radical polymerization.

Ionic and Coordination chain (Addition) Polymerization - chemistry of Nonradical chain polymerization, Cationic polymerization, Anionic polymerization, Coordination polymerization. Copolymerization - Kinetics of copolymerization, Composition of copolymers, Chemistry of copolymerization.

Polymerization Conditions and Polymer Reactions - polymerization in Homogeneous Systems, polymerization in Heterogeneous Systems, Degradation of polymers. **(9)**

PROPERTIES OF COMMERCIAL POLYMERS

Hydrocarbon plastics and Elastomers - low density (branched) Polyethylene, High density (linear) Polyethylene, polypropylene, Natural Rubber and other Polyisomers, Rubbers derived from Butadiene.

Other carbon chain polymers - polystyrene and related polymers, Acrylic polymers, poly (Vinyl Esters) and Derived polymers. Heterochain Thermoplastics - Polyamides. Thermosetting Resins - Phenolic Resins, Amino Resins. **(9)**

POLYMER PROCESSING

Plastic Technology - Molding, Other processing Methods, Fillers, Plasticizers, and Other Additives. Fiber Technology - Textile and Fabric properties, Spinning, Fiber After Treatments. Elastomer Technology - Compounding and Elastomer properties, Vulcanization, Reinforcement. **(9)**

Total : 45

TEXT BOOKS

1. *Billmeyer F.W., Textbook of Polymer Science, Third Edition, Wiley Interscience, 1984.*
2. *Charles E., Carraher Jr., Seymour/carraher's polymer chemistry, Seventh Edition, Crc Press, 2012.*

REFERENCE BOOKS

1. *Fried J.R., Polymer Science and Technology, Second Edition, Prentice Hall of India Pvt Ltd., 2003.*
2. *Bhatnagar M.S., A Textbook of Polymers, Vol. 2, S.Chand and Company Ltd., 2012.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X		X				X		
CO2			X				X			X	
CO3		X			X			X			

13E03 - PETROCHEMICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the knowledge about design, reserves, composition and pretreatment of crude oil, refinery and testing methods of petroleum products.*
- *To provide the knowledge about the petroleum products atmospheric and vacuum industrial distillations.*
- *To provide knowledge about improving the quality and quantity of gasoline from refinery products by thermal cracking, catalytic cracking, hydro cracking and refining.*
- *To provide the knowledge about converting useless products into useful forms of gasoline by alkylation, isomerization, polymerization etc.,*

COURSE OUTCOMES :

CO1 *: To provide the basic knowledge of essential nutrients for the plant growth*

CO2 *: To provide the knowledge of production of various types of fertilizers.*

CO3 *: To understand the application of fertilizer in agricultural fields.*

CO4 *: To provide various pollutants and their standards from various fertilizer industries.*

PETROCHEMICAL INDUSTRY-FEEDSTOCKS

Feed stock selection for Petrochemicals. Production and purification of raw materials like gaseous hydrocarbons, liquid hydrocarbons, Separation of impurities and precise fractionation, etc. **(9)**

OLEFINIC POLYMERS

Production of mono-olefines from gaseous and liquid petroleum fractions. Purification and polymerization for products like Polyethylene, Poly propylene, Poly-isobutylene and Co-polymers of Olefines. **(9)**

AROMATIC POLYMERS

Production and purification of Aromatics. Synthetic Rubbers, Synthetic Fibres, etc., Synthetic Detergents. **(9)**

ALKYLATION, ISOMERIZATION

Alkylation, Isomerization, Oxosynthesis, Udex process and Fischer-Tropsch reactions. Modern methods of production of Acetylene and its compounds. **(9)**

SYNTHESIS GAS AND CHEMICALS

Hydrogen and Synthesis gas production. Petroleum Carbon and Petroleum coke. Oxidation Products of Paraffines and Aromatics. **(9)**

Total : 45

TEXT BOOKS

1. *Bhaskara Rao B.K., Textbook on Petrochemicals, Fourth Edition, Khanna Publishers Delhi, 2007.*
2. *Waddams A.L., Chemicals from Petroleum, Fourth Edition, John Murray Publishers Ltd., ELBS, 1980.*
3. *Belov P.S., Fundamentals of Petroleum Chemicals Technology, Mir Publishers, Moscow, 1970.*

REFERENCE BOOKS

1. *Kobe K.A., McKetta J.J.(Jr.), Advances in Petroleum Chemistry and Refining, Vol. 2,3 and 4, Interscience, New York, 1958 - 1962.*
2. *Hengstebeck R.J., Petroleum Processing, McGraw Hill, New York, 1959.*
3. *Chauvel A., Lefebvre G., Petrochemical Processes, Vol. 1 and 2, Second Edition, Paris, 1989.*
4. *Tonohue D., Lang K., A First Course in Petroleum Technology, Prentice Hall, New Jersy, 1989.*
5. *Wiseman P., Petrochemicals, Ellis Horwood, 1986.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X		X							X
CO2			X							X	X
CO3			X	X				X			
CO4		X						X	X		

13E04 - FERTILIZER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the basic knowledge of essential nutrients for the plant growth.*
- *To provide the knowledge of production of various types of fertilizers.*
- *To understand the application of fertilizer in agricultural fields.*
- *To provide various pollutants and their standards from various fertilizer industries.*

COURSE OUTCOMES :

CO1 *: Understands about essential nutrients for the plant growth*

CO2 *: Understands the application of fertilizer in agricultural fields.*

CO3 *: Understands production of various types of fertilizers.*

CO4 *: Understands the various type pollutants from various fertilizer industries and the standards.*

INTRODUCTION

Chemical Fertilizers and Organic Manures - Types of chemical Fertilizers. Nitrogenous Fertilizers - Methods of production of Ammonia and Urea. **(9)**

NITROGEN FERTILIZERS

Nitric acid, Ammonium sulphate, Ammonium Sulphate Nitrate, Ammonium Nitrate, Calcium Ammonium Nitrate, Ammonium Chloride - Their methods of production, characteristics, storage and handling specifications. **(9)**

PHOSPHATIC FERTILIZERS

Raw materials, phosphate rock, Sulphur pyrites - Process for the production of Sulphuric and Phosphoric acids. Ground phosphate rock, bone meal. Single Super Phosphate, Triple Super phosphate - Methods of production, characteristics and specifications. **(9)**

POTASSIC FERTILIZERS

Potassium chloride, Potassium sulphate, Potassium schoenite - Methods of production, specification, characteristics. Complex Fertilizers, NPK Fertilizers, Mono ammonium phosphate, Diammonium phosphate, Nitrophosphate Methods of production. **(9)**

MISCELLANEOUS FERTILIZERS

Secondary nutrients, micro nutrients, Fluid fertilizers. Controlled Release of fertilizers. Solid, Liquid and Gaseous pollution from fertilizer industries and standards laid down for them. Fertilizer production in India. **(9)**

Total : 45

TEXT BOOKS

1. *Gopala Rao M., Marshall Sittig, Dryden's Outlines of Chemical Technology, Third Edition, WEP East-West Press, New Delhi, 2010.*
2. *George T. Austin., Shreve's Chemical Process Industries, Fifth Edition, McGraw Hill Professional, 2012*
3. *Vincent Sauchelli., The Chemistry and Technology of Fertilizers, Reinhold Pub. Corp., 1960*

REFERENCE BOOKS

1. *Editorial Committee - FAI Seminar on Fertilizer in India in the Seventies (Proceedings), The Fertilizer Association of India, New Delhi,1973.*
2. *Editorial Committee - Seminar on Recent Advances in Fertilizer Technology, The Fertilizer Association of India, New Delhi, 1972.*
3. *Sauchelli V., Manual on Fertilizer Manufacture, Industry Publication Inc, New Jersy, 1963.*
4. *CHEMTECH - II - (Chapter on Fertilizers by Chari, K.S.), Chemical Engineering Education Development Centre, I.I.T., Madras, 1977.*
5. *Menon M.G., Fertilizer Industry - Introductory Survey, Higginbothams, Madras, 1973.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X				X			X		X	
CO2	X								X	X	
CO3		X	X						X		
CO4	X			X						X	

13E05 - FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The main objective of this course is to provide clear picture about the source, constituents, and standard limits of food ingredients in the food stuff.*
- *To give idea about the basic behind the methods of food preservation, packing, handling of food stuff.*

COURSE OUTCOMES :

CO1 *: Upon successful completion of this subject the student will be aware of food processing operations, Unit Operations and Unit Processes applied to food processing industry.*

CO2 *: The manufacturing processes of different value added food products and the aseptic conditions to be maintained in food processing industry will be the outcome of this course.*

INTRODUCTION

General aspects of food industry; World food need and Indian situation; Constituents of food; Quality and nutrition aspects; Food additive and standards; **(8)**

DETERIORATIVE FACTORS

Deteriorative factor and their control; Preliminary processing methods; Conservation and Preservation operations **(8)**

PRESERVATION METHODS

Preservation by heat and cold; Dehydration; Concentration; Frying; Drying; Irradiation; Microwave heating. **(8)**

PACKING METHODS

Sterilization and pasteurization; Fermentation; Pickling; Packing methods. Cereal, grains; pulses; Vegetables; Fruits; Spices; Fats and Oils. **(10)**

PRODUCTION AND UTILIZATION OF FOOD PRODUCTS

Bakery, confectionery and chocolate products; Soft and alcoholic beverages; Dairy products; Meat; poultry and fish products: - Factory Hygiene - Wastewater disposal and pollution control in food industry. **(11)**

Total : 45

TEXT BOOKS

1. *John Laurence Heid, Maynard Alexander Joslyn, Fundamentals of Food Processing Operations, The AVI Publishing Co., Westport, 1975.*
2. *Potter N.N., Food Science, Fifth Edition, The AVI Publishing Co., Westport, 2006.*
3. *Watson E.L., Elements of Food Engineering, Second Edition, Van Nostrand - Reinhold, New York, 1988.*

REFERENCE BOOKS

1. *Ronsivalli L.J., Elementary Food Science, Van Nostrand - Reinhold, New York, 1991.*
2. *Considine D.M., Considine G.D., Considine P.E., Foods and Food production Encyclopedia, Vol. 8, Van Nostrand - Reinhold, 1982*
3. *Considine D.M., Foods and Food Production Encyclopedia, First Edition, Springer, 1995.*
4. *Hall C.W., Farrall A.W., Rippen A., Encyclopedia of Food Engineering, Second Edition,Van Nostrand - Reinhold, New York, 1986.*
5. *Ernest R.V., Elementary Food Science, Fourth Edition, Springer, 2001.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X						X
CO2		X				X	X			X	

13E06 - PULP AND PAPER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the basic knowledge of Paper manufacturing process.*
- *To provide the knowledge of production of various grades of papers and its properties.*
- *To provide various pollutants and their standards from various paper and pulp industries.*

COURSE OUTCOMES :

CO1 *: Understands about various method used in pulp treatment processes.*

CO2 *: Ability to carry out economic feasibility of a given grade of product production.*

CO3 *: Ability to present coherent data and analysis about a given process.*

INTRODUCTION TO SOURCE OF PULP AND PROPERTIES

Source of Pulp wood, Structure and properties of pulp wood. Preparation of pulp wood. **(9)**

PULPING PROCESS AND TREATMENT

Manufacture of pulp - Mechanical, Sulphite, Kraft and alkaline process pulps. Treatment of pulp. Bleaching of pulp. **(9)**

PULP TESTING

Testing of wood pulp. Preparation of stock for preparing making. **(9)**

PAPER MAKING EQUIPMENT AND PROCESSES

Manufacture of paper and boards. Special papers. Auxiliary paper mill equipment. Recycling of waste and recovery of chemicals in the paper and pulp industry. Pollution control and effluent treatment in paper and pulp industries. **(9)**

PAPER TESTING AND SCOPE OF PAPER INDUSTRY

Specification for paper and boards. Testing of paper and paper products. Future and scope of paper industry in India. Use of alternate raw materials. **(9)**

Total : 45

TEXT BOOKS

1. *John B. Calkin, Modern Pulp and paper Making, Third Edition, Reinhold Pub.Corp, 1960.*
2. *Stephenson N., Pulp and Paper manufacture, Vol.1, 2, 3 and , McGraw Hill, New York, 1950.*
3. *Halpern M.G, Pulp Mill Processes, Park Ridge, N.J: Noyce Data Corporation, 1975.*

REFERENCE BOOKS

1. *Britt.K.W., Handbook of Pulp and Paper Technology, Second Edition, CBS Publishers Delhi, 1984.*
2. *Smook, G.A., Handbook for pulp and paper technologist, Third Edition, Angus Wilde Publications, Inc., 2003.*
3. *Casey J.P., Pulp and Paper: Chemistry and Chemical technology, Third Edition, Vol. 4, Wiley Interscience, 1983.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X		X						X	
CO2	X						X				X
CO3		X			X				X		

13E07 - INDUSTRIAL WASTE WATER TREATMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The study of the subject constitutes the sources, characteristics and treatment of wastewater.*
- *It imparts the knowledge of basic principles of science and engineering applied to the problem of water pollution.*
- *To provide an understanding of effluent characteristics and effects.*
- *To understand various analysis and treatment methods for effluent treatments.*

COURSE OUTCOMES :

CO1 : *The ultimate goal of waste water treatment is to protect public health and environment.*

CO2 : *Be able to understand the knowledge of waste water constituents and their impacts when waste water is dispersed into the environment.*

CO3 : *Recognize and define the quality parameters typically used to characterize wastewater.*

WASTE WATER ENGINEERING

Waste water treatment, waste water constituents, physical characteristics, inorganic non-metallic constituents, metallic constituents and biological characteristics. **(7)**

PHYSICAL UNIT OPERATIONS

Screening, flow equalization, mixing, flocculation, grit removal, sedimentation, aeration system and filtration. **(9)**

CHEMICAL UNIT PROCESS

Fundamentals of chemical coagulation, chemical precipitation for improved plant performance, chemical precipitation for phosphorous removal, heavy metals, dissolved inorganic substances, chemical oxidation and chemical neutralization. **(11)**

FUNDAMENTALS OF BIOLOGICAL TREATMENT

Objective of biological treatment, role of microorganisms in waste water treatment, types of biological process for wastewater treatment, aerobic biological oxidation, biological nitrification, biological de-nitrification, biological phosphorous removal, anaerobic fermentation and oxidation. Biological removal of heavy metals, suspended growth biological treatment process - activated sludge process, attached growth and combined biological treatment process - trickling filters. **(9)**

WATER REUSE

Wastewater reclamation and reuse, water reclamation technologies, risk assessment and management. Solid processing flow diagrams, sludge and scum pumping, grinding, screening, degritting, blending, anaerobic digestion, composting, conditioning, dewatering and incineration. **(9)**

Total : 45

TEXT BOOKS

1. *Metcalf Eddy, Wastewater Engineering -Treatment and Reuse, Fourth Edition, Tata McGraw Hill, New Delhi, 2002.*

REFENCE BOOKS

1. *Mark J. Hammer, Water and Wastewater Technology, Seventh Edition, Prentice Hall of India Pvt. Limited, New Delhi, 2011.*
2. *James M. Montgomery, Water Treatment Principles and Design, First Edition, A Wiley Interscience publication, New York, 1985.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X		X		X		
CO2	X			X	X				X	X	X
CO3		X				X		X	X		

13E08 - SURFACE COATING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *This subject knowledge gives confidence to chemical engineer playing a role in construction field and process industries.*
- *To provide coverage of the materials used in coating manufacture: polymers, pigments, solvents and additives and applications of surface coating products.*

COURSE OUTCOMES :

CO1 *: To analyze and improve the surface properties of materials for protection in demanding contact conditions or aggressive environments.*

CO2 *: To understand the protection against all types of corrosion.*

FILM FORMATION AND DRYING OILS

Film formation - film forming compositions - properties - types of polymerization in film forming compounds. Drying oils - composition - Manufacturing procedure. **(9)**

RESINS

Resins - types - Natural resins and its extraction - Alkyl resin - manufacturing procedure - compositions - properties - Various synthetic resins - Chemical constitution - manufacturing procedure. **(9)**

SOLVENTS AND ADDITIVES

Diluents - Thinners - Plasticizers - Driers - Additives - Anti settling agents in surface coating. **(9)**

PIGMENTS

Pigments - properties - types - White Pigments - properties - Red Pigments - Green Pigments - Blue Pigments - Black Pigments - Properties and Manufacturing procedure. **(9)**

COATINGS TYPES

Formulation of exterior coating - Interior - Decorative - Industrial - Special purpose - Marine - Bituminous - powder coatings. Manufacture of Various paints. **(9)**

Total : 45

TEXT BOOKS

1. *Payne H., Organic Coating Technology, Vol. I, John Wiley and Sons Inc., New York, 1954.*
2. *Payne, H., Organic coating technology, Pigments and Pigmented Coatings, Vol.2, John Wiley and Sons Inc., New York, 1961.*

REFERENCE BOOKS

1. *Oil and Colour chemists Association, Australia: Surface coatings, Vol. 1, Raw materials and their usage, Third Edition, Tafe educational books, Chapman and Hall, London, 1993.*
2. *Oil and Colour chemists Association, Australia: Surface coatings, Vol.2, Paints and their applications, Second Edition, Tafe educational books, Chapman and Hall, London, 1984.*
3. *Oil and Colour chemists Association, Australia: NON- convertible coatings, Part 1, Eleventh Edition, Tafe educational books, Chapman and Hall, London, 1987. (H.W. Keenan, chairman, Technical education committee.)*
4. *Parkar P.K., Technology of Resins.*
5. *Noel Heaton, Introduction to Paint Technology, Second Edition, Charles Griffin and Co. Ltd., London, 1940.*
6. *Noel Heaton, Outlines to Paint Technology, Third Edition, Charles Griffin and Co. Ltd., London, 1947.*
7. *Keenan H.W., Convertible Coatings, Vol. 1 and 2, Oil and Colour chemists Association, Australia, Chapman and Hall, London, 1961.*
8. *Wood H.R., Morrel R.S., The Chemistry and Technology of Drying Oils, Ernest Benn ltd., Seventh Edition, 1984.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X		X					X	
CO2			X						X	X	

13E09 - PETROLEUM REFINERY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the knowledge about design, reserves, composition and pre-treatment of crude oil, refinery and testing methods of petroleum products.*
- *To provide the knowledge about the petroleum products at atmospheric and vacuum industrial distillations.*
- *To provide knowledge about improving the quality and quantity of gasoline from refinery products by thermal cracking, catalytic cracking, hydro cracking and refining.*
- *To provide the knowledge about converting useless products into useful forms of gasoline by alkylation, isomerization, polymerization etc.,*

COURSE OUTCOMES :

CO1 *: An ability to understand the extent of availability of petroleum resources for future generation.*

CO2 *: An ability to succeed in the competitive examinations of petroleum industries.*

CO3 *: An ability to use innovative methods in extracting the highly demanded petroleum products from crude oil.*

CO4 *: An ability to identify and improving the qualities of petroleum products. Determination of type of gasoline for different climatic conditions.*

ORIGIN, FORMATION AND COMPOSITION OF PETROLEUM

Origin and formation of petroleum, petroleum reserves in India. History of Refining. Composition of petroleum. Refinery products and test methods. Evaluation of oil stocks. **(9)**

PETROLEUM PROCESSING

Physical properties of oil. Processing details. Refinery and distillation process. Auxiliary processes and operations. Refinery corrosion and materials of construction. **(9)**

TREATMENT TECHNIQUES

Chemical treatments. Solvent Extraction of petroleum fractions. Dewaxing of Petroleum fractions. **(9)**

THERMAL AND CATALYTICAL PROCESS

Thermal cracking and Decomposition processes. Rebuilding hydrocarbons. Catalytic cracking and reforming. Natural and refinery gases. **(9)**

EQUIPMENT AND DESIGN CALCULATIONS

Tube still heaters, heat exchangers and condensers, Fractionation towers, typical design calculations. Economics of design. **(9)**

Total : 45

TEXT BOOKS

1. *Baskara Rao B.K., Modern Petroleum Refining processes, Fifth Edition, Oxford-IBH, New Delhi, 2008.*
2. *Nelson W.L., Petroleum Refinery Engineering, Fourth Edition, McGraw Hill, Auckland, 1985.*

REFERENCE BOOKS

1. *Hengstebeck R.J., Petroleum processing principle and applications, McGraw Hill, New York, 1959.*
2. *Kobe, K.A.,McKetta (Jr.), J.J., Advances in petroleum chemistry and Refining, Vol.1, 2,3 and 4, Interscience, New York, 1958-62.*
3. *Bland, W.F., Davidson, R.L., Petroleum Processing Handbook, McGraw Hill, New York, 1973.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X		X							
CO2		X	X		X					X	
CO3			X	X	X						X
CO4		X						X	X		X

13E10 - ELECTROCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To apply chemical engineering principles to develop mathematical models for electro chemical processes*
- *The course objective is to explain the principles and describe the design and operation of electrochemical reactors and processes, fuel cells and batteries.*
- *To provide the concept of electrode potentials and their use in predicting spontaneous and anti-spontaneous paired redox reactions; diffusion and migration processes to overall transport rates in electrochemical systems*
- *To provide knowledge on electrodes used in different electro chemical industries.*

COURSE OUTCOMES :

CO1 : *Students will be able to understand balanced electrochemical reactions and to analyze the open-circuit potentials of electrochemical cells, including liquid-junction potentials and understand the structure of the electric double layer, based partly on surface-tension data.*

CO2 : *Students will be able to understand the reaction mechanisms and kinetics to obtain electrode over potentials and mass-transfer phenomena, including the estimation of limiting currents.*

CO3 : *Students will be able to explain the principles and working conditions of the different types of primary and secondary batteries.*

CO4 : *Students will be able to understand the uses of electrodes in used in various electrochemical; industries like metal finishing, electroplating and electro polishing, etc.*

REVIEW OF BASICS ELECTROCHEMISTRY

Faraday's law -Nernst potential -Galvanic cells -Polarography, The electrical double layer: It's role in electrochemical processes -Electro capillary curve -Helmholtz layer -Guoy -Steven's layer -fields at the interface. **(9)**

MASS TRANSFER IN ELECTROCHEMICAL SYSTEMS

Diffusion controlled electrochemical reaction -the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution -rotating disc electrode. **(9)**

CORROSION PROCESS

Introduction to corrosion, series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Forms of corrosion- definition, factors and control methods of various forms of corrosion-corrosion control measures- industrial boiler water corrosion control -protective coatings -Vapor phase inhibitors -cathodic protection, sacrificial anodes -Paint removers. **(9)**

ELECTROCHEMICAL PROCESSES

Electro deposition -electro refining -electroforming -electro polishing -anodizing -Selective solar coatings, Primary and secondary batteries -types of batteries, Fuel cells. **(9)**

TYPES OF ELECTRODES

Metals-Graphite -Lead dioxide -Titanium substrate insoluble electrodes -Iron oxide -semi conducting type etc. Metal finishing- cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors. **(9)**

Total : 45

TEXT BOOKS

1. *Picket, Electrochemical Engineering, Prentice Hall. 1977.*
2. *Newman J., Thomas K.E.A., Electrochemical systems, Third Edition, John Wiley and Sons,Inc., New Jersey,2004.*

REFERENCE BOOKS

1. *Barak M., Stevenge U.K., Electrochemical Power Sources - Primary and Secondary Batteries, The Institution of Electrical Engineers, 1980.*
2. *Mantell C., Electrochemical Engineering, Fourth Edition, McGraw Hill, 1972.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X		X					X	
CO2		X		X			X				
CO3		X	X				X		X		
CO4			X			X					

13E11 - MODERN SEPARATION TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the suitable range of operating conditions for every process and separation problem.*
- *To provide the basic understanding of the concept underlying the selection and behavior of separation techniques.*
- *To provide the discussion of different separation techniques, advantages and limitations of each techniques.*
- *The course will focus on separation mechanisms and on the right choice of separation technique for different analytical problems.*

COURSE OUTCOMES :

CO1 : *Understand the membrane technology to apply in accordance with the characteristics of the species to be separated.*

CO2 : *Ability to select the right material and membrane structure according to the properties of the involved compounds.*

CO3 : *To understand the common aspects of functioning and analysis of different separation processes in the development of engineering industries.*

GENERAL

Review of conventional processes, recent advances in separation techniques based on size and surface properties. Process concept - theory and equipment used in cross flow filtration. Surface based solid - liquid separations involving a second liquid. **(9)**

MEMBRANE SEPARATIONS

Types, choice of membrane, plate and frame, tubular, spiral wound and hollow fiber membrane reactors - relative merits. Commercial, pilot plant and laboratory membrane permeators involving dialysis. Reverse osmosis, nanofiltration, ultrafiltration, microfiltration and economics of membrane operations. **(9)**

SEPARATIONS BY ADSORPTION TECHNIQUES

Mechanism, types and choice of adsorbents, foam separation - surface adsorption, nature of foams. Normal adsorption techniques, types of equipment and commercial process, recent advances and process economics. **(9)**

IONIC SEPARATIONS

Controlling factors, applications, types of equipment employed for electrophoresis, dielectrophoresis, electro dialysis and commercial processes. **(9)**

OTHER TECHNIQUES

Pervaporation - basic principles, mass transfer in pervaporation, factors affecting pervaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, zone melting-equilibrium diagrams, adductive crystallization - fundamental and process techniques. **(9)**

Total : 45

TEXT BOOK

1. *Kaushik Nath, Membrane separation processes, First Edition, Prentice Hall publishers, 2008.*

REFERENCE BOOKS

1. *Herbert M.Schoen, New Chemical Engineering Separation Techniques, Interscience publishers, 1962.*
2. *Svarovsky L., Solid-Liquid separation, Fourth Edition, Butterworth and co publishers, 2001.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X		X		X			X		
CO2	X	X			X			X	X		
CO3			X				X	X	X	X	X

13E12 - MINERAL PROCESSING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *The main objective of this course is to give a broad outlook about the various methods by which the minerals are extracted by applying various unit operations.*

COURSE OUTCOMES :

CO1 *: Upon the completion of the course it will be possible to have an idea about the importance of mineral liberation, principles and processes of crushing, grinding and size classification.*

COMMUNITION

Testing Sieve Analysis. Principles of Size Reduction, Size separation. Different types of crushers, Grinding mills, Screens and Classifiers. Closed and Open circuit operations in Size Reduction **(9)**

CONCENTRATING OPERATIONS

Principles of specific Gravity separation. Launders, Vibrating Tables, Spiral Concentrators, Cone concentrators, Vanners, Cordouries, Pans and Other types of Specific Gravity separators. **(9)**

SEPARATION PROCESSES

Electrical separation and Magnetic separation of Minerals. Different types of Electrical and Magnetic separators. **(9)**

FROTH FLOTATION

Interfacial phenomenon for Mineral Particles in water. Collection, Frothing, Activation, Depression, Regulation and conditioning. Froth Flotation Machines. Design of Froth Flotation circuits. **(9)**

WASTE DISPOSAL

Dewatering and Drying operations. Disposal and Treatment of Mineral sludges. Mineral processing flow sheets for Copper, Lead, Zinc and Gold only. **(9)**

Total : 45

TEXT BOOKS

1. *Gaudin A.M., Principles of Mineral Dressing, First Edition, Tata McGraw Hill, New Delhi, 2002.*
2. *Wills B.A., Mineral Processing Technology, Seventh Edition, Maxwell Macmillan, 2006.*
3. *Pryor E.J., Mineral Processing, Third Edition, Elsevier, New York, 1965.*

REFERENCE BOOKS

1. *Richards R.H., Locke C.E., Text Book of Ore Dressing, Third Edition, McGraw Hill, New York, 1940.*
2. *Taggart A.F., Hand Book of Mineral Dressing, John Wiley, New York, 1954.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X				X		X		

13E13 - OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *To provide the various optimized techniques, which are useful in data analysis, engineering systems design, environmental management, inventory control, production process control, risk management, sequencing and scheduling of tasks.*

COURSE OUTCOMES :

CO1 *: Understands the concepts of linear programming technique, applications.*

CO2 *: Understands the use of assignment and transportation model, techniques of PERT and CPM, detailed knowledge of Inventory control and queing theory, decision theory and game theory techniques.*

INTRODUCTION AND LINEAR PROGRAMMING

Introduction to operations research - Art of operations research Modeling - Phases of operations research study - Computations of operations research - Linear programming formulation - Simplex method - Two phase technique, Primal and dual problems - Degeneracy - Unbounded solution - Infeasible solution. **(9)**

TRANSPORTATION PROBLEM

Modeling - Basic feasible solution - N.W. Corner - Row minima - Column minima - Vogel's approximation method - MODI method - Optimality test - Degeneracy - Assignment and routing problems - Hungarian assignment method - Maximization and minimization - Unbalanced situation - Travelling salesman problem - Transshipment problem. **(9)**

SEQUENCING AND GAME THEORY

Introduction - Johnson's rule - Processing jobs through 2 machines - 'n' jobs 3 machines - 2 jobs 'm' machines - [Gantt chart - Graphical method] - Game theory - Two person zero sum games - Pure strategies and saddle points - Mixed strategies - Solution of games by dominance - Graphical solution - Linear programming model in game theory. **(9)**

PROJECT MANAGEMENT AND INVENTORY CONTROL

Introduction to Network in project management. Fulkerson's rule - Comparison between Gantt chart and PERT Network - CPM Network - Crashing - Resource scheduling. Inventory control - Functions - Definition of terms and costs - EOQ Models for purchasing, Manufacturing [without and with shortages, price breaks] - Dynamic order quantity - ABC analysis - Lead time - Safety stock - Reorder level. **(9)**

QUEUEING THEORY AND SYSTEM SIMULATION

Definition of terms of queuing model - Derivation of single-channel infinite population model [Poisson arrival and exponential service]. Multichannel service model [No derivation - only problems]. Systems

concepts - Types of systems and models - System simulation - Monte-Carlo method - Introduction to simulation languages. **(9)**

Total : 45

TEXT BOOKS

1. *Dharani Venkatakrishnan S., Operations Research - Principles and Problems, Keerthi Publishing House, Coimbatore, 1996.*
2. *Taha H.A., Operations Research - An Introduction, Ninth Edition, Pearson Education, Limited, 2011.*

REFERENCE BOOKS

1. *Levin R.I.,Kirkpatrick, C.A., Rubin D.S., Quantitative Approaches to Management, Eighth Edition, McGraw Hill International, 1992.*
2. *Hiller F.S., Lieberman G.J., Operations Research - An Introduction, Holden Day San Francisco, Fifth Edition, 1997.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X	X							X	
CO2	X	X					X				

13E14 - FLUIDIZATION ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *This course is designed to cover fluidization regimes, fluid mechanics of particle suspensions, and motion of single and multi-bubbles in fluidized beds.*
- *To provide heat and mass transfer studies and gas-solid reactions in multistage fluidization.*
- *To understand movement of bubbles mixing in bed.*
- *To get qualitative appreciation of mathematical models of fluidized bed.*

COURSE OUTCOMES :

CO1 *: To know the in depth industrial application of fluidization engineering.*

CO2 *: To carry out heat and mass balances to solve engineering problems related to fluid flow.*

CO3 *: To analyze flow past solid surfaces, through packed bed and in fluidized beds.*

CO4 *: To analyze simple flow problems involving turbulence or non- Newtonian fluid.*

INTRODUCTION

Fluidized state - nature of Hydrodynamic Suspension, Regimization of the fluidized state, Operating models for fluidization systems. **(9)**

HYDRODYNAMICS OF FLUIDIZATION SYSTEM

General bed behavior, pressure drop, empirical correlations for solid holdup, flow Models. **(9)**

SOLIDS MIXING AND SEGREGATION

Degree of segregation, Operation shifts, reversal points, mixing - segregation Equilibrium generalized fluidization of poly systems, Liquid phase mixing and gas phase mixing. **(9)**

HEAT AND MASS TRANSFER IN FLUIDIZATION SYSTEMS

Mass Transfer - Gas- Liquid Mass Transfer, Liquid-Solid mass Transfer and wall to bed Mass Transfer. Heat Transfer - Column wall to bed Heat transfer. **(9)**

MISCELLANEOUS SYSTEM

Moving bed, slurry bubble column, two phase and three phase inverse fluidized bed, typical applications. **(9)**

Total : 45

TEXT BOOKS

1. *Leva M., Fluidization, McGraw Hill, New York, 1959.*
2. *Kunii D., Levenspiel O., Fluidization Engineering, Second Edition, Butterworth-Heinemann, 1991.*
3. *Davidson J.F., Harrison D., Fluidization, Academic Press, New York, 1971.*

REFERENCE BOOKS

1. *Zenz F.A., Othmer D.F., Fluidization and Fluid Particle Systems, Reinhold, New York, 1960.*
2. *Geldart D., Gas Fluidization Technology, John Wiley, New York, 1986.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X			X			X			
CO2	X			X						X	
CO3	X		X					X			X
CO4	X	X	X	X			X				

13E15 - DRUGS AND PHARMACEUTICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The main objective of this course to provide widened spectrum of knowledge in the field of drug and pharmaceutical technology as it is considered to be a life saving field.*
- *This subject gives basics about drug metabolism, Pharmacokinetics, all kind of pharmaceutical formulations, packing methods, and the involvement of unit operations, processes and their application of manufacturing of life saving drugs*

COURSE OUTCOMES :

CO1 *: By knowing the basics of drugs and pharmaceutical technology one can exactly select the formulations process as well as chemical conversion processes and their equipments.*

CO2 *: Understands the basic idea for design of processes and equipments used for drug manufacturing.*

INTRODUCTION

Development of Drugs and Pharmaceutical Industry; Organic Therapeutic agents, Uses and Economics. **(6)**

DRUGS METABOLISM AND PHARMACOKINETICS

Drugs metabolism; Physio - Chemical principles; Radio Activity; Pharma Kinetics; Actions of drugs on human bodies. **(9)**

IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS

Chemical conversion processes; Alkylation; Carboxylation; Condensation and Cyclisation; Dehydration; Esterification (Alcoholysis); Halogenation; Oxidation; Sulphonation; Complex chemical Conversion; Fermentation. **(9)**

MANUFACTURING PRINCIPLES

Compressed tables; Wet granulation; Dry granulation or Slugging; Direct compression; Tablet presses; Formulation; Coating; Pills; Capsules; Sustained action dosage forms; Parental solutions; Oral liquids; Injectibles; Ointments; Standard of hygiene and good manufacturing practice as per Drugs and Cosmetics Act as amended update **(9)**

PHARMACEUTICALS, MICROBIOLOGICAL AND ANIMAL PRODUCTS

Vitamins; Cold remedies; Laxatives; Analgesics; Non - steroidal contraceptives; External Antiseptics; Antacids and Others.

Antibiotics; Biologicals; Harmones; Vitamines and Preservation Pharmaceutical Analysis. Analytical methods and test for various drugs and pharmaceuticals. Packing; Packing techniques; Quality control **(12)**

Total : 45

TEXT BOOKS

1. *Tyagi O.D., Yadav M., A Text Book of Synthetic Drugs, Anmol Publications, New Delhi,2011.*
2. *Chatwal G.R., Synthetic Drugs, Himalaya Publishing House, Delhi, 2009.*

REFERENCE BOOKS

1. *Rawlins E.A, Bentleys Text Book of Pharmaceutics, A.I.T.S.S. Publisher and Distributor, Delhi, 1996.*
2. *Remingtons The Science Practice of Pharmacy, Edited by Alfonso R. Gennaro, Pharmaceutical Press, 2012.*
3. *Peter G.W., The drug development process, Taylor and Francis, 1996.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X			X			
CO2	X		X				X			X	

13E16 - ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *To impart knowledge on energy resources, planning for energy needs, energy, environment and society and management of energy conservation in chemical industries.*

COURSE OUTCOMES :

CO1 *: On completion of the module it will be possible to prepare energy audit report and understand energy conservation techniques and needs in chemical industry.*

PLANNING FOR ENERGY NEEDS

Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modelling and optimal mix of energy sources. **(9)**

ENERGY AND ENVIRONMENT

Energy; various forms; energy storage; structural properties of environment; bio-geo-chemical cycles; society and environment population and technology. **(9)**

ENERGY AND SOCIETY

Energy and evolution; growth and change; patterns of consumption in developing and advanced countries; commercial generation of power requirements and benefit. **(9)**

MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES

Chemical industries; classification; conservation in unit operation such as separation; cooling tower; drying; conservation applied to refineries, petrochemical, fertilisers, cement, pulp and paper, food industries, chloroalkali industries; conservation using optimization techniques. **(9)**

ECONOMIC BALANCE IN ENERGY CONSUMPTION

Cost analysis; capacity; production rate; system rate; system cost analysis; corporate models; production analysis and production using fuel inventories; input-output analysis; economics; tariffs. **(9)**

Total : 45

TEXT BOOKS

1. *Jerrold H Kertz, Energy Conservation and Utilization, Allyn and Bacur Inc, 1976.*
2. *Gemand M Gramlay, Energy, Macmillion publishing Co, Newyork, 1975.*

REFERENCE BOOKS

1. *Krentz J. H., Energy Conservation and Utilization, Allyn and Bacur Inc., 1976.*
2. *Gramlay G. M., Energy, Macmillan Publishing Co., New York, 1975.*
3. *Rused C. K., Elements of Energy Conservation, McGraw-Hill Book Co., 1985.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1		X	X		X						

13E17 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The main objective of this subject is to give broad outlooks to know about how the corrosion engineering is also important in chemical engineering.*
- *To gain knowledge on material selection in the industries to minimize the cost.*
- *This course will emphasize the need of corrosion studies in various industries and their treatment methods.*

COURSE OUTCOMES :

CO1 *: The student after studying this subject would have the confidence in basic chemistry behind the corrosion, studies and prevention methods.*

INTRODUCTION

Introduction, classification, economics and cost of corrosion. Emf series, galvanic series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Fe-H2O system, application and limitation. Passivation-definition, anodic passivation theory of passivation, oxidation laws, effects of oxygen and alloying on oxidation rates. **(9)**

CORROSION CONTROL METHODS

Forms of corrosion- definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, fretting corrosion, hydrogen embitterment, corrosion processes and control methods in fertilizers, petrochemical, chemical building industries **(9)**

MECHANISM OF CORROSION

Environmental aspects, atmospheric corrosion- classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature, and flows rates on corrosion, marine corrosion, underground corrosion. Biological corrosion, definition, mechanism of corrosion, control of bio-corrosion. **(9)**

CORROSION PREVENTION

Corrosion control aspects, electrochemical methods of protection-theory of cathodic protection design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection.

Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system-boiler water system. Organic coating, surface preparation, natural, synthetic resin, paint, formulation and application. Design aspects in corrosion prevention, corrosion resistant materials. **(9)**

CORROSION TEST

Corrosion testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC

and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion processes, inspection methods by NDT. Surface analytical techniques such as AES, ESCA, SEM. Evaluation of paints by conventional and electrochemical methods. **(9)**

Total : 45

TEXT BOOKS

1. *Roberge P. R., Corrosion Engineering, McGraw Hill, New York, 2008.*
2. *Fontana M.G., Greene N.D., Corrosion Engineering, Third Edition, McGraw Hill, NewYork, 2005.*
3. *Uhling H. H., Revie R.W., Corrosion and Corrosion Control, John Wiley and Sons, Inc, 1985.*

REFERENCE BOOK

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X							X		

13E18 - ENVIRONMENTAL IMPACT ASSESSMENT AND CLEAN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *To give an exposure to various control acts, the advantages and disadvantages of impact assessment methods and how to reduce the waste and its reuse.*

COURSE OUTCOMES :

CO1 : *At the end of the course, it will be possible to apply the various impact assessment methods and also to implement clean technology.*

INTRODUCTION AND VARIOUS ACTS

Introduction and need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies - collection of data and analysis, cost benefit analysis. **(9)**

APPLICATIONS

Application of Impact assessment methods in specific developmental projects, advantages, disadvantages of different methods, applicability of specific methods with examples. **(9)**

PROJECTS

Impact assessment report contents for developmental projects like thermal power projects, refinery process and chemical process industries. **(9)**

CONCEPTS AND AUDITS

Ranking of impacts, concepts and contents of environmental management plan. Environmental audits, waste audit, life cycle assessment, industrial symbiosis. **(9)**

CLEAN TECHNOLOGY

Clean Technology Options: Clean technology and Clean up technology, materials reuse, waste reduction at source and clean synthesis. **(9)**

Total : 45

TEXT BOOK

1. *Kirkwood R. C., Longley A. J., Clean Technology and the Environment, First Edition Chapman and Hall, 1995.*
2. *Larry W. Canter., Environmental Impact Assessment, Second Edition, McGraw Hill book Co., 1997.*

REFERENCE BOOKS

1. *Peter W., Environmental Impact Assessment theory and practice, Taylor and Francis, 1990.*
2. *Harrison L., Environmental Health and Safety Auditing Handbook, Second Edition, McGraw Hill, Inc., New York, 1995.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X							X		X	

13E19 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To give an exposure to the risk assessment techniques.*
- *To estimate financial risk and to assist in emergency planning.*

COURSE OUTCOMES :

CO1 *: Upon the completion of the course it will be possible to explore risk management practices and understand risk management concepts, apply risk analysis techniques and analyze case studies that utilize risk analysis technique.*

INTRODUCTION AND DISPERSION MODELS

Risk analysis introduction, quantitative risk assessment, rapid risk analysis-comprehensive risk analysis-emission and dispersion-leak rate calculation. Single and two-phase flow-dispersion model for dense gas -flash fire-plume dispersion-toxic dispersion model-evaluation of risk. **(9)**

RADIATION INTENSITY

Radiation -tank on fire-flame length -radiation intensity calculation and its effect on plant, people and property radiation VCVCE- explosion due to over pressure- effects of explosion, risk contour -effects, explosion, BLEVE-jet fire-fire ball. **(9)**

RISK ANALYSIS

Overall risk analysis-generation of meteorological data-ignition data-population data-consequences analysis and total risk analysis-overall risk contours for different failure scenarios-disaster management plan-emergency planning-on site and off site emergency planning, risk management ISO 14000, EMS models case studies-marketing terminal, gas processing complex, refinery. **(9)**

HAZARD ANALYSIS

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag-Bopal analysis **(9)**

CASE STUDIES

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system. **(9)**

Total : 45

TEXT BOOKS

1. *Ragavan K.V., Khan A.A., Methodologies in Hazard identification and assessment -Manual, CLRI publication, 1990.*
2. *Marcel.V.C., Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.*

3 *Skeleton B., Process Safety Analysis, Institution of chemical Engineers, U.K., 1997.*

REFERENCE BOOKS

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X			X			X			

13E20 - PROCESS AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *To provide the basic instrumentation, control strategies, optimization and simulation technique that needs to meet global competition and safety regulation.*

COURSE OUTCOME :

CO1 : *At the end the students know very well about the basic measurement, instruments, control strategies, optimization technique and simulation concepts.*

INTRODUCTION

Principles of measurement and classification of process control instruments, temperature, pressure fluid flow, liquid level, velocity, fluid density, viscosity, conductivity etc., instrument scaling, sensors, transmitters and control valves, instrumentation symbols and labels. **(9)**

PROCESS AUTOMATION

Basic concepts, terminology and techniques for process control, control modes, tuning of process controllers. **(9)**

ADVANCED CONTROL

Advanced control techniques, feed forward and ratio control, controller design, adaptive control system, statistical process control, expert system, multivariable control techniques, supervisory control. **(9)**

DIGITAL CONTROL

Digital control techniques, z-transforms, sampling and filtering, response of discrete time systems, sampled data control systems, design of digital controllers. **(9)**

OPTIMAL CONTROL

Optimization and simulation, optimization techniques, single and multivariable constrained optimization, dynamic simulation of distillation columns and reactors. **(9)**

Total : 45

TEXT BOOKS

1. *Nakara B.C., Choudary K.K., Instrumentation and Analysis, Second Edition, Tata McGraw Hill, New Delhi, Seventh Reprint, 2006.*
2. *Stephanopoulos G., Chemical Process Control, Tata McGraw Hill, New Delhi, 1993.*

REFERENCE BOOKS

1. *Karl J.Astrom, Bjorn Willermans., Computer Controlled Systems, Prentice Hall of India Pvt. Ltd., 1994.*
2. *Chemical Engineering Refresher Series on Process Automation, McGraw-Hill Publications, New York, 1991.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X	X							

13E21 - OPTIMIZATION OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the knowledge for the maximizing and minimizing methods for single variable functions.*
- *To develop objective functions for optimizing design of flow and mass transfer equipment.*
- *To improve the ability to solve the optimization problems in chemical processes.*

COURSE OUTCOMES :

CO1 *: Ability to fit data to linear and nonlinear functions.*

CO2 *: Ability to formulate chemical processes as optimization problems.*

CO3 *: Ability to solve linear convex objective functions.*

CO4 *: Ability to simplify and solve complex chemical engineering processes.*

PROBLEM FORMULATION

Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods Lagrange multiplier methods. **(9)**

NUMERICAL METHODS

Unimodal functions; Newton's quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; random, grid. Hooke's Nelder and Mead methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant methods. **(9)**

LINEAR PROGRAMMING

Review on basic concepts of LP formulations; Simplex methods; Duality in linear programming **(9)**

NON-LINEAR PROGRAMMING

The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming. **(9)**

APPLICATIONS

Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems. **(9)**

Total : 45

TEXT BOOKS

1. *Edgar T.F., Himmelblau D.M., Lasdon,L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill Book Co., New York, 2001.*
2. *Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, John Wiley, New York, 1980.*

REFERENCE BOOKS

1. *Biles W.E., Swain J.J., Optimization and Industrial Experimentation, Inter Science, New York, 1980.*
2. *Seinfeld J.H., Lapidus L., Process Modeling, Estimation and Identification, Prentice Hall, Englewood Cliffs, New Jersey, 1974.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X				X					X	
CO2	X		X								X
CO3	X					X		X			
CO4		X	X							X	

13E22 - COMPUTER AIDED DESIGN

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *The students are able to apply knowledge of mathematics, science and engineering to solve numerical problems in Chemical Engineering.*
- *The course gives the student the opportunity to analyze and interpret data, to identify, formulate and solve engineering problems.*
- *To provide the numerical methods for the approximate solution of mathematical equations encountered in chemical engineering.*

COURSE OUTCOMES :

CO1 : *An ability to prepare process flow sheets for design showing reactors, distillation columns and other process equipment.*

CO2 : *An ability to apply knowledge of mathematics, science and engineering.*

CO3 : *An ability to design a system, component, or process to meet desired needs.*

CO4 : *An ability to use the techniques, skills and modern engineering computer tools necessary for engineering practice.*

PHYSICAL PROPERTIES EVALUATION

Review on Programming languages, Physical properties evaluation, Thermodynamic properties of gases, binary mixtures, methods of calculating vapor liquid equilibrium, data for ideal and non-ideal mixture. Bubble point and dew point. Flash and distillation calculation. **(9)**

FLOWSHEETING

Conceptual design- hierarchical approach- General Structure of computer aided design programme - hierarchical design procedure for chemical processes- Importance of Flow sheeting of Flow sheet - Flow sheet structure **(9)**

DEVELOPMENT OF SOFTWARES

Development of Software for rectors- batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions **(9)**

SIMULATION SOFTWARE

Introduction to simulation software Design II, Design of process equipment using Design II - tubular exchanger, surface condenser, evaporator, crystallizer, storage tank. **(9)**

APPLICATIONS OF DESIGN SOFTWARES

Linear Programming, Dynamic Programming in Chemical Engineering, Formulation and solution through PC based programs. Introduction to simulation software Aspen Plus, Simulation of chemical processes using Aspen Plus. Introduction to EVAP software. Design of multiple effect evaporator using EVAP. **(9)**

Total : 45

TEXT BOOKS

1. *Douglas J.M., Conceptual Design of Chemical Processes, McGraw Hill, New York, 1988*
2. *Sinnott R.K., Coulson and Richardson's Chemical Engineering Vol.6, Fourth Edition, Chemical Engineering Design, Butterworth-Heinemann, 2005.*
3. *Hanna O.T., Scandell, O.C., Computational Methods in Chemical Engineering, Prentice Hall, 1995.*
4. *Leasley M.E., Computer Aided Process Plant Design, Gulf Publishing, 1982.*

REFERENCE BOOKS

1. *Jerry O.P., Breneman G.L., Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991.*
2. *Myers A.L., Seider W.D., Introduction to Chemical engineering and Computer Calculations, Prentice-Hall,1976*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1			X				X				
CO2	X				X			X			
CO3			X	X	X						
CO4	X		X				X				X

13E23 - BIOCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *To provide the fundamental background of the principles of biology and biochemistry in order to understand, design and operation of biochemical processes.*
- *To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.*
- *To provide knowledge regarding cell growth patterns and design of various bioreactors.*
- *To expose the students to the various unit operations and unit processes involved in the downstream processing.*

COURSE OUTCOMES :

CO1 *: To understand and use the basic principles of biology and biochemistry to successfully design and operate a biochemical process.*

CO2 *: To derive the kinetic expression for the rates of enzyme catalyzed reactions.*

CO3 *: To understand the factors effecting cell growth and to design and operate various bioreactors.*

CO4 *: To apply various unit operations and unit processes for carrying out downstream processing.*

INTRODUCTION

An overview of industrial biochemical processes with typical examples, comparison of chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains and their classification; structure; cellular genetics; typical examples of microbial synthesis of biologicals. **(9)**

ENZYMES AND ENZYME KINETICS

Enzymes fundamental concepts, classification of enzymes; industrial applications of enzymes; industrially important enzymes; mechanism of enzymatic reactions; Michaelis-Menten and Briggs Haldane equation; Models for complex enzyme kinetics; enzymes inhibition; factors affecting the reaction rates; industrial production, purification and immobilization; enzyme reactors with typical examples. **(9)**

MICROBIAL KINETICS

Typical growth characteristics of microbial cells; factors affecting growth; Monod`s equation; modeling of batch and continuous cell growth; immobilized whole cells and their characteristics. **(9)**

TRANSPORT IN MICROBIAL SYSTEMS

Newtonian and Non-Newtonian behavior of broths; agitation and mixing; power consumption; gas-liquid transport in cells; transfer resistances; mass transfer coefficients and their role in scale-up of equipments; enhancement of O2 transfer; heat transfer correlation; sterilization cycles and typical examples of heat addition during biological production. **(9)**

BIOREACTORS

Batch and continuous types; immobilized whole cell and enzyme reactors; high performance bioreactors; sterile and non-sterile operations; reactors in series with and without recycle; design of reactors and scale-up with typical examples.

Downstream Processes and Effluent Treatment

Recovery and purification of products; Different unit operations in down streaming with special reference to membrane separations; extractive fermentation; anaerobic treatment of effluents; typical industrial examples for downstream processing and effluent disposal. **(9)**

Total : 45

TEXT BOOK

1. *Shuler M.L., Kargi F., Bioprocess Engineering Basic Concepts, Second Edition, Prentice Hall of India, 2002.*
2. *Bailey J.E., Ollis D.F., Biochemical Engineering Fundamentals, McGraw-Hill, International Edition, Second Edition, Reprint, New York, 2010.*

REFERENCE BOOKS

1. *Lee J.M., Biochemical Engineering, First Edition, Prentice Hall, 1992 (Second Edition e-book 2001).*
2. *Blanch H.W., Clark D.S., Biochemical Engineering, Marcel Dekker, 1997.*
3. *Rao D.G., Introduction to Biochemical Engineering, Second Edition, McGraw Hill, 2010.*
4. *Doran P.M., Bioprocess Engineering Principles, Second Edition, Academic press, 1995.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X			X		X					
CO2		X	X					X			
CO3		X	X					X			
CO4		X	X					X			

13E24 - MATERIAL SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *This course explains the basic principles of material engineering, corrosion, its prevention and applications of various materials.*

COURSE OUTCOMES :

CO1 *: To understand the knowledge of different characterization techniques and processing routes of various metals and their alloys as processing routes highly govern the structure of materials.*

NATURE AND PROPERTIES

Nature and properties of materials, phases, binary phase diagrams, iron-carbon equilibrium diagram, time temperature - transformation curves, methods of fabrication and failure under service conditions testing of materials. **(9)**

HEAT TREATMENT

Heat treatment of ferrous metal and alloys: Quenching, tempering, normalizing, carburising, nitriding, carbonitriding, cyaniding and chormizing, siliconizing. **(9)**

CORROSION

Dry corrosion- wet corrosion- mechanisms of corrosion, polarization and corrosion rates, passivity, galvanic corrosion- concentration cell, corrosion Atmospheric corrosion- Underground corrosion- Microbiological corrosion- stray current corrosion pitting, erosion corrosion- stress corrosion- corrosion fatigues- selective corrosion, oxidation and tarnish. **(9)**

CORROSION CONTROL AND PREVENTION

Cathodic protection, anondic protection, metallic coatings, organic coatings, inorganic coatings, inhibitors. **(9)**

APPLICATIONS

Application of the following materials: Iron and steel, Copper, Nickel, Chromium, Aluminium and Zinc and their alloys, Timber, Rubber, Plastics and glass. **(9)**

Total : 45

TEXT BOOKS

1. *Jastrzebski Z.D., Nature and properties of Engineering Materials, John Wiley and Sons, 1987.*
2. *Uhlig R., Winston Reive., Corrosion and Corrosion Control, Third Edition, John Wiley, 1991.*

REFERENCE BOOKS

1. *Cremer C.W., Davies T.R., Chemical Engineering Practice, Vol.9, Butterworths, 1965.*
2. *Raghavan V., Material Science and Engineering, Fifth Edition, Prentice Hall India, New Delhi, 2006.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X		X	X						

13E25 - INTEGRATED DESIGN OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVE :

- *The objective is to emphasize the conceptual issues that are fundamental to the creation of the chemical process design requiring the selection of a series of processing steps and their integration to form a complete manufacturing system.*

COURSE OUTCOMES :

CO1 *: At the end of the course the student will be able to integrate equipment, process and utility system design.*

CO2 *: The course will give an exposure to use raw materials, energy and utility streams as efficiently as is economic and practicable both to prevent the production of waste that can be environmentally harmful and to preserve the reserves of raw materials, fuels and water as much as possible.*

REACTOR CONDITIONS AND CONFIGURATION

Hierarchy and approaches of Chemical process Design and Integration. Role of process economics, optimization.

Reactor Performance - Idealized reactor models and their choice. Reactor conditions - Reactor temperature, pressure and concentration. Reactor Configuration - temperature control, reactors for homogeneous and hetero reactions. **(9)**

HOMOGENEOUS SEPARATORS

Separators for Heterogeneous mixtures. Settling and Sedimentation, Inertial and Centrifugal separation, Filtration, Scrubbing, Flotation and Drying. **(9)**

HETEROGENEOUS SEPARATORS

Separator for Homogeneous fluid mixtures, Distillation, Absorption, stripping and Liquid-Liquid extraction, Adsorption, Membranes, Crystallization, Evaporation, Sequencing. **(9)**

NETWORKING

Reaction, separation and Recycle systems for continuous processes and for batch processes. Heat exchanger networks - Heat transfer equipments, Energy capital and total cost targets, network Design. **(9)**

PROCESS INTEGRATION

Heat Integration of reactions, Distillation columns, Evaporators, Dryers. Steam systems and Cogeneration, Cooling water networking design. **(9)**

Total : 45

TEXT BOOK

1. *Robin Smith, Chemical Process Design and Integration, Second Edition, Willey India Pvt Ltd, New Delhi, 2009.*

REFERENCE BOOKS

1. *Alexandre C. Dimian, Costin Sorin Bildea, Chemical Process Design: Computer-Aided Case Studies, WIELY-VCH Verlag Gmbh and Co KGaA, Weinheim, 2008.*
2. *Anil Kumar, Chemical Process Synthesis and Engineering Design, McGraw Hill, 1982.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X	X		X							X
CO2		X			X						X

13E26 - PIPING AND INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE EDUCATIONAL OBJECTIVES :

- *The objective is to emphasize the fundamental creation of Piping Drawings, Isometric Drawing, Line List, and Shutdown Keys essential for day to day operation of facilities.*
- *This course also prerequisites the drawings for the analysis of emergency situations and the assessment of safety, environmental and regulatory compliance issues.*

COURSE OUTCOMES :

CO1 *: Produce with reasonable accuracy and efficiency a set of working drawings for piping and process instrumentation*

CO2 *: Ability to attain the proper knowledge in the application of instrumentation to P and I for control systems.*

CO3 *: Exhibit a general comprehension of the instrumentation of a plant function and operation.*

INTRODUCTION

Types of flow sheets, Flow sheet Presentation, Flow Sheet Symbols, Process flow diagram- Synthesis of steady state flow sheet - Flow sheeting software. **(9)**

BASICS OF PIPING DRAWINGS

P&ID objectives, guide rules, Symbols, Line numbering, Line schedule, P&ID development, typical stages of P&ID, P&ID for rotating equipment and static pressure vessels, Process vessels, absorber. **(9)**

CHEMICAL EQUIPMENTS DESIGN AND CONTROL

Control System for Heater, Heat exchangers, reactors, dryers, Distillation column and Evaporators. **(9)**

INSTRUMENTATION DESIGN

Distributed Control Systems (DCS), Safety Instrument System (SIS), Instrument Symbols, Instrument Signal Lines, Temperature Instruments, Flow Instruments. **(9)**

APPLICATIONS

Applications of P and I D in design stage - Construction stage - Commissioning stage - Operating stage - Revamping stage - Applications of P and I D in HAZOPS and Risk analysis. **(9)**

Total : 45

TEXT BOOKS

1. *Ernest E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Vol.1, Gulf Publishing Company, Houston, 1989.*
2. *Max. S. Peters, Timmerhaus K.D., Plant Design and Economics for Chemical Engineers, McGraw Hill, Inc., New York, 1991.*

REFERENCE BOOKS

1. *Anil Kumar, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill Publishing Company Limited, New Delhi 1981.*
2. *Westerberg A.N., Process Flow sheeting, Cambridge University Press, 1979.*

Mapping of Course Outcomes with Programme Outcomes											
COs	POs										
	a	b	c	d	e	f	g	h	i	j	k
CO1	X		X		X						
CO2	X		X	X							X
CO3		X			X	X			X		

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GOLDEN JUBILEE

(1956 - 2006)

Department of Chemical Engineering

B.Tech. (CHEMICAL ENGINEERING)

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

(For the students admitted during 2013 - 2014 onwards)

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