B. Tech. (CHEMICAL ENGINEERING)

THIRD TO EIGHTH SEMESTER SYLLABUS

(For the students admitted from 2009-2010 and subsequently)

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution affiliated to Anna University and Accredited by NBA)

COIMBATORE - 641 014

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DEPARTMENT OF CHEMICAL ENGINEERING

Semester III

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CE31	Mathematics III	3	1	0	4
09CH32	Mechanics of Solids	3	0	0	3
09CH33	Heat Power Engineering	3	0	0	3
09CH34	Electrical Technology	3	0	0	3
09CH35	Chemical Process Calculations	3	1	0	4
09CH36	Organic Chemistry	3	0	0	3
	PRACTICALS				
09CH47A	Electrical Engineering Lab	0	0	3	0
09CH47B	Mechanical Engineering Lab				
09CH48	Organic Chemistry and Physical Chemistry Lab	0	0	3	0
09CH49	Science of Creativity and Professional Ethics	2	0	0	0
	Total Credits				**20**

Semester IV

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CH41	Mathematics IV	3	1	0	4
09CH42	Fluid Mechanics	3	0	0	3
09CH43	Mechanical Operations	3	1	0	4
09CH44	Chemical Process Industries I	3	0	0	3
09CH45	Principles of Environmental Science and Engineering	3	0	0	3
09CH46	Physical Chemistry	3	0	0	3
	PRACTICALS				
09CH47A	Electrical Engineering Lab	0	0	3	4
09CH47B	Mechanical Engineering Lab				
09CH48	Organic Chemistry and Physical Chemistry Lab	0	0	3	4
09CH49	Science of Creativity and Professional Ethics	2	0	0	2
	Total Credits				**30**

Semester V

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CH51	Heat Transfer	3	1	0	4
09CH52	Chemical Engineering Thermodynamics	3	1	0	4
09CH53	Mass Transfer-I	3	1	0	4
09CH54	Chemical Process Industries II	3	0	0	3
09CH55	Environmental Engineering	3	0	0	3
09CH56	Instrumental Methods of Analysis	3	0	0	3
	PRACTICALS				
09CH67	Mini Project	0	0	3	0
09CH68	Technical and Instrumental Analysis Lab	0	0	3	0
09CH69	Fluid Mechanics and Mechanical Operations Lab	0	0	3	0
	Total Credits				**21**

Semester VI

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CH61	Process Instrumentation, Dynamics and Control	3	1	0	4
09CH62	Chemical Reaction Engineering	3	1	0	4
09CH63	Mass Transfer-II	3	1	0	4
09CH64	Energy Technology	3	0	0	3
09CH65	Process Equipment Design and Drawing -I	3	0	3	4
09CH66	Chemical Process Plant Safety	3	0	0	3
	PRACTICALS				
09CH67	Mini Project	0	0	3	2
09CH68	Technical and Instrumental Analysis Lab	0	0	3	4
09CH69	Fluid Mechanics and Mechanical Operations Lab	0	0	3	4
	Total Credits				**32**

Semester VII

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CH71	Transport Phenomena	3	1	0	4
09CH72	Process Economics and Industrial Management	3	0	0	3
09CH73	Process Equipment Design and Drawing -II	3	0	3	4
09CH74	Elective I	3	0	0	3
09CH75	Elective II	3	0	0	3
	PRACTICALS				
09CH86	Heat and Mass Transfer Lab	0	0	3	0
09CH87	Reaction Engineering and Process Control Lab	0	0	3	0
09CH88	Project Work and Viva-Voce	0	0	6	0
	Total Credits				**17**

Semester VIII

Subject Code	Subject Name	L	T	P	C
	THEORY				
09CH81	Total Quality Management	3	0	0	3
09CH82	Process Utilities	3	0	0	3
09CH83	Process Modeling and Simulation	3	0	0	3
09CH84	Elective III	3	0	0	3
09CH85	Elective IV	3	0	0	3
	PRACTICALS				
09CH86	Heat and Mass Transfer Lab	0	0	3	4
09CH87	Reaction Engineering and Process Control Lab	0	0	3	4
09CH88	Project Work and Viva-Voce	0	0	6	6
	Total Credits				**29**

LIST OF ELECTIVES

Subject Code	Subject Name	L	T	P	C
09E01	Sugar Technology	3	0	0	3
09E02	Polymer Science and Technology	3	0	0	3
09E03	Petrochemicals Technology	3	0	0	3
09E04	Fertilizer Technology	3	0	0	3
09E05	Food Technology	3	0	0	3
09E06	Pulp and Paper Technology	3	0	0	3
09E07	Industrial Waste Water Treatment	3	0	0	3
09E08	Surface Coating Technology	3	0	0	3
09E09	Petroleum Refinery Engineering	3	0	0	3
09E10	Electrochemical Engineering	3	0	0	3
09E11	Modern Separation Techniques	3	0	0	3
09E12	Mineral Processing Technology	3	0	0	3
09E13	Operations Research	3	0	0	3

Subject Code	Subject Name	L	T	P	C
09E14	Advanced Chemical Reaction Engineering	3	0	0	3
09E15	Fluidization Engineering	3	0	0	3
09E16	Drugs and Pharmaceuticals Technology	3	0	0	3
09E17	Energy Management in Chemical Industries	3	0	0	3
09E18	Corrosion Science and Engineering	3	0	0	3
09E19	Environmental Impact Assessment and Clean Technology	3	0	0	3
09E20	Risk Analysis and Hazop	3	0	0	3
09E21	Process Automation	3	0	0	3
09E22	Optimization of Chemical Processes	3	0	0	3
09E23	Computer Aided Design	2	1	0	3
09E24	Biochemical Engineering	3	0	0	3
09E25	Material Science and Technology	3	0	0	3
09E26	Process Instrumentation	3	0	0	3
09E27	Integrated Design of Chemical Processes	3	0	0	3

L - Lecture, T - Tutorial, P - Practical, C - Credit

09CE31 - MATHEMATICS III

(Common to Third Semester B.E., / B.Tech, all Branches)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

The objective is to incorporate the ideas of complex variables, partial differential equations and its applications and Fourier transforms that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

OUTCOME

At the end of this course the students will be familiar in applying Complex variables ideas to solve Engineering problems, Partial differential equation ideas in modeling and solving Engineering problems and Fourier Transform ideas to analyze and solve communication oriented problems.

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, $\frac{1}{z}$, 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.et al ., "Engineering Mathematics", Volume - II & III S.Chand &Co. (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", (for B.E., Third Semester), (Revised and Enlarged Fourteenth Edition) The National Publishing Company, (2008).*
4. *Venkataraman.M.K., "Engineering Mathematics III-A",(Eleventh Edition) The National Publishing Company, (2008).*

REFERENCE BOOKS

1. *Erwin Kreyszig, "Advanced Engineering Mathematics", (8th Edition), John Wiley & Sons (Asia) Private Limited. (2008).*
2. *Grewal B.S., "Higher Engineering Mathematics", (40th Edition), Khanna Publishers (2007) .*

09CH32 - MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The study of fundamental concepts of solid mechanics is essential to analyse and make solutions to field problems.

OUTCOME

The knowledge of this subject is promoting an Engineer to enable him in designing his all types of structures and machines.

CONCEPT OF STRESS AND STRAIN

Simple stresses and strains at a point -Normal and shear Stresses - Hook's Law - Young's modulus - Bars subjected to axial Forces - simple problems. Thermal stresses - Simple statically Indeterminate problems like compound bars - Elastic constants - Modulus of rigidity - Bulk modulus - Relationships. **(8)**

TRANSVERSE LOADING ON BEAMS

Beams - support conditions - types of beams - transverse loading on beams - shear force and bending moment in beams - analysis of cantilevers, simply supported beams and over hanging beams - relationships between loading, S.F. and B.M. in beams and their applications -S.F. and B.M. diagrams. **(8)**

STRESSES IN BEAMS

Theory of simple bending - assumptions and derivation of bending equation - analysis of stresses in beams - load carrying capacity of beams - proportioning of beam sections - leaf springs - flitched beams - shear stress distribution in beams - determination of shear stress in rectangular beams. **(8)**

TORSION

Torsion of solid and hollow circular shafts - Power transmitted through shafts - closed coiled helical springs - spring constants - springs in series and springs in parallel. **(8)**

COLUMNS

Axially loaded short columns - columns of unsymmetrical sections - Euler's theory of long columns - critical loads of prismatic columns with different end conditions - Rankine's empirical theory. **(8)**

PLANE TRUSSES

Analysis of statically determinate plane trusses - Method of Joints and method of sections. **(5)**

Total : 45

TEXT BOOKS

1. *Dr.R.K.Bansal, Strength of Materials , Fourth Edition, Laxmi Publications (p) Ltd (2007).*
2. *Dr.Sadhu Singh, Strength of materials, Third Edition, Khanna Publications, New Delhi, (2003)*

REFERENCE BOOKS

1. *R.S. KHURMI, Strength of Materials, First Edition Reprint, S.Chand and Company Ltd, (2005)*
2. *J.P. SINGH, Mechanics of Solids, Fourth Edition, Khanna Publications, New Delhi,(2005)*

09CH 33 - HEAT POWER ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This subject is introduced to make the students study about heat energy conversion devices. Also the production of cooling effect and heating effect in a confined space is studied.

OUTCOME

The students will acquire knowledge of the various heat power systems to apply for an application.

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

Otto cycle, Diesel cycle, Dual cycle, comparison. Mean Effective Pressure (MEP) - Brayton cycle - Simple problems. **(6)**

GAS TURBINES

Open and closed cycle gas turbine system - practical gas turbines - Regeneration - Intercooling and Reheating - Simple Problems. **(6)**

JET PROPULSION

Turbo jet - thrust - thrust power - propulsion efficiency - Rocket propulsion. **(3)**

STEAM BOILERS

Properties of steam - steam tables and charts. Study of boilers - fire tube, water tube boilers- Mounting - Accessories. **(6)**

STEAM POWER CYCLE AND TURBINES

Steam Power Cycle - Working Principle - simple problems.

Steam Turbines - Principle of impulse and reaction turbines - compounding of turbines - Simple problems. **(6)**

REFRIGERATION & AIR-CONDITIONING

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

Total : 45

TEXT BOOKS

1. *Rudramoorthy R., "Thermal Engineering", Tata McGraw Hill, 2007.*
2. *Kothandaraman C.P., Khajuria P.R., Arora S.C. & Domkundwar, S., " A Course in Thermodynamics and Heat Engines", Dhanpat Rai & Sons, 2007.*

REFERENCE BOOKS

1. *Rajput R .K., "Thermal Engineering", Laxmi Publication (P) Ltd., 2005.*
2. *Ballaney P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 2005.*

09CH34 - ELECTRICAL TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To acquire basic knowledge in AC and DC machines and to drive the machines using solid state schemes. To know about various sensor operations and electronic controllers.

OUTCOME

Students gain knowledge in AC machines, DC machines, transformers, electric drives, sensors, and electronic controllers.

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 - 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

Characteristics of electric drives and loads-selection of motor rating. Speed control of DC motors: Converter fed DC drives. Induction motor drives: Methods of speed control-solid state speed control schemes

(no analysis required). Selection of drives for industrial, agricultural and marine applications. **(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)**

ELECTRONIC CONTROLLERS

Introduction to A/D and D/A converters, microprocessors-general block diagram (8085), temperature control, liquid level control. Programmable logic controllers: PLC programming, ladder diagram. **(9)**

Total : 45

TEXT BOOKS

1. *Mittle V.N. "Basic Electrical Engineering", Tata McGraw Hill, New Delhi, 2005.*
2. *Dubey G.K , "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2002.*
3. *Sawhney A.K, "A Course in Electrical and Electronics Measurements", Dhanpet Rai and Sons, New Delhi, 2007.*

REFERENCE BOOKS

1. *Robert L.Boylsteadd and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education Asia, 2005.*
2. *Ian G.Warnock, "Programmable Controllers Operation and Application", Prentice Hall International, UK,1992.*
3. *Singh S.K, "Industrial Instrumentation and Control", 3rd Edition, Tata McGraw Hill Publishers, New Delhi 2009.*

09CH35 - CHEMICAL PROCESS CALCULATIONS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Every Chemical reaction involves consumption of materials and energy. The reactions are to be balanced with correct quantity of materials and energy to achieve good percentage conversion of products. The main Objective of this course is to give a fundamental knowledge on such material and energy balances with a proper understanding of the properties of solid, liquid and gaseous phases and also the various unit operations in Chemical industries.

OUTCOME

At the end of the course it will be possible to accurately calculate the material and energy requirement of an entire process with a clear understanding of the properties of the pure substances and all the basic operations and processes in a Chemical industry.

MATHEMATICAL PRINCIPLES

Graphical and Numerical methods of data fitting - Extrapolation and Interpolation techniques.

Units and dimensions :Basic and derived units - Different ways of expressing units & quantities .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)**

HUMIDITY AND SATURATION

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

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

MATERIAL BALANCE

Concepts of tie elements, recycle, by-pass and purge. Batch, stage wise and continuous operations. Material balance in systems without chemical reactions. Concept of limiting and excess reactants, 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, Trouton's rule. Standard heat of reaction, formation & combustion, Hess's law of heat summation and its application to determine heat of reaction, heat of neutralisation, 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)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Bhatt B.I. & Vora, S.M.: Stoichiometry, (2nd Ed.), Tata-McGraw Hill, New Delhi, (2004).*
2. *Narayanan. K.V. and Lakshmikutty .B "Stiochiometry and Process Calculations" 1st Edition Prentice-Hall of India private limited, New Delhi(2006).*

REFERENCE BOOKS

1. *David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, (6th Ed) Prentice Hall of India, (1997).*
2. *Hougen O.A., Watson R.M. & Ragatz R.A.: Chemical Process Principles - Part I, (2nd Ed.), John Wiley (ISE), (1976).*

09CH36 - ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The course is to provide essential fundamental concepts of electron displacement effects that occur in organic molecules, preparation, characteristics and applications of cycloalkanes, aromatics, heterocyclics, alkaloids, carbohydrates and organo-metallics.

OUTCOME

After successful completion of the course, the students shall have thorough knowledge of the fundamentals of organic chemistry, useful synthetic applications and structural features of varied organic molecules, physiological and medicinal values of organic compounds and scope for novel organic chemicals.

NOMENCLATURE AND ELECTRON DISPLACEMENT EFFECTS

Nature and structure of organic molecules - Homologous series - Functional groups - IUPAC nomenclature.

Electron Displacement Effects - Inductive, Electromeric, Mesomeric and Hyperconjugative effects and Applications. **(8)**

ALICYCLICS AND AROMATICS

Cycloalkanes: Preparation, properties and stability of Cycloalkanes - Baeyer's strain theory - Sachse-Mohr concept of strainless ring systems.

Recovery of benzene and their homologous from coal tar and petroleum.

Aromaticity - Electrophilic substitution reactions of benzene and toluene. Orientation and reactivity - Disubstitution in benzene - theories of orientation. **(8)**

STEREOCHEMISTRY

Geometrical isomerism - Beckmann rearrangement - Optical isomerism - Configurational isomerism - D - L and R-S systems - Racemization - Resolution - Asymmetric synthesis - Walden inversion.

Conformational isomerism - Conformers of ethane, propane, butane and cyclohexanes. **(7)**

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.

Polysaccharides : sources and structures (no elucidation) of starch and cellulose - Applications of cellulose derivatives. **(7)**

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, preparation, 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 Atropine. **(8)**

SYNTHETIC APPLICATIONS OF ORGANIC COMPOUNDS AND DYES

Synthetic applications of Grignard reagents, Organolithium, Organolead and Organozinc - synthetic 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). **(7)**

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, Newyork, 2004*
2. *I.L. Finar, "Organic Chemistry Vol. 1. The Fundamental Principles" 6th Edition ELBS Edition, England, 2002*

09CH41 - MATHEMATICS IV

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

The objective is to incorporate the basic Numerical methods required for solving Engineering problems and also to study the basic Statistical ideas that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

OUTCOME

At the end of this course the students will be familiar in applying Numerical methods for solving the system of equations and Ordinary differential equations and Partial differential equations. They will also be familiar in Two dimensional random variables and curve fitting and sampling theory and 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 series - Modified Euler - 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 - inverse 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., et al., "Numerical methods", S Chand and Company (2008).*
2. *Kandasamy P., et al, "Probability Statistics and Random Process", (S Chand and Company (2008) .*
3. *Veerarajan T., "Engineering Mathematics", (III Semester) (Third Edition) Tata.McGraw-Hill Publishing Company Limited (2008).*
4. *Veerarajan T, "Probability Statistics and Random Process", (Third edition) (2007) Tata McGraw Hill Publishing Company Limited.*

REFERENCE BOOKS

1. *Kapoor J.N and Saxena H.C., "Mathematical Statistics", (12th Edi.), S Chand and Company (2003).*
2. *Grewal B.S . "Higher Engineering Mathematics", (40th Edi.) Khanna Publishers (2007)*
3. *Grewal B.S., "Numerical Methods in Science and Engineering", (40th Edi.) Khanna Publishers (2007).*
4. *Venkataraman M.K., "Numerical Methods in Science and Engineering", (5th Edi.) National Publishing Company (2008) .*

09CH42 - FLUID MECHANICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To develop an understanding of the essential concepts of fluid dynamics including continuum concept, statics of fluid systems, flow in conduits and flow through packed beds. To cover the topics of applications of dimensional analysis and its applications in fluid flow.

OUTCOME

A clear understanding of the fluid mechanics fundamentals and the ability to solve problems in fluid mechanics.

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.

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 **(9)**

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. **(9)**

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 - Dimensional analysis and its applications in fluid flow. **(9)**

Total : 45

TEXT BOOK

1. *McCabe W.L, Smith J C and Harriot. P "Unit operations of Chemical Engineering", McGraw Hill, VI Edition, 2001*

REFERENCE BOOKS

1. *Douglas J.F.,Gasiorek, J.M.,& Swaffielf, J.A,"FLUID MECHANICS", Pitman,(1979).*
2. *Hughes. F, John A Brighton and Nicholas Winowich., "Schaum's Outline of Fluid Dynamics, 1999*
3. *Ranald. V.Giles, Cheng Liu and Jack Evett., Schaum's outline of Fluid Mechanics & Hydraulics, 3rd Edi., 2009*

09CH43 - MECHANICAL OPERATIONS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Knowledge of basic fundamentals of engineering and science include general material balance and fundamental laws of science. The knowledge of mathematics will also help while understanding derivation for some equipments or operation. This course of study is to give students basic knowledge about hydro-mechanical operations and its applications in process industry so as to improve their intellectual understanding for solving of different process problems.

OUTCOME

On successful completion of this course, it will be possible to understand various mechanical operations which are very essential in the chemical process industries and also to solve different problems related to size reduction, size separation, mixing and agitation.

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 & 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 & Impingement methods. **(12)**

MIXING AND AGITATIONS

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

SIZE SEPARATION BY SETTLING AND SEDIMENTATION METHODS

Drag on spherical and non-spherical particles, Terminal settling velocity under laminar and turbulent conditions (Stokes' law & Newton's law). Size separation by settling methods - Free settling & 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. *W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th Ed., McGraw-Hill, New York, 2005.*

2. *Badger, W.L., & Banchero, J.T.: Introduction to Chemical Engineering, McGraw Hill (ISE), (1955).*

REFERENCE BOOKS

1. *R. H. Perry and D. W. Green, Ed., Perry's Chemical Engineer's Handbook, (8th Ed.) McGraw-Hill, New York, 2007.*
2. *C.M. Narayanan & B.C. Bhattacharyya, Mechanical Operation for Chemical Engineers (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 2005.*

09CH44 - CHEMICAL PROCESS INDUSTRIES I

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To introduce the basic concepts in process flow sheeting, unit operations, major engineering problems in inorganic process industries.

OUTCOME

Upon successful completion of this course student will be able to understand general process flow diagrams, parameters, major engineering problems and they can also sort out any kind of problem which is possible to occur in common chemical process industries

WATER, SALT AND SULPHUR BASED INDUSTRIES

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

INDUSTRIAL GASES NITROGEN AND PHOSPHORUS 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 & Phosphate esters. Mixed fertilizers (NPK Mixtures). Materials for handling, storage and transportation. **(9)**

ELECTROCHEMICAL AND SURFACE COATING INDUSTRIES

Aluminium, Magnesium, Sodium, Calcium carbide & Calcium cynamide. Constituents of paints & varnishes and their functions. Paint mixing

process. Manufacture of pigments such as White lead, Zinc oxide, Lithopone and Titanium dioxide. Manufacture of varnishes & Lacquers. Materials for handling, storage and transportation. **(9)**

CEMENT, LIME AND CERAMIC INDUSTRIES

Types of cements, their properties and applications. Manufacture of Portland cement. Beneficiation & 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, safety glass & Pyrex glass. Manufacture of porcelain, enamel and chemical stoneware. Materials for handling, storage and transportation. **(9)**

REFRACTORY MATERIALS

Properties of refractory materials. Manufacture of refractories. Varieties of refractories - 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, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).*
2. *Austin G.T.: Shreve's Chemical Process Industries, (5th Ed.), McGraw Hill (ISE), (1984).*
3. *Shukla S.D., Pandey G.N. : A Text Book of Chemical Technology, Vol.I, Vikas, New Delhi, (1994).*

REFERENCE BOOKS

1. *Venkateswaralu D., Upadrashta K.R. & Chandrasekaran K.D. (Editors): CHEMTECH - I, S. Chand & Co., 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, (1974).*
4. *Stephenson R.M. : Introduction to Chemical Process Industries, Van Nostrand, New Jersy, (1966).*
5. *Furnas C.C.(Editor) : Roger's Manual of Industrial Chemistry, Vol. I, (6th Ed.), Van Nostrand, New Jersy, (1942).*
6. *Lowenheim F.A. & Moran M.K.: Faith, Keyes and Clark's INDUSTRIAL CHEMICALS, (4th Ed.), John Wiley, New York, (1975).*

09CH45 - PRINCIPLES OF ENVIRONMENTAL SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course is intended to provide a basic knowledge of the environment, threat to environment, social issues related to it, the necessity for Environmental Legislation, Sustainable Development and the option of Green Chemistry.

OUTCOME

After successful completion of this course, the students shall have better understanding of the concept of environment, the causes for deterioration, the measure taken for its preservation and the need for Sustainable Development.

ENVIRONMENTAL CHEMISTRY

Chemistry and environment - Environmental segments - Composition and characteristics of Atmosphere, Hydrosphere, Lithosphere, and Biosphere: Chemical species and particulates present in the environment - reactions in the atmosphere. Photochemical smog. Impact of man on environment. Impact of environment upon humans.

(9)

ECOSYSTEMS AND BIODIVERSITY

Concepts of an ecosystem: types, structure and functions of the ecosystem. Food chains, food webs and ecological pyramids.

Biodiversity: Definition - Genetic, species, ecosystems and landscape diversities - India as a mega diversity nation - Hot spots of biodiversity. Importance of biodiversity - loss of biodiversity - causes of reduction in biodiversity. Conservation of biodiversity - restoration of biodiversity.

(9)

ENVIRONMENTAL POLLUTION

Sources, causes, effects and management of Air, Water, Soil, Marine, Noise and Radioactive pollution.

Sources of Solid, Hazardous, Biomedical and Chemical wastes. Solid Waste Disposal and treatment methods. **(9)**

ENERGY AND ENVIRONMENT

Energy resources - Growing energy needs - renewable and non-renewable energy sources - use of alternate energy sources - Solar, Wind, Tidal Geothermal and OTEC (Principles only) merits and limitations. **(3)**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development - Urban pollution - Problems related to energy - Water conservation. Rainwater harvesting - Environmental ethics - Green house effect, Global warming, climate change, Nuclear hazards and accidents. Issues involved in enforcement of environment legislation - precautionary principle - polluter pays principle the beneficiary pays principle role of an individual in environment protection - Environment (protection) Act - Air (prevention and control of pollution) Act. Water (Prevention and control of pollution) Act. Wildlife protection Act and Forest (conservation) Act. **(9)**

BIOTECHNOLOGY AND GREEN CHEMISTRY

Biotechnology and its application in environmental protection - Bioinformatics - Bioremediation. Biological purification of contaminated air.

Green chemistry for clean technology: Significance of green chemistry - Basic components of green chemistry. Industrial applications of green chemistry. Green fuels - e -green propellants and bio catalysts. **(6)**

Total : 45

TEXT BOOKS

1. *Dara S.S. "A Text Book of Environmental Chemistry and Pollution Control". Eighth revised edition S.Chand and Company Ltd., 2008.*
2. *Kaushik A. and Kaushik C.P. "Environmental Science and Engineering" Second Edition, New Age International (P) Limited Publishers, 2006.*
3. *Dr. Raghavan Nambiar K. " Text book of Environmental Studies" Scitech Publications (India) Pvt. Ltd., Chennai, 2007.*

REFERENCE BOOKS

1. *Benny Joseph, "Environmental Studies" Tata McGraw Hill Publishing Company Ltd., 2008.*
2. *Surinder Deswal and Anupama Deswal, "A Basic Course in Environmental Studies" Dhanpat Rai & Co. (P) Ltd., 2006.*

09CH46 - PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on the fundamental and application aspects of Physical Chemistry

OUTCOME

After successful completion, the student shall be familiar with reaction kinetics and surface behaviour of chemical compounds.

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. *Atkins P and Paula D.J "Atkins' Physical Chemistry", Seventh Edition, Oxford University Press, London, 2003*
3. *Bahl B.S., Tuli G.D., Bahl. A "Essentials of Physical Chemistry", S.Chand and Company, New Delhi, 2006.*

REFERENCE BOOKS

1. *Soni P.L., Charmarha O.P., Dash U.N., "Textbook of Physical Chemistry", Twenty Second Edition, S.Chand & Sons, New Delhi 2006*
2. *Raj G., "Advanced Physical Chemistry", 27th Edition, Goel Publishing Company, New Delhi 2002*
3. *Kundu M., Jain S.K., "Physical Chemistry", S. Chand and Sons, New Delhi, 2004*

09CH47A - ELECTRICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

OBJECTIVE

To give hands on training on the instrument calibration and to conduct all basic tests on DC machines, transformers and AC machines and to study their performance and to study the transducers.

OUTCOME

The students will be able to diagnose the errors in the measuring instruments and analyze the performance of DC machines, transformers and DC machines using different tests and also able to learn about transducers also.

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

Total : 30

09CH47B - MECHANICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

OBJECTIVE

To make the students to understand the concepts of thermodynamics, thermal engineering and IC engines.

OUTCOME

To acquire the practical knowledge about the IC engines and Refrigeration and Air Conditioning.

EXPERIMENTS

1. Viscosity of lubrication oil by Say Bolt Universal Viscometer.
2. Viscosity of lubrication oil by Red Wood Viscometer.
3. Flash and Fire point test by open cup Cleveland apparatus.
4. Flash and Fire point test by Pensky- Marten apparatus.
5. Calibration of Pressure and Vacuum gauges.
6. Load test on Kirloskar Engine.
7. Port timing diagram on Two-Stroke Engine.
8. Valve timing diagram on Four-Stroke Engine.
9. Volumetric efficiency of Reciprocating Air Compressor.
10. Heat balance test on Field Marshal Engine.
11. Economic speed test on DPF Engine.
12. Calorific Value by Junker's Gas Calorimeter.
13. Study of Internal Combustion (IC) Engine and Boiler.
14. Performance test on Vapour Compression Refrigeration System.
15. Performance test on Heat Pump.
16. Study of Air - Conditioning System test rig.

Total : 30

09CH48 - ORGANIC CHEMISTRY AND PHYSICAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

OBJECTIVE

To train the students to prepare and characterize simple organic molecules and to make students appreciate the principles involving physical and chemical aspects of different substances.

OUTCOME

After successful completion of the practical course, the students shall be well-versed with single stage synthetic organic preparations, quantifications, purifications, the nature, properties and analytical applications of organic compounds and further the students shall understand reaction mechanisms, kinetics, conductance, characteristics and surface behaviour of chemical substances.

I Organic Chemistry Experiments

Preparation of Organic Compounds (Any Six)

1. Preparation of Acetanilide from Aniline
2. Preparation of Benzoic acid from Ethyl benzoate
3. Preparation of Salicylic acid from Methyl salicylate
4. Preparation of Sym. Tribromoaniline from Aniline
5. Preparation of Nitrobenzene from Benzene
6. Preparation of m - Dinitrobenzene from Nitrobenzene
7. Preparation of Benzoic acid from Benzaldehyde
8. Preparation of Benzanilide from Aniline
9. Preparation of Phthalimide from Phthalic acid
10. Preparation of Aspirin from Salicyclic acid.

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

1. Aldehydes and Ketones
2. Amides and Imides
3. Amines
4. Carbohydrates
5. Carboxylic acids
6. Esters
7. Nitrocompounds
8. Phenols.

II Physical Chemistry Experiments

1. Determination of transition point of the given salt hydrate.
2. Determination of partition coefficient of iodine between water and Carbon tetrachloride
3. Determination of association factor of benzoic acid between benzene and water
4. Determination of equilibrium constant for the triiodide formation by partition method.
5. Determination of heat of neutralization of hydrochloric acid and sodium hydroxide.
6. Determination of heat of solution of ammonium chloride, ammonium nitrate and potassium nitrate.
7. Determination of specific rate constant for the reaction between potassium persulphate and potassium iodide.
8. Determination of velocity constant of acid hydrolysis of methyl acetate.
9. Determination of CST for phenol-water system.
10. Study of effect of impurity on CST of phenol water system.

11. Construction of binodal curve for water, nitrobenzene, and acetic acid.
12. Determination of the strength of an acid by conductometric method.
13. Determination of the strength of ferrous sulphate potentiometrically.
14. Determination of Freundlich and Langmuir adsorption isotherms of acetic acid in aqueous solution by activated charcoal.

Total : 60

TEXT BOOKS

1. *Venkateshwaran V., Veeraswamy R., Kulandaivelu A.R., "Basic Principles of Practical Chemistry", Second Edition, S. Chand & Sons, New Delhi. (2004)*
2. *Dey B.B., Sitaraman M.V. and Govindachari T.R., "Laboratory Manual of Organic Chemistry", Fourth Edition, Allied Publishers, New Delhi. (1992).*

REFERENCE BOOKS

1. *Puri B.R., Sharma L.R., Pathania M.S., "Elements of Physical Chemistry", Second Edition, Vishal Publishing Company, Jalandhar. (2004).*
2. *Bahi B.S., Tuli G.D., Bahl A., "Essentials of Physical Chemistry", S. Chand and Company, New Delhi. (2004).*

09CE49 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
2	0	0	2

ASSESSMENT : THEORY

OBJECTIVE

The objective is to inculcate among the students the importance of spirituality, yoga and procedures to manage stress and strain and to impart the knowledge of professional and management skills.

OUTCOME

The students will be able to manage stress and strain in their profession in future. They will have knowledge of introspection procedures, practical considerations and guidelines for their living.

INTRODUCTION

Science of creativity and personality development - objectives - evolution of the universe - creation theory - evolution theory - theory of permanence - theory of mithya - big-bang theory - static and dynamic States - etherial particles - panchabhudas - evolution of life - science and spiritualism - physical transformation of biomagnetism - harmony in life - self, family, society and nature - cause and effect system. **(9)**

LIFE FORCE, MIND AND CONCIOUSNESS

Life force - origin - potentiality of the life force - pathway to realize universal force - premordial state - almighty - mind - existence and purpose of mind - greatness and mystery - role of mind in shaping one's personality - ten stages - totality - wisdom - consciousness - sixth sense - action, word and deed - six temperaments. **(9)**

TECHNIQUES FOR SELF EVALUTION

Blockades for personality development - six impurities - introspection - analysis of thought - moralization of desire - eradication of worries - neutralization of anger - realization of self or actualization of the universe - understanding of morality, duty and charity - yoga - different types -

kundalini yoga - nine centers - removal of six imprints - meditation and its benefits. **(9)**

HUMAN BODY

Body structure - endocrine glands and six chakras - seven thadus - health and nature - medicines - understanding the need, habit, environmental conditions, society and evolutionary process of life - physical exercise and its importance - regulating food, work, rest, sex and thought. **(9)**

PROFESSIONAL ETHICS

Engineering Ethics - variety of moral issues - moral autonomy - professions and professionalism - professional ideals and virtues - engineers as responsible experimenters - safety and risk - reducing risk - collegiability and loyalty - professional rights - intellectual property rights - multinational corporations - environmental ethics - engineers as managers. **(9)**

Total : 45

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications, 1986.*
2. *Mike Martin and Roland Schinzinger,"Ethics in Engineering", McGraw Hill, NewYork 1996.*

REFERENCE BOOKS

1. *Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.*
2. *Laura Schlesinger, "How Could You Do That: The Abdication of Character, Courage, and Conscience", Harper Collins, NewYork, 1996.*

3. *Stephen Carter, "Integrity", Basic Books, NewYork, 1996.*
4. *Tom Rusk, "The Power of Ethical Persuasion: From Conflict to Partnership at work and in Private Life", Viking, NewYork, 1993.*
5. *R.S. Naagarazan, "A Text book on Protenional Ethics and Human Values", New Age International Publishers, New Delhi, 2009.*

09CH51 - HEAT TRANSFER

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Heat transfer is the science dealing with the transfer of energy in the form of heat from one body to another as a result of a temperature difference between them. The science of heat transfer provides an explanation for the different modes of heat transfer and also enables one to predict the rate at which energy transfer takes place under specified conditions.

OUTCOME

At the end of the course it is possible to develop the students' skills in applying differential equations for describing steady state heat transfer problems with and without phase changes, practical analysis skills associated with conductive and convective heat transfer and design calculations of heat transfer equipments.

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)**

COVECTION

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)**

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)**

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)**

Theory : 45

Tutorial : 15

Total : 60

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', 8th Ed., McGraw Hill, 1997.*

REFERENCE BOOKS

1. *McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 6th Ed., McGraw-Hill, 2001.*
2. *Kern D.Q., " Process Heat Transfer ", McGraw-Hill, 1999.*
3. *Coulson J.M. and Richardson J.F., "Chemical Engineering" Vol. I, 4th Ed., Asian Books Pvt. Ltd., India, 1998.*
4. *Donald Pitts., "Schaum's Outline of Heat Transfer", 1998.*

09CH 52 - CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Thermodynamics plays a vital role in both unit operations and unit processes. This course covers the basic concepts of thermodynamics, application of thermodynamics to phase equilibria including fundamental property relations, partial molar properties, Vapour liquid Equilibria.

OUTCOME

At the end of the course it will be possible to apply first law and second law of thermodynamics to open and closed systems, to evaluate the feasibility and efficiency of a process. It is also possible to analyze refrigeration cycles, to determine the equilibrium composition for a reacting system given the stoichiometry, temperature and pressure.

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. PVT behaviour of gases. Equation of states. 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 Vapor liquid equilibrium data. **(12)**

CHEMICAL REACTION EQUILIBRIA

Criteria of equilibrium. Standard free energy change and equlibrium constants. Effect of temperature. Evaluation of equlibrium 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.: Introduction to Chemical Engineering Thermodynamics, (7th Ed.), Tata McGraw Hill (ISE),(2007)*

REFERENCE BOOKS

1. *Dodge B.F.: Chemical Engineering Thermodynamics, McGraw Hill (ISE), (1960).*
2. *Sandler S.I.: Chemical and Engineering Thermodynamics, (2nd Ed.), John Wiley (ISE),(1989)*
3. *Y.V.C. Rao, "Chemical Engg Thermodynamics", united press (India) ltd.1997.*
4. *K.V. Narayanan ,"Atext Book of C.E.T" Prentice-Hall of India Pvt Ltd 2001.*
5. *Merle Potter and Craig Somerton., "Schaum's outline of Thermodynamics for Engineers, 2nd Edi., 2009*
6. *Hendrick.C.Vanness and Michael M.Abbott., "Schaum's outline of Thermodynamics with Chemical Applications", 1989.*

09CH53 - MASS TRANSFER I

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Mass transfer operation is one of the unit operations of Chemical Engineering concerned with a problem of changing the compositions of solutions and mixtures through methods not necessarily involving chemical reactions. Mass transfer operations are usually used for preliminary purification of raw materials and final separations of product from byproduct.

OUTCOME

It imparts the knowledge of various separation methods like diffusion, humidification, drying and crystallization. The student shall enrich with knowledge of simultaneous heat and mass transfer operations.

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. **(12)**

HUMIDIFICATION

Humidification operation of air-water system. Psychrometric 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. **(12)**

CRYSTALLIZATION

Factors governing nucleation and crystal growth, theory of crystallization. Batch and continuous crystallizers. Performance and applications of Industrial crystallizers. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *McCabe W.L., Smith J.C. & Harriott P.: Unit Operations of Chemical Engineering (7th Ed.), McGraw Hill (ISE), (2005).*
2. *Treybal R.E.: Mass Transfer Operations,(3rd Ed.), McGraw Hill (ISE), (1980).*

REFERENCE BOOKS

1. *Badger W.L. & Banchero J.T.: Introduction to Chemical Engineering, McGraw Hill (ISE), (1955).*
2. *Geankoplis C.J., "Transport Processes and Unit Operations", 3rd Ed., Prentice Hall of India Pvt Ltd, New Delhi, 2004.*

09CH54 CHEMICAL PROCESS INDUSTRIES II

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on various aspects of production engineering and understand the practical methods of production in chemical factory

OUTCOME

Upon completion of the course student will be able to describe the general process flow diagrams, parameters, major engineering problems in common chemical industry and also will be able to choose proper raw material, operate plant efficiently, safely and economically.

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 Cane sugar. Manufacture of Ethyl alcohol, Acetic acid & 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 & 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 & 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, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).*
2. *Austin G.T.: Shreve's Chemical Process Industries, (5th Ed.), McGraw Hill (ISE), (1984).*
3. *S.D., Pandey G.N. : A Text Book of Chemical Technology, Vol.II, Vikas, 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. (Editor): Roger's Manual of Industrial Chemistry, Vol. II, (6th Ed.), Van Nostrand, New Jersy, (1942).*

09CH55 - ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The main objective of this subject is to create awareness on the various environmental pollution aspects and issues. A comprehensive insight into natural resources, ecosystem and biodiversity. And also educate the ways and means to protect the environment from various types of pollution and their disposal methods.

OUTCOME

The Students able to understand the chemistry, biological, ecological, and physical concepts necessary to analyze basic environmental engineering problems and to understand the important local, regional, and global problems as they relate to air pollution, solid waste management and water quality.

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 & Eddy Inc.,"Waste Water Engineering, Treatment and Disposal", Tata McGraw Hill, New Delhi, (1987).*

REFERENCE BOOKS

1. *Pandey G.N. & Carney G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi, 1998.*
2. *Kapoor B.S, "Environmental Engineering - (An Overview)", (3rd Ed.,) Khanna Publishers, Delhi, 1989.*

09CH56 - INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course is intended to provide the students with the fundamental knowledge of various analytical techniques like U.V., I.R., N.M.R., and Mass spectroscopic techniques and thermal methods like TGA and DTA.

OUTCOME

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

UV Spectroscopy and NMR 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. Principles of colorimetry - multiple standard method - dilution method. **(5)**

NMR Spectroscopy

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

IR Spectroscopy and Mass 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 - Mc Lafferty rearrangement - applications. **(4)**

SEPARATION 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 method. **(2)**

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. **(5)**

Fluorimetric method - fluorescence - phosphorescence - theory - fluorimeter. **(2)**

Turbidimetry and Nephelometry - principles - turbidimeter - applications. **(2)**

ELECTROCHEMICAL METHODS

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

Conductometric titrations principle - specific conductance - equivalent conductance - conductivity cell - measurement of conductance - types of Conductometric titrations. Applications - advantages. **(3)**

Potentiometric titrations - theory - instrumentation - acid base titrations - redox titrations - Applications - advantages. **(3)**

Total : 45

TEXT BOOKS

1. *Sharma B. K., "Instrumental Methods of Chemical Analysis (18th Edition), GOEL publishing House. (2002)*
2. *Ewing G.W., Instrumental Methods of Chemical Analysis (5th Ed.), Mc Graw Hill, New York, (1992).*

3. *Chatwal, Anand, Instrumental Methods of Chemical Analysis (7th Edition) Himalaya Publishing House. (2005)*

REFERENCE BOOKS

1. *Skoog D.A. - Principles of Instrumental Analysis (6th Edition), Saunders College Publication (2007)*
2. *Willard H.H., Meritt L.C. and Dean J.H., - Instrumental Methods of Analysis (6th Edition), (1990).*

09CH61 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Process Instrumentation and control has become increasingly important in the process industries as a consequence of global competition, rapidly changing economic conditions and safety regulations. A Chemical Engineer need to master the basic control strategies, to be able to design and operate modern chemical plant. The main objective of this course is to provide an appropriate balance of process control theory and practice. In particular this course will emphasize the dynamic behaviors, control concepts, advanced control strategies and also basic principles of Instrumentation.

OUTCOME

The usefulness of this subject to the students at the end they know very well about the basic concepts of process dynamics behavior and advanced control strategies implemented in industries and also they may solve many real life problems faced by the industries.

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 theorem, 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, Nyquist diagram (Principles), stability criterion, tuning of controller settings. **(12)**

ADAVNCED CONTROL SYSTEMS

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

INSTRUMENTATION

Principles of Instrumentation and classification of process instruments, Measurement of Temperature, Pressure, Fluid flow, pH and Concentration. **(12)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Cougnowr. D. "Process Systems Analysis and Control", 2nd Ed., McGraw Hill, New York,1991.*
2. *Prof. R. P. Vyas., "Process Control and Instrumentation" Central Technology Publications.., Nagpur.*
3. *Eckman D.P., "Industrial Instrumentation", Wiley Eastern Ltd., New York. (1990)*

REFERENCE BOOKS

1. *Dale E. Seborg, Thomas F. Edgar, and Duncan A. Mellichamp, "Process Dynamics & Control", 2nd Ed., John Wiley & sons, 2004.*

2. *Smith C.A. and Corripio A.B., "Principles and Practice of Automation process control", 2nd Ed., John Wiley, New York, 1997.*
3. *P. Harriot,"ProcessControl",TataMcGraw Hill, New Delhi, 1997.*

09CH62 - CHEMICAL REACTION ENGINEERING

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Every Chemical reaction, whether homogeneous or heterogeneous has a kinetics which has to be precisely known. The properties and behaviour of the various types of reactors and their deviations from ideality also has to be known. Hence the main objective of this course is to give a fundamental knowledge on homogeneous & heterogeneous reaction, the types of ideal reactors, and the deviation of a real reactor from ideality.

OUTCOME

At the end of the course it will be possible to develop the kinetics of any homogeneous or heterogeneous reaction. It will also be possible to design, develop and analyse an ideal and a real reactor 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 & 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 modelling 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. *Levenspiel O "Chemical Reaction Engineering"(Third Edition) Wiley Eastern, New Delhi,(2000).*
2. *Smith J.M., "Chemical Engineering kinetics"(Third Edition) , McGraw Hill (ISE)(1981)*

REFERENCE BOOK

1. *Scott Fogler H., "Elements of Chemical Reaction Engineering" (2nd Edition). Prentice Hall of India, Eastern Economy Edition, New Delhi (1995).*

09CH63 - MASS TRANSFER - II

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

This course explains the group of Mass Transfer Operations for separating the compounds of mixtures based on the transfer of material from homogeneous phase to another ultimately product purity and quality control is achieved.

OUTCOME

The cost of any Mass Transfer Operation depends mainly on the separation and purification of the product. This subject imparts the knowledge of selection among various Mass Transfer Operations.

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. Principles of ion exchange - techniques and applications - equilibria rate of ion exchange. **(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. Counter current multistage operation, one component transferred continuous contact equipment, absorption of one component in packed tower, overall coefficients and transfer units, graphical and analytical methods, overall height of transfer units. Absorption with chemical reaction. Tower packings and packed tower. **(12)**

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)**

EQUIPMENT FOR CONTINUOUS DISTILLATION

Plate columns, Packed columns. Determination of number of theoretical plates using McCabe -Thiele & 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. & Harriott P.: Unit operations of Chemical Engineering (7th Ed.), McGraw Hill (ISE) (2005).*
2. *Treybal R.E.: Mass Transfer Operations (3rd Ed.), McGraw Hill (ISE), (1980).*

REFERENCE BOOKS

1. *Coulson J.M., J.F. Richardson, J.R.Backhurst and J.M. Harker, Coulson & Richardson's Chemical Engineering, Vol II, (6th Ed.,) Butter Worth Heinemann, Oxford, 1999.*
2. *Geankoplis C.J., "Transport Processes and Unit Operations", 3rd Ed., Prentice Hall of India Pvt Ltd, New Delhi, 2004.*

09CH 64 - ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The purpose of this course is to provide an overview of the most important renewable and non renewable energy resources, and the technologies for harnessing these within the framework of a broad range of simple to state-of the-art advanced energy systems.

OUTCOME

After completion of the course, students will be able to describe the fundamentals and main characteristics of renewable and non renewable energy sources and they can also be able to compare different renewable energy technologies and choose the most appropriate based on local conditions.

SOLID FUELS

Principal solid fuels, Coal- Preparation, Storage, Carbonisation, 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 & 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 & Ocean thermal sources. **(9)**

Total : 45

TEXT BOOKS

1. *Gupta O.P. : Elements of Fuels, Furnaces & 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, (2nd Ed.), Leonard Hill, London, (1958).*

REFERENCE BOOK

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

09CH65 - PROCESS EQUIPMENT DESIGN AND DRAWING - I

L	T	P	C
3	0	3	4

ASSESSMENT : THEORY & PRACTICAL

OBJECTIVE

To introduce the students the basic concept in design, different types of stresses involved, various types of joints, design of various types of equipments like pressure vessel, storage vessel, vessel supports, agitator and various separation equipments

OUTCOME

Upon completion of the course it will be possible to apply their understanding of chemical engineering fundamentals to specify the function of the equipment, operation and size of the equipment, choice of material of construction, strength of materials and also able to design individual pieces of equipments.

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 tanks. **(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 EQUIPMENTS

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

Theory : 30

Practical : 30

Total : 60

N.B. Detailed drawings for all the equipment covered from Section 1 to 3 only. University examination will be of 4 hours duration. The question paper will be in two parts. Part A will carry 50 marks and Part B will carry 25 marks. In part A Question cover both design and drawing. Part B shall have only drawing. All data are to be provided.

TEXT BOOKS

1. *Perry R.H. & Green D.W.: Perry's Chemical Engineers' Handbook, (8th Ed.), McGraw Hill (ISE), (2005).*
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 & 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 & 9*
3. *Joshi M.V.: Process Equipment Design, (3rd Ed.), 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).*
6. *Kern D.Q.: Procss Heat Transfer, McGraw Hill (ISE), (1950).*

REFERENCE BOOKS

1. *Brownell L.E, & Young E.H.: Process Equipment Design, Wiley Eastern, New Delhi, (1977).*

2. *Smith B.D.: Design of Equilibrium Stage Processes, McGraw Hill, New York, (1963).*
3. *Ludwig E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, (1977, 1979, 1983).*
4. *Strigle R.F.: Random Packings & Packed Towers (Design & Application), Gulf Publishing Company, Texas, (1987).*
5. *Fraas A.P. & Ozisik M.N.: Heat Exchanger Design, (2nd Ed.), John Wiley, New York, (1989).*
6. *Bednar H.H.: Pressure Vessel Design Handbook, (2nd Ed.), CBS Publishers & Distributors, New Delhi, (1989).*
7. *Backhurst J.R. & Harker J.H.: Process Plant Design, Heinemann Books, London, (1973).*

09CH66 - CHEMICAL PROCESS PLANT SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To give an exposure about the importance of safety in industries, Prevention of accidents in industries and to create awareness about the rights of employees.

OUTCOME

At the end of the course it will be possible to get awareness about the human, environmental and business consequences of poor safety, Key factors influencing the basis for poor safety , the hazards associated with the process plant and how the risks can be controlled.

DEVELOPMENT OF INDUSTRIAL PLANT SAFETY

Safety in Industries. Need for development. Importance of safety consciousness in Indian Chemical Industries, Social environmental setup; Tolerance limit of society, Psychological attitude towards safety programmes.

Elements of safety programme; Effective realization, Economic and social benefits; Effective communication, Training at various levels of production and operation. **(9)**

INDUSTRIAL SAFETY

Chemical process Industries; Potential hazards, Classification of Chemicals based on physical and chemical properties, Fire & Explosion characteristics and toxicological properties-MSDS. High pressure, High temperature operations, Dangerous and Toxic chemicals, Highly Explosive and Inflammable chemicals, Highly radioactive materials, Electrostatic, dust explosion, fire, thermal, gas/vapour flammability, chemical reaction. Safe handling and operation of Materials and Machineries; Storage and transportation of dangerous chemicals, Planning and layout. **(9)**

SAFETY PERFORMANCE

Appraisal; Effective steps to Implement safety procedures; Periodic Inspection and study of plant layout and constant maintenance; Periodic advice and checking to follow safety procedures; Proper Selection and Replacement of handling equipments; Personal protective equipments. **(9)**

ACCIDENTS

Industrial accidents; Accident toll, Accident costs, and Identification of accident spots; Remedial measures; Identification and Analysis of causes of injury to men and machines; Accident prevention; Accident proveness; Vocational guidance, Fault trees, Fire prevention and fire protection. Hazop & Hazan in Chemical process Industries, process description and flow chart, systematic questioning of the process and hazard identification, deviation and safeguard assessment, case study. **(9)**

POLLUTION

Atmospheric pollution; Chemicals and Dust; Toxicity, Toxic Materials and Gases; Environmental pollution by effluents and industrial wastes; Treatment methods - in brief.

Health hazards; Occupational; Industrial health hazards; Health Standards and Rules; Safe working environments; Parliamentry legislations; Factories act; Labour welfare act; ESI Act; Workman compensation act. **(9)**

PROMOTION OF INDUSTRIAL SAFETY

Role of Government, Safety organisations, Management and Trade Unions in promoting industrial safety. **(9)**

Total : 45

TEXT BOOKS

1. *Closs G.S. & Wardel M.G.: Introduction to Safety Engineering, Wiley, New York, (1984).*

2. *Fawcett H.H. & Wood, W.S. : Safety and Accident Prevention in Chemical Operations, (2nd Ed.), John Wiley, New York, (1982).*

3. *Heinrich H.W., Roos N. & Dan Peterson P.E.: Industrial Accident Prevention, (5th Ed.), McGraw Hill, New York, (1979).*

REFERENCE BOOKS

1. *Handley W. : Industrial Safety Handbook, McGraw Hill, London, (1977).*

2. *Venkateswaralu D., Upadrashta K.R. & Chandrasekaran, K.D.(ditors): CHEMTECH - I, Safety in Chemial Industry - (Chapter by Betrabet, R.V. & Rajan, T.P.S.) S. Chand & Co., New Delhi, (1975).*

3. *Crowl D. & Louver J.: Chemical Process Safety - Fundamentals with Applications, 2nd Edition,Prentice Hall, New Jersy, (2002).*

4. *Bodurtha F.T.: Industrial Explosion Prevention and Protection, McGraw Hill, New York, (1980).*

5. *Buschart R.J.: Electrical and Instrumentation Safety for Chemical Processes, Van Nostrand - Reinhold, New York, (1991).*

09CH68 - TECHNICAL AND INSTRUMENTAL ANALYSIS LABORATORY

L	T	P	C
0	0	3	4

ASSESSMENT : PRACTICAL

OBJECTIVE

This course concentrates on the various chemical techniques utilized for analysis in the chemical industries and demonstrates the knowledge of analysis and operation principles of analytical instruments.

OUTCOME

The students shall be able to understand and analyze the samples by quantitative and qualitative methods.

EXPERIMENTS

Analysis of water, cement, lime, ores, soap, sugar, metals and alloys. Estimation of available chlorine in Bleaching powder, nitrogen in inorganic fertilizer, sulfate in ores, purity in calcium carbonate, magnesium silicate in talcum powder.

Determination of acidity or alkalinity of a solution using pH meter, estimation of the concentration of unknown samples using Nephelometer, UV-Visible Spectrophotometer, Flame photometer.

Total : 60

09CH69 - FLUID MECHANICS AND MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	3	4

ASSESSMENT : PRACTICAL

OBJECTIVE

A chemical engineer need to be exposed into more practical knowledge in fluid mechanics and more equipment. The main objective of this laboratory is to provide an platform to the students so that they will apply their theoretical knowledge what they gained in the classroom. In particular these practical classes will emphasize the fluid flow meters, pump characteristics, size reduction studies and filtration operations.

OUTCOME

This practical subject is very useful to the students because they can do the experiment individually in the assigned classes, take the readings and it would be of more confidence after knowing the theory behind the respective subjects, once they will go to industries.

EXPERIMENTS

FLUID FLOW

Orificemeter, Venturimeter and Flow nozzle meter. Losses in Valves, Bends and Fittings. Flow through Helical and Spiral coils. Flow through Packed and Fluidized beds. Friction in straight pipes and Annular Pipes. Losses due to sudden expansion and contraction. Notches and Weirs. Open orifice. Drag on falling spheres. Pump characteristics of Centrifugal, Reciprocating.

MECHANICAL OPERATIONS

Size reduction studies in Jaw crusher, Roll crusher, Ball mill, Raymond mill. Grindability. Power consumption in size reduction. Drop weight crusher - Estimation of Rittinger's constant. Particle size analysis by Sieving, Sedimentation. Screen effectiveness. Classification of particles with air classifier. Filtration and cake characteristic studies. Centrifugal separations.

Total : 60

09CH 71 - TRANSPORT PHENOMENA

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

Transport phenomena which consists of fluid mechanics, heat and mass transfer is one of the two chemical engineering topics that justify the practical importance of chemical engineers in a number of interdisciplinary fields. It is the goal of this course to move the graduate students from the introductory level of transport phenomena to a level that will allow them to communicate, be confident and be effective in researching transport-related topics in a variety of chemical and allied engineering areas.

OUTCOME

On completion of this course, it is possible to provide the student with a competitive foundation in transport phenomena, demonstrate the applicability of transport analysis to practical problems, and allow the student to develop and practice analysis of real problems with an appreciation for solution approximation methods, their limitations and their use in evaluating computed solutions.

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. *Bird R.B., Stewart W.E. & Lightfoot E.W.: Transport Phenomena, Revised 2nd Ed., John Wiley, (ISE), (2007).*
2. *Brodkey R.S. & Hershey H.C.: Transport Phenomena, McGraw Hill (ISE), (2003).*

REFERENCE BOOKS

1. *Welty J.R., Wicks C.E. & Wilson R.E.: Fundamentals of Momentum, Heat and Mass Transfer, (5th Ed.), John Wiley, (ISE), (2008).*
2. *Bennet C.O. & Meyers J.E.: Momentum, Heat and Mass Transfer, (3rd Ed.), Tata-McGraw Hill, New Delhi, (1983).*
3. *Geankoplis C.J.: Transport Processes - Momentum, Heat and Mass, Allyn & bacon, Inc., Boston, USA, (1983).*

09CH72 - PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The main objective of this subject is to present the basic economics and elementary accounting technique as applied in the process industries. The subject gives the widened spectrum of chemical Engineering knowledge by inclusion of considerable material on profitability, evaluation, optimum design methods, interest compounding, cost estimation, industrial management principles, organization structure and inventory control and their importance in the industries.

OUTCOME

The students would have gained confidence in plant design, interest calculation, depreciation method, balance sheet preparation, other areas of plant Economics, and the basic concepts of management principles.

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)**

PRINCIPELS 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. *Peters M.S. and Timmerhaus K D: plant design and economics for chemical Engineers (4th Ed), McGraw Hill (ISE), (2002).*
2. *Ahuja K.K. "Industrial management", Kanna publishers, New Delhi, 1985.*
3. *H.E. Schwyer, "Process Engineering Economics", McGraw Hill Book co., New York.*

REFERENCE BOOKS

1. *F.C. Jelen, "Cost and Optimization Engineering", McGraw-Hill., New York. (1970).*
2. *Robin Smith, "Chemical Process Design", McGraw Hill Book co., New York.(1995)*

09CH 73 PROCESS EQUIPMENT DESIGN AND DRAWING - II

L	T	P	C
3	0	3	4

ASSESSMENT : THEORY & PRACTICAL

OBJECTIVE

To introduce the students about the design of various equipments like heat exchangers, plate and packed towers, distillation column, rotary drier and extractor.

OUTCOME

Upon completion of the course it will be possible to design various types of heat and mass transfer equipments of suitable size, material of construction and strength that suits processing conditions.

HEAT TRANSFER EQUIPMENTS

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

MASS TRANSFER EQUIPMENTS

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

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

Design of Rotary Dryers and cooling towers. **(15)**

Theory: 30

Practical: 30

Total: 60

TEXT BOOKS

1. *Perry R.H. & Green D.W.: Perry's Chemical Engineers' Handbook, (8th Ed.), McGraw Hill (ISE), (2005).*
2. *Indian Standard Codes:*
   (a) *IS : 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels & Equipment.*

(b) *IS : 4503 - 1967: Specifications for Shell & 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).*

(d) *ASME Section 8 & 9*

3. *Joshi M.V.: Process Equipment Design, (3rd Ed.), MacMillan, India, (2004)*
4. *Coulson J.M., Richardson J.F. & Sinnott R.K.: Chemical Engineering, Vol. VI, Maxwell-Macmillan, New York, (1989).*
5. *Kern D.Q.: Procss Heat Transfer, McGraw Hill (ISE), (1950).*
6. *Brownell L.E, & Young E.H.: Process Equipment Design, Wiley Eastern, New Delhi, (1977).*

REFERENCE BOOKS

1. *Smith B.D.: Design of Equilibrium Stage Processes, McGraw Hill, New York, (1963).*
2. *Ludwig E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, (1977, 1979, 1983).*
3. *Strigle R.F.: Random Packings & Packed Towers (Design & Application), Gulf Publishing Company, Texas, (1987).*
4. *Fraas A.P. & Ozisik M.N.: Heat Exchanger Design, (2nd Ed.), John Wiley, New York, (1989).*
5. *Bednar H.H.: Pressure Vessel Design Handbook, (2nd Ed.), CBS Publishers & Distributors, New Delhi, (1989).*
6. *Backhurst J.R. & Harker J.H.: Process Plant Design, Heinemann Books, London, (1973).*

7. *Dr. S.D. Dawande: Process Design of Equipments, Central Techno Publications, Nagpur,1999*

N.B. University Examination will be of 4 Hours duration. The Question paper will be in TWO parts. Part A will carry 50 marks and Part B will carry 25 marks. In Part A Question cover both Design and Drawing. Part B shall have only drawing. All data are to be provided.

09CH81 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To make the students learn about the basic concepts of Quality and TQM. Also, to make them learn about TQM principles, SPC, TQM tools and quality systems.

OUTCOME

The students will learn about concepts of TQM. Then, they will 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 concepts, 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, Quality Costs Analysis techniques. **(9)**

STATISTICAL PROCESS CONTROL

The Seven tools of Quality, Statistical Fundamentals, Process Capability, Control Charts for Variables 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. D. H., et al., "Total Quality Management ", 3rd 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. S. Kumar "Total Quality Management ", Ist Edition, Reprint, Laxmi Publications (P) Ltd., New Delhi , 2007.*
2. *R.S. Naagarazan and A.A.Arivalagar, "Total Quality Management", Ist Edition, Reprint, New Age International (P) Ltd., New Delhi , 2005.*

09CH82 - PROCESS UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The plant utilities is of great importance in a chemical industries, the students will be given good exposure to know more about all types of problems faced in industries not only in chemical and also in other areas of Engineering knowledge. The objective of the course will emphasize the primary and secondary utilities been used in all the chemical industries.

OUTCOME

The student at the end of the course will be strong in basic concepts of water treatment and conservation, compressors and vacuum, refrigeration production and air conditioning, steam production and economy.

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. (Editors): Perry's Chemical Engineers' Handbook,(6th Ed.), McGraw Hill (ISE), (1984).*
2. *McCabeW., Smith J. and Harriott," Unit Operations of Chemical Engineering",(7th Ed.) McGraw Hill. Publication, (2008).*
3. *E. Luduig, "Applied Process Design for Chemical and Petrochemical Plant", Gulf. Publishing, Houston, Texas, (1983).*

05CH 83 - PROCESS MODELLING AND SIMULATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To develop knowledge in different aspects of process modeling technique to support the pre-coding phases of a simulation project that could capture a detailed description of various aspects of chemical process systems and also familiarize the numerical simulation of models.

OUTCOME

At the end of this course, it will be possible to familiarize Basics of modelling, Modelling of CSTR, Modelling of Batch reactors, Vaporizer, Batch distillation with holdup, Dynamic simulation of batch reactor, CSTR, Dynamic simulation of various types of distillation columns.

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. **(9)**

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. **(9)**

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, Nonisothermal CSTR, Binary distillation column, Batch reactor. **(9)**

Total : 45

TEXT BOOKS

1. *Luyben W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill (ISE), 1990.*
2. *Franks R.G.E.: Modeling and Simulation in Chemical Engineering, Wiley-Interscience, New York, (1972).*

REFERENCE BOOKS

1. *Himmelblau D.M. & Bischoff K.B.: Process Analysis and Simulation, Wiley, (1968).*
2. *Ramirez W.F.: Computational methods for Process Simulation, Butterworths, NewYork, 1989.*

09CH86 - HEAT AND MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	4

ASSESSMENT : PRACTICAL

OBJECTIVE

This course of laboratory provides the necessary background for a chemical engineer to understand the fundamental of heat and mass transfer operations by doing experiments in various heat and mass transfer equipments, observing data and analyzing the results. This makes the students gain confidence before entering the actual arena.

OUTCOME

After completion of the laboratory course the students are expected to be able to measure steady state and unsteady state heat and mass transfer operations, work in teams to obtain and process data accurately, and report the experimental work individually.

EXPERIMENTS

HEAT TRANSFER

Thermal conductivity of solid materials, Transient Heat conduction, Electrical analogies, Natural convection, 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.

MASS TRANSFER

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 : 60

09CH87 - REACTION ENGINEERING AND PROCESS CONTROL LABORATORY

L	T	P	C
0	0	3	4

ASSESSMENT : PRACTICAL

OBJECTIVE

Reaction engineering: Study of the kinetics of Chemical reactions in Batch, Tubular, Plug Flow, Stirred Tank and Adiabatic reactors.

Instrumentation & Process Control: Calibration of Instruments, Transient response of Thermometers and Thermocouples. Control valve characteristics and study of Control systems involving Temperature, Pressure, Flow and Level.

OUTCOME

Reaction Engineering: Develop experience in handling small scale chemical reactors and better understand the kinetics of reactions.

PROCESS CONTROL

Understand the response of systems including Second order system and Non-interacting system. Comprehend the use and response of the controllers.

EXPERIMENTS

REACTION ENGINEERING

Performance characteristics and reaction rates of reactors including Batch, Plug Flow, Mixed Flow and Adiabatic type reactors.

PROCESS CONTROL

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

Total : 60

09CH88 - PROJECT WORK AND VIVA VOCE

L	T	P	C
0	0	6	6

ASSESSMENT : PRACTICAL

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.

OUTCOME

On successful completion it will be possible to prepare a detailed report on the manufacture of a chemical compound from its process selection till cost estimation.

The students should solve the problem in about three months time on the manufacture of a chemical compound allotted to them. 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 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

09E01 - SUGAR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

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

OUTCOME

The students would have gained the confidence by knowing the principles 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 process. 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 process. Centrifugal operation. Engineering principles of sugar centrifugals and the centrifugal process. Centrifugal equipment and auxiliaries. Production of final molasses and molasses utilization. Grading of sugar. **(9)**

Total : 45

TEXT BOOKS

1. *Honig P. (Editor) : Principles of Sugar Technology, Vol.I to III, Elsevier Publishing Company, 1953.*
2. *D.W. Van der Poel, H. Schwartz: Sugar Technology [Beet and Cane Sugar Manufacture], 1 st Edition.*

REFERENCE BOOKS

1. *Payne J.H.: "Sugarcane factory Analytical control", Elsevier Publisher, Co. London.*
2. *Jenkens.:" Introduction to Sugarcane technology", Elsevier Publisher, Co. London.*
3. *Hoing P.:" Principle of Sugar Cane Technology", Elsevier Publisher, Co. London.*

09 E02 - POLYMER SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

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.

OUTCOME

Survey the current usage of Polymer and Compounding ingredients. Compare the use and general properties of Polymers with traditional materials. Recognize the different types of polymers. (Step-growth and Chain growth)

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 BOOK

1. *F.W. Billmeyer., "Textbook of Polymer Science", Wiley Interscience, 3rd Ed., 1984.*

REFERENCE BOOKS

1. *J.R. Fried,"Polymer Science and Technology", Prentice Hall of India Pvt Ltd, 2nd Ed., 2003.*
2. *M.S. Bhatnagar., "A Textbook of Polymers", Vol I & II, S.Chand & Company Ltd, 2004.*

09E03 - PETROCHEMICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The purpose of this subject is to provide knowledge on various feedstocks, mechanism of polymerisation, alkylation, isomerisation manufacture of various products of petrochemicals.

OUTCOME

At the end of the course student would have gained knowledge of various feed stocks available, general flow diagrams, major engineering problems in petrochemical industry. This gives them confidence in identifying and solving problems that would occur in petrochemical 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)**

POLYMERS OF OLEFINES

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)**

POLYMERS OF AROMATICS

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.: Text on Petrochemicals, 4TH Ed,Khanna Publishers Delhi, (2007).*
2. *Waddams A.L.: Chemicals from Petroleum, (4th Ed.), ELBS, (1980).*
3. *Belov P.: Fundamentals of Petroleum Chemicals Technology, Mir Publishers, Moscow, (1970).*

REFERENCE BOOKS

1. *Kobe K.A. and McKetta J.J.(Jr) (Editors): Advances in Petroleum Chemistry & Refining, Vols. I to VI, Interscience, New York, (1958 - 1962).*
2. *Hengstebeck R.J.: Petroleum Processing, McGraw Hill, New York, (1959).*
3. *Chauvel A. & Lefebvre G.: Petrochemical Processes, Vols. I & II, Gulf Publishing Co., Texas, (1989).*
4. *Tonohue D. & Lang K.: A First Course in Petroleum Technology, Prentice Hall, New Jersy, (1989).*
5. *Wiseman P.: Petrochemicals, Ellis Horwood, (1986).*

09E04 - FERTILIZER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The purpose of this subject is to provide knowledge on various aspects of production, unit operations and major engineering problems in fertilizer industry and also about environmental affects of using inorganic fertilizers and the ways to minimise effects of inorganic fertilizers.

OUTCOME

At the end of the course student would have gained knowledge on various general flow diagrams, major engineering problems in fertilizer industry. Methods of application of fertilizers for different plants.This gives them confidence in identifying and solving problems that would occur in fertilizer industries.

INTRODUCTION

Chemical Fertilizers and Organic Manures - Types of chemical Fertilizers. Nitrogeneous 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 & 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, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).*
2. *Austin G.T.: Shreve's Chemical Process Industries, (5th Ed.), McGraw Hill (ISE), (1984).*
3. *Sauchelli V. (Editor): The Chemistry & Technology of Fertilizers, ACS Monograph No.148, Reinhold.*

REFERENCE BOOKS

1. *Editorial Committee - FAI Seminar on Fertiliser in India in the Seventies (Proceedings), The Fertiliser Association of India, New Delhi, (1973).*
2. *Editorial Committee - Seminar on Recent Advances in Fertilizer Technology, The Fertiliser 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).*

09E05 - FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Food Technology is a declared thrust area besides IT for economic growth of our country. Food processing is essential for agriculture based economy for value addition of agriculture products. The main objective of this course is to provide clear picture about the source, constituents, standard limits of food ingredients in the food stuff and also it gives idea about the basic behind the methods of food preservation, packing, handling of food stuff.

OUTCOME

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. 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 needs and Indian situation; Constituents of food; Quality and nutrition aspects; Food additives 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. *Heid J.L: Jolyn M.A., "Fundamentals of Food Processing Operations", The AVI Publishing Co., Westport, (1975).*
2. *Potter N.N,: " Food Science" (5th edition) The AVI Publishing Co., Westport, 2006.*
3. *Watson E.L.: Elements of Food Engineering, (2 nd 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. and Considine P.E.: Foods and Food production Encyclopedia, Van Nostrand - Reinhold, (1982).*
3. *Hall C, W., Farrall A.W. and Rippen A.l.; Encyclopedia of Food Engineering, Van Nostrand - Reinhold, New York, (1986).*

09E06 - PULP AND PAPER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The main objective of this course is to impart knowledge and skills related to source of pulp, properties, process, treatment, testing and scope of paper industry. This subject is introduced to increase employability of students in the field of pulp and paper Technology.

OUTCOME

Upon successful completion of this course the students will be able to understand source of pulp and their properties, pulp process and treatment, pulping testing, paper making equipment process, testing and scope of paper industry.

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 paper 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, 1954.*
2. *Stephenson N: Pulp and Paper manufacture, Vol.1 to vol.1 v, McGraw Hill (New York), 1950.*
3. *Halpern M.G.:Pulp Mill Processes, Noyce Data Corporation.*

REFERENCE BOOKS

1. *Britt K.W.(Editor): Handbook of Pulp and Paper Technology, 2nd Ed., CBS Publishers Delhi, 1984.*
2. *Smook G.M. Handbook for pulp and paper technologist, 3rd Ed, Atlanta, GA: TAPPE Publications, 2002.*
3. *J.P. Casey, pulp and Paper: Chemistry and Chemical technology, third Edition Volumes 1 and 2, Wiley Interscience, 1980.*

09E07 - INDUSTRIAL WASTE WATER TREATEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The study of the subject constitutes the sources, characteristics and treatment of waste water. It imparts the knowledge of basic principles of Science & Engineering applied to the problems of water pollution control.

OUTCOME

The ultimate goal of Waste Water Engineering is to protect public health and environment and to have knowledge of constituents of concern in waste water, impacts of these constituents when waste water is dispersed into the environment.

WASTE WATER ENGINEERING

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

PHYSICAL UNIT OPERATIONS

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

CHEMICAL UNIT PROCESS

Fundamentals of chemical coagulation, chemical precipitation for improved plant performance, chemical precipitation for phosphorous removal, chemical precipitation for removal of heavy metals & dissolved inorganic substances, chemical oxidation, 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 & 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 & management, solid processing flow diagrams, sludge and scum pumping, grinding, screening, degritting, blending, anaerobic digestion, aerobic digestion, composting, conditioning, dewatering, incineration. **(9)**

Total : 45

TEXT BOOKS

1. *Metcalf & Eddy, Inc.: Wastewater Engineering (Treatment and Reuse), 4th Ed., (Revised by Tchobanoglous, G) Tata - McGraw Hill, New Delhi, (2003).*

REFERENCE BOOKS

1. *Mark J. Hammer.: "Water and waste water technology" - 5 th Ed.: - Prentice Hall of India Pvt. Limited, New Delhi (2007).*
2. *James M. Montgomery.: "Water treatment principles and design" - A Wiley interscience publication, Newyork (1985).*

09E08 SURFACE COATINGS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Generally the surface coatings give the beauty, identification and protection to the material. This subject knowledge gives confidence to chemical engineer playing a role in construction field and process industries. It provides coverage of the materials used in coating manufacture: polymers, pigments, solvents and additives and applications of surface coating products.

OUTCOME

It will be possible to analyze and improve the surface properties of materials for protection in demanding contact conditions or aggressive environments and to provide 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 - Alkyd resin - manufacturing procedure - compositions - properties - Various synthetic resins - Chemical constitution - manufacturing procedure. **(9)**

SOLVENTS AND ADDIDIVES

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, Wiley publishers, New York. (1954)*
2. *Payne H..: "Organic coating technology", Pigments and Pigmented Coatings, Vol. II, Wiley publishers, New York. (1961)*

REFERENCE BOOKS

1. *Oil and Colour chemists Association, Australia: Surface coatings, Vol I, raw materials and their usage, 3rd Ed., Tafe educational books, Chapman & Hall, London, 1993.*
2. *Oil and Colour chemists Association, Australia: Surface coatings, Vol II, Paints and their applications, 2nd Ed., Tafe educational books, Chapman & Hall, London, 1984.*
3. *Oil and Colour chemists Association, Australia: Non- Convertible coatings, Part I, 11th Ed., Tafe educational books, Chapman & Hall, London, 1987. (H.W. Keenan, chairman, Technical education committee.)*
4. *Parkar P.K.: Technology of Resins.*
5. *Noel Heaton: Introduction to Paint Technology, 2nd Ed., Charles Griffin & Co. Ltd., (1940).*
6. *Noel Heaton: Outlines to Paint Technology, 2nd Ed., Charles Griffin & Co. Ltd., (1940).*
7. *Keenan H.W.(Editor): Convertible Coatings, Vol I&II, Oil and Colour chemists Association, Australia, Chapman & Hall, London,(1961).*
8. *Wood H.R. & Morrel R.S.: The Chemistry and Technology of Drying Oils, Ernest Benn ltd., 7th Ed., 1984.*

09E09 - PETROLEUM REFINERY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The refinery plays a main role in world wide. This course provides a sound knowledge to chemical engineer playing a very important role in refineries. This intensive course presents a detailed overview of the integrated fuel refinery of today, from the crude oil feed to the finished products as well as the terminology and economics of the petroleum refinery.

OUTCOME

At the end of the course it is possible to identify crude oil, petroleum products properties specifications, operation of petroleum refinery, storage, transport and marketing issues. It will help to design various Equipments used in refinery.

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 petroleum 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)**

EQUIPMENTS 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, (4th Ed.), Oxford-IBH, New Delhi, (2002).*
2. *Nelson W.L.: Petroleum Refinery Engineering, (4th Ed.), 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. (Editors): Advances in petroleum chemistry and Refining, Vols. I to VI , Interscience, New York, (1958-62).*
3. *Bland W.F. & Davidson R.L. (Editors): Petroleum Processing Handbook, McGraw Hill, New York, (1967).*

09E10 - ELECTROCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The objective of this course is to impose the ideas of electrochemistry, electrical double layer, and Mass transfer in electrochemical systems, primary- secondary current distribution, corrosion studies, types of batteries and fuel cells. The main objective is to implement the ideas of selection of electrode for different electrochemical industries to the students.

OUTCOME

At the end of the course students will be aware of the electrochemical process, its advantage and disadvantage. They will also be able to choose electrode for different electrochemical industries.

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 -Helmoltz 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. S., "Electrochemical systems", Prentice Hall, 1973.*

REFERENCE BOOKS

1. *Barak M. and Stevenge, U. K., "Electrochemical Power Sources - Primary and Secondary Batteries" 1980*
2. *Mantell C., "Electrochemical Engineering", McGraw Hill, 1972.*

09E11 - MODERN SEPARATION TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course imparts a basic understanding of the concepts underlying the selection and behavior of separation processes.

OUTCOME

This subject deals with the recent advances of membrane separation, ionic separation and adsorption techniques. It emphasizes the common aspects of functioning and analysis of different separation processes in the growth 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 and choice of membranes, plate and frame, tubular, spiral wound and hollow fiber membrane reactors and their 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 and electrodialysis, 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", Prentice Hall publishers, 2008.*

REFERENCE BOOKS

1. *Herbert M. Schoen, "New Chemical Engineering Separation Techniques", Interscience publishers, 1962.*
2. *L. Svarovsky," Solid-Liquid Separation (4th Edition)", Butterworth and co publishers, 2000.*

09E12 MINERAL PROCESSING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

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.

OUTCOME

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 Treatement 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, Tata McGraw Hill, New Delhi, (1971).*
2. *Wills B.A.: Mineral Processing Technology, (7th Ed.), Maxwell Macmillan, (2006).*
3. *Pryor E.J. : Mineral Processing (3rd Ed.), Elsevier, New York, (1965).*

REFERENCE BOOKS

1. *Richards R.H. & Locke C.E. : Text Book of Ore Dressing, (3rd Ed.), McGraw Hill, New York, (1940).*
2. *Taggart A.F. : Hand Book of Mineral Dressing, John Wiley, New York, (1954).*

09E13 - OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Operations Research is a vast branch of mathematics which encompasses many diverse areas of minimization and optimization. In general it has great many applications, for instance, in agricultural planning, biotechnology, data analysis, engineering systems design, environmental management, inventory control, production process control, risk management, sequencing and scheduling of tasks and etc. This course provides to enlighten the students with the various optimized techniques.

OUTCOME

At the end of the course it is possible to understand the concepts of linear programming technique, applications and 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 Modelling - 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

Modelling - 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 - Transhipment 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 queueing 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 & Problems, Keerthi Publishing House, Coimbatore, (1996).*
2. *Taha H.A.: Operations Research - An Introduction, Printice hall of India, 8th Ed., 2007.*

REFERENCE BOOKS

1. *Levin R.I., Kirkpatrick C.A. & Rubin, D.S: Quantitative Approaches to Management, McGraw Hill International, 8th Ed., 1992.*
2. *Hiller F.S. & Lieberman G.J.: Operations Research - An Introduction, Holden Day San Fransisco, 5th Ed., 1997.*

09E 14 - ADVANCED CHEMICAL REACTION ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Heterogeneous reactions are equally important as homogeneous reactions in Industrial Practice. The main objective of the course is to give an in depth exposure of both catalytic and non catalytic heterogeneous reactions and the design of multi phase reactors.

OUTCOME

At the end of the course it will be possible to, develop the kinetics of any heterogeneous reaction. It will also be possible to analyze and design a Gas-Solid and Gas-Liquid reactor in which a catalytic or a non catalytic reaction is carried out.

TEMPERATURE AND PRESSURE EFFECTS

Single reactions- Heat of reaction and temperature. Equilibrium conversion. Adiabatic and non-adiabatic operations. Optimum temperature progression. Criteria for stability of reactors **(9)**

HETEROGENEOUS REACTIONS AND SOLID CATALYSIS

Heterogeneous catalysis, nature of catalysts, preparation and testing and characterization of catalysts.Poisoning. Determination of physical properties-surface area and pore-volume distribution, Adsorption isotherms **(9)**

GAS-SOLID CATALYTIC REACTIONS

Rate of adsorption, desorption, surface reaction. Analysis of rate equation and rate controlling steps. Kinetics and rate expression for gas-solid catalytic reactions. Diffusion within catalyst particle, Thiele Modulus and effectiveness factor. Fixed bed reactors. **(9)**

GAS-SOLID NON-CATALYTIC REACTIONS

Models for explaining kinetics. Controlling resistances and rate controlling steps. Time versus conversion relationship for particles of same size under various controlling regimes. Conversion for mixture of particles of different sizes under plug flow and mixed flow conditions. Applications to fluidized bed. **(9)**

GAS-LIQUID REACTIONS

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Enhancement factor for first order reaction, tower reactor design. **(9)**

Total : 45

TEXT BOOKS

1. *Levenspiel O "Chemical Reaction Engineering" (Third Edition) Wiley Eastern, New Delhi, (2000).*
2. *Smith J.M., "Chemical Engineering Kinetics" (Third Edition), McGraw Hill (ISE)(1981)*

REFERENCE BOOK

1. *Scott Fogler. H., "Elements of Chemical Reaction Engineering" (2nd Ed.). Prentice Hall of India, Eastern Economy Edition, New Delhi (1995).*

09E15 - FLUIDIZATION ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The main objective of this subject to under graduate students is to give an exposure to all the fundamental operations involved in fluidization, their heat and mass transfer studies, so that it will cater to the needs of chemical industries.

OUTCOME

The students at the end of the course would know about the basic operation of fluidization, types, heat and mass transfer studies, design aspects and also some of the case studies.

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, Wiley-Toppan, (2005).*
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).*

09E16 - DRUGS AND PHARMACEUTICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

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.

OUTCOME

The role of chemical engineers in pharmaceutical drug manufacture has increased a lot. Knowing basics of drugs and pharmaceutical technology one can exactly select the formulations process as well as chemical conversion processes and their equipments. The basic idea for design of processes and equipments can be achieved.

INTRODUCTION

Development of Drugs and Pharmaceutical Industry; Organic Therapeutic agents, Uses and Economics.

DRUGS METABOLISM AND PHARMACO KINETICS

Drugs metabolism; Physico - 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 Conversions, 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 PRODUCTS

Vitamins; Cold remedies; Laxatives; Analgesics; Non - steroidal contraceptives; External Antiseptics; Antacids and Others. **(9)**

MICROBIOLOGICAL AND ANIMAL PRODUCTS

Antibiotics; Biologicals; Harmones; Vitamins and Preservation of Pharmaceutical products. Analytical methods and test for various drugs and pharmaceuticals.

PACKING AND QUALITY CONTROL

Packing; Packing techniques; Quality control. **(9)**

Total : 45

TEXT BOOKS

1. *Tyagi O.D. & Yadav M.: A Text Book of Synthetic Drugs. Anmol Publications, New Delhi,(1990).*
2. *Chatwal G.R.: Synthetic Drugs, Himalaya Publishing House, Delhi, (1988).*

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, Mack Publishing Company of Eastern, Pennsylvania, 1997.*
3. *The drug development process by Peter G.Welling, Louis Lasagna.*

09E17 - ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

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

OUTCOME

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 TECHNOLOGICAL SOCIETY

Energy and evolution; growth and change; patterns of consumption in developing and advances 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 optimisation 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 Utilisation ", 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.*

09E18 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

The main objective o this subject is to give broad outlooks to know about how the corrosion engineering is also important in chemical engineering. Here is a large felt need to comprehensive 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.

OUTCOME

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, 1999.*
2. *Fontana M. G. and Greene, N. D., " Corrosion Engineering ", McGraw Hill, NewYork, 1987.*
3. *Uhling H. H. and Revie R. W., " Corrosion and Corrosion Control", John Wiley & Sons, Inc, 1985.*

REFERENCE BOOK

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

09E19 ENVIRONMENTAL IMPACT ASSESSMENT AND CLEAN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

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.

OUTCOME

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)**

APPLICATION

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

REFERENCE BOOKS

1. *EIA, theory and practice - Unwin Hyman Ltd., 1988.*
2. *Environmental Health and Safety Auditing Handbook, 2nd edition, 1995, McGraw Hill, Inc., New York.*
3. *Larry W. Carter - EIA, 1997, McGraw Hill book Co.,*
4. *Kirkwood R. C. and Longley A. J., "Clean Technology and Environment", Chapman & Hall, 1995.*

09E20 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

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

OUTCOME

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 & 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 & off site emergency planning, risk management ISO 14000, EMS models case studies-marketing terminal, gas processing complex, refinery. **(9)**

HAZARD

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. *K.V. Ragavan, A.A. Khan. Methodologies in Hazard identification and assessment -Manual, CLRI publication 1990.*
2. *V.C. Marcel. Major Chemical Hazard- Ellis Hawood Ltd., Chi Chester, UK, 1987.*
3. *Process Safety Analysis, B. Skeleton, Institution of chemical Engineers, U.K., 1997.*

REFERENCE BOOKS

1. *Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.*

09E21 - PROCESS AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Process Automation has become today's new concept in the industries. To meet global competition and safety regulation, a Chemical Engineer needs to master in both control Techniques and Simulation. The main objective of this course will provide the basic instrumentation, control strategies, optimization and simulation technique.

OUTCOME

The usefulness of this subject to the students, at the end they 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 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

Optimisation and simulation; optimisation techniques; single and multivariable constrained optimisation; dynamic simulation of distillation columns and reactors. **(9)**

Total : 45

TEXT BOOKS

1. *Nakara B.C.; Choudary K.K.; " Instrumentation and Analysis ", Tata McGraw Hill, New Delhi, Eigth Reprint, 1993.*
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.*

09E22 - OPTIMIZATION OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Optimization is a central theme that impacts most areas of process systems engineering including process design, process control, process operations and scheduling, and parameter estimation. The primary goals of this course are to provide an overview of state of the art optimization algorithms, the theoretical principles that underpin them, and their use for solving several types of practically relevant optimization problems arising in process systems engineering.

OUTCOME

At the end of this course it will be possible to understand various optimization techniques with numerical computation and their applications in chemical process industries.

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", 2nd Ed., McGraw-Hill Book Co., New York, 2001.*
2. *Reklaitis G.V., Ravindran A., Ragsdell K.M. " Engineering Optimisation", John Wiley, New York, 1980.*

REFERENCE BOOKS

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

09E23 - COMPUTER AIDED DESIGN

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

OBJECTIVE

Nowadays PC based softwares are essential to carry out the process and design calculations to minimize the time consumption for chemical engineers. The main objective of this course is to analysis the physical properties of the systems, conceptual design, development of software package and their applications.

OUTCOME

On completion of this course it is possible to do the material and energy balance calculations using softwares, to develop software packages for the design of chemical process equipments.

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 programes. 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)**

Theory : 30

Tutorial : 15

Total : 45

TEXT BOOKS

1. *J.M. Douglas, Conceptual Design of chemical processes. McGraw Hill, NY, 1988.*
2. *R. K. Sinnott, Coulson & Richardson's Chemical Engineering Volume 6: Chemical Engineering Design, Butterworth-Heinemann, 4th Ed., 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., Breneman, G.L. Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991.*
2. *Myers A.L., Seider W.D. Introduction to Chemical Engineering and Computer Calculations, 1976.*

09E24 - BIOCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Introduce the essential concepts of bio-processing including enzymes and enzyme kinetics, microbial kinetics and transport in microbial systems. To cover the topics of design of reactors/bioreactors and scale-up, downstream processing and effluent treatment.

OUTCOME

A clear understanding of the bio-processing principles, the design and analysis of bioreactors.

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 equations; 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 O_2 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 and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India (2002)*

REFERENCE BOOKS

1. *Lee J.M, Biochemical Engineering, 1st Edition, Prentice Hall, 1992 (2nd Edition e-book 2001)*
2. *Blanch H.W and Clark D.S, Biochemical engineering, Marcel Dekker, 1997*
3. *Bailey J.E., Ollis D.F. Biochemical Engineering Fundamentals, McGraw-Hill, International Edition, 2nd Edition, New York, 1986.*
4. *Rao D.G., Introduction to biochemical engineering, 2nd Edition, McGraw Hill, 2006.*
5. *Doran P.M., Bioprocess Engineering principles, Academic press, 1995.*

09E25 - MATERIAL SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

Materials of construction for equipment in chemical process industries play a vital role in the design of any product to minimize the operating cost and to maximize the profit. This course explains the basic principles of material engineering, corrosion, its prevention and applications of various materials.

OUTCOME

It impacts 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)**

APPLICATION

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. *Jasrrzebski Z.D., Nature and properties of Engineering Materials, John Wiley & Sons, 1987.*
2. *Uhlig and R.Winston Reive, Corrosion and Corrosion Control, 3rd Ed., John Wiley, 1991.*

REFERENCE BOOKS

1. *Cremer and Davies, Chemical Engineering Practice, Vol.9 Butterworths, 1965.*
2. *Raghavan V., Material Science and Engineering, Prentice Hall India, New Delhi, 1998.*

09E26 - PROCESS INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

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

OUTCOME

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 & I Diagrams.

PRINCIPES OF MEASUREMENT

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

TEMPERATURE MEASUREMENT

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

PRESSURE MEASUREMENT

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

FLOW, DENSITY & LEVEL MEASUREMENTS

Variable head flow meters. Area flow meters. Positive displacement meters. Pressure Probes. Level measurements - Direct & internal types. Measurement of density and specific gravity. Instruments for weighing & 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&I diagrams. Distributed Control system. **(9)**

Total : 45

TEXT BOOKS

1. *Eckman D.P. "Industrial Instrumentation" Wiley Eastern Ltd, New York, (1990).*
2. *Jain R.K, "Mechanical & Industrial Measurements", (8th Ed.), ELBS, (1985).*

REFERENCE BOOKS

1. *Considine, D.N.(Editor), "Process Instruments & Controls Handbook", McGraw Hill, New York, (1957).*
2. *Benedict R.P, "Fundamentals of Temperature, Pressure & Flow Measurements", (3rd Ed.), John Wiley, New York, (1957).*
3. *Patranabis D, "Principles of Industrial Instrumentation", Tata - McGraw Hill, New Delhi, (1976).*

09E27 - INTEGRATED DESIGN OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

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.

OUTCOME

At the end of the course the student will be able to integrate equipment, process and utility system design. 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 & water as much as possible.

REACTORS CONDITION & 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 & 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 & 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 & Cogeneration, Cooling water networking design.**(9)**

Total : 45

TEXT BOOK

1. *Robin Smith, "Chemical Process Design and Intergration", 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 & Co KGaA, Weinheim. (2008).*
2. *Anil Kumar, Chemical Process Synthesis and Engineering Design, McGraw Hill, 1982.*