ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

R - 2008

B.TECH. CHEMICAL ENGINEERING

III – VIII SEMESTERS CURRICULUM & SYLLABI

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA 9211	Mathematics III	3	1	0	4
CY 9211	Organic Chemistry	3	0	0	3
CY 9213	Instrumental Methods of Analysis	3	0	0	3
CH 9203	Mechanics of Solids	3	0	0	3
CH 9204	Basic Mechanical Engg	3	0	0	3
CH 9205	Process Calculations	3	0	0	3
CH 9206	Fluid Mechanics	3	0	0	3
PRACTICALS					
CY 9212	Organic Chemistry Lab	0	0	4	2
EE 9214	Electrical Engineering Lab	0	0	4	2
	TOTAL	**21**	**1**	**8**	**26**

SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA 9262	Numerical Methods	3	1	0	4
CY 9261	Physical Chemistry	3	0	0	3
CH 9253	Chemical Engg. Thermodynamics I	3	0	0	3
CH 9254	Mechanical Operations	3	0	0	3
CH 9255	Heat Transfer	3	0	0	3
CH 9259	Material Science and Technology	3	0	0	3
PRACTICALS					
CY 9262	Technical Analysis Lab	0	0	4	2
CH 9257	Mechanical Engineering Lab	0	0	4	2
CH 9258	Fluid Mechanics Lab	0	0	4	2
	TOTAL	**18**	**1**	**12**	**25**

SEMESETER V

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CH 9301	Chemical Technology	3	0	0	3
CH 9302	Chemical Engg. Thermodynamics II	3	0	0	3
CH 9304	Mass Transfer-I	3	0	0	3
CH 9305	Chemical Reaction Engg. I	3	1	0	4
GE 9261	Environmental Science and Engineering	3	0	0	3
	Elective I	3	0	0	3
PRACTICALS					
GE 9371	Communication Skills and Soft Skills Lab	0	0	2	1
CH 9307	Mechanical Operations Lab.	0	0	4	2
CH 9308	Heat Transfer Lab	0	0	3	2
	TOTAL	**18**	**1**	**9**	**24**

SEMESETER VI

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA 9267	Statistics and Linear Programming	3	1	0	4
CH 9351	Mass Transfer-II	3	1	0	4
CH 9352	Chemical Reaction Engg. II	3	0	0	3
CH 9353	Process Instrumentation Dynamics and Control	3	0	0	3
CH 9354	Plant Safety and Risk Analysis	3	0	0	3
	Elective II	3	0	0	3
PRACTICALS					
CH 9355	Chemical Reaction Engg. Lab	0	0	3	2
CH 9356	Computational Chemical Engg. Lab	0	0	4	2
CH 9357	Technical Seminar	0	0	2	1
	TOTAL	**18**	**2**	**9**	**25**

SEMESETER VII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CH 9401	Transport Phenomena	3	1	0	4
CH 9402	Process Equipment Design	3	1	0	4
CH 9403	Chemical Process Design	3	0	0	3
CH 9404	Process Economics	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
PRACTICALS					
CH 9405	Mass Transfer Lab	0	0	4	2
CH 9406	Process Control Lab	0	0	4	2
CH 9407	Comprehension	0	0	2	1
CH 9408	Industrial Training [+]	-	-	-	1
	TOTAL	**18**	**2**	**10**	**26[+]**

[+] Including credit for Industrial Training
* training should be undergone by the student during the summer vacation of sixth semester

SEMESETER VIII

CODE NO	COURSE TITLE	L	T	P	C
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
PRACTICALS					
CH 9451	Project Work	0	0	12	6
	TOTAL	**6**	**0**	**12**	**12**

LIST OF ELECTIVES

CODE NO	COURSE TITLE	L	T	P	C
CH 9021	Optimization of Chemical Processes	3	0	0	3
CH 9022	Modern Separation Techniques	3	0	0	3
CH 9023	Biochemical Engineering	3	0	0	3
CH 9024	Process Modeling and Simulation	3	0	0	3
CH 9025	Process Plant Utilities	3	0	0	3
CH 9026	Supply Chain Management	3	0	0	3
CH 9027	Energy Technology	3	0	0	3
CH 9028	Electrochemical Engineering	3	0	0	3
CH 9029	Petroleum Refining and Petrochemicals	3	0	0	3
CH 9030	Drugs and Pharmaceutical Technology	3	0	0	3
CH 9031	Polymer Technology	3	0	0	3
CH 9032	Frontiers of Chemical Engineering	3	0	0	3
GE 9021	Professional Ethics in Engineering	3	0	0	3

MA9211 **MATHEMATICS III** **L T P C**

(Common to all branches of B.E / B.Tech Programme) **3 1 0 4**

AIM

To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

OBJECTIVES

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems

UNIT I FOURIER SERIES **9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORM **9+3**

Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's Linear equation – Integral surface passing through a given curve – Solution of linear equations of higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Method of separation of Variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS **9+3**

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and Final value theorems – Formation of difference equation – Solution of difference equation using Z-transform.

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOK

1. Grewal, B.S. "Higher Engineering Mathematics", Khanna Publications (2007)

REFERENCES

1. Glyn James, "Advanced Modern Engineering Mathematics, Pearson Education (2007)
2. Ramana, B.V. "Higher Engineering Mathematics" Tata McGraw Hill (2007).
3. Bali, N.P. and Manish Goyal, "A Text Book of Engineering 7th Edition (2007) Lakshmi Publications (P) Limited, New Delhi.

CY9211 ORGANIC CHEMISTRY L T P C
3 0 0 3

(Common to Chemical, Textile, Leather, Petroleum Refining & Petrochemicals and Apparel Technology)

AIM

To learn fundamental and applied aspects of organic chemistry towards different applications.

OBJECTIVE

- To acquire knowledge about chemical bonding, hybridization, bond fission, different types of chemical reactions and their mechanism, isomerism in organic molecules, synthesis of organic compounds and various applications of organic products.

UNIT I STRUCTURAL CONCEPT OF ORGANIC MOLECULES 5

Nature of bonding (covalent, hydrogen) – atomic orbitals – hybridization – electronegativity – conjugation – mesomerism and resonance – hyper-conjugation – inductive effect.

UNIT II REACTION AND THEIR MECHANISM 10

Homolytic bond fission – free radicals – heterolytic bond fission – electrophiles, carbonium ion, nucleophiles – acids and bases – Bronsted - Lowry concept, Lewis concept, strength of acids and bases. Substitution reactions – S_N1, S_N2, S_Ni, Addition reactions – carbon – carbon (double bond), Addition of dienes – carbon – oxygen (double bond), carbon – carbon (triple bond) – poly addition reactions, Elimination reactions – E1, E2, Condensation – simple and polycondensation , Redox reactions.

UNIT III ISOMERISM 6

Structural isomerism – stereoisomerism – optical isomerism – racemic mixture – resolution, racemisation – asymmetric synthesis, Walder Inversion.

Geometrical isomerism – cis, trans isomerism, syn, anti isomerism – determination of configuration of geometrical isomers – tautomerism.

UNIT IV HYDROCARBONS AND THEIR CLASSIFICATION 10

Alkanes – alkenes – alkynes – alicylic compounds – Bayers-strain theory - Hydrocarbons related to petrol, diesel, kerosene, lube oil and waxes. Benzene and its homologues – aromatic substitution, Friedal - Crafts reactions, Kolbe's synthesis – Riemer – Tiemann reaction, Benzoin condensation, Perkin reaction, Beckmann rearrangement, Claison condensation, Hoffmann rearrangements.

UNIT V SYNTHETIC ORGANIC CHEMISTRY 14

Synthesis of different types of compounds – alcohol – aldehyde – carboxylic acid – ester – ether – nitrocompounds – amines – amides (industrial methods only). Synthetic reagents – acetoacetic ester – malonic ester and Grignard reagent.

APPLIED ORGANIC CHEMISTRY

Polysaccharides – starch and cellulose – Proteins – amino acids and peptides – Dyes and dyeing – colour and constitution – classification of dyes based on chemical constitution and applications.

TOTAL : 45 PERIODS

TEXT BOOKS

1. B.S. Bahl and Arun Bahl, "Essentials of Organic Chemistry", S.Chand and Company, New Delhi (2005).
2. K.S. Tiwari, N.K. Vishnoi and S.N. Malhotra "A Text Book of Organic Chemistry", Third Edition, Vikas Publishing House Pvt. Ltd., New Delhi (2006).

REFERENCES

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition, Prentice Hall of India Pvt. Ltd., New Delhi (2000).
2. I L Finar "Organic Chemistry", Volume – I, IX Edition, Pearson Education (Singapore) Pte. Ltd., New Delhi (2004).
3. I L Finar "Organic Chemistry", Volume – II, VII Edition, Pearson Education (Singapore) Pte. Ltd., New Delhi (2004).

CY9213 INSTRUMENTAL METHODS OF ANALYSIS L T P C
3 0 0 3

(Common to Chemical, Textile, Leather, Ceramic and Petroleum Refining & Petrochemicals)

AIM

To know the principle and importance of various analytical instruments used for the characterization of various materials

OBJECTIVES

- To have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials, intermediates and finished products
- To know the importance of analytical instrumentation during the purification, compounding and formulating the finished product

UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 12

ELECTROMAGNETIC RADIATION: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Classification of instrumental methods based on physical properties

QUANTITATIVE SPECTROSCOPY: Beer -Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer -Lambert's Law

UNIT II UV AND VISIBLE SPECTROCOPY 12

Various electronic transitions in organic and inorganic compounds effected by UV, and Visible radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Choice of solvents, cut off wavelengths for solvents, Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and efffects of conjugation on the absorption maxima, Different shifts of absorption peaks(Batho chromic, hypsochromic, hypochromic), Multicomponent analysis (no overlap, single way overlap and two way overlap), Instrumentation for UV and VISIBLE spectrophotometers (source, optical parts and detectors), Photometric titration (Experimental set -up and various types of titrations and their corresponding curves), Applications of UV and VISIBLE spectroscopies

UNIT III IR , RAMAN AND ATOMIC SPECTROSCOPY 10

Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques, Applications.Raman spectroscopy: Theory, Differences between IR and Raman. Atomic absorption spectrophotometry: Principle, Instrumentation (Types of burners, Types of fuels, Hollow cathode lamp, Chopper only) and Applications, Various interferences observed in AAS (Chemical, radiation and excitation) Flame photometry: Principle, Instrumentation, quantitative analysis (Standard addition method and internal standard method) and applications

Differences between AAS and FES.

UNIT IV THERMAL METHODS 5

Thermogravimetry: Theory and Instrumentation, factors affecting the shapes of thermograms (Sample Characteristics and instrumental characteristics), thermograms of some important compounds (CuSO4. $5H_2O$, CaC_2O_4. $2H_2O$, MgC_2O_4, Ag_2CrO_4, Hg_2CrO_4, $AgNO_3$ etc), applications. Differential thermal analysis: Principle, Instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples)

UNIT V CHROMATOGRAPHIC METHODS 6

Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation and Technique). Separation of organic compounds by column and Thin layer, mixure of Cu, Co and Ni by Paper, separation of amino acids by paper, estimation of organic compounds by GC and HPLC

TOTAL : 45 PERIODS

REFERENCES

1. Willard, H.H., Merritt.l.l., Dean J.a., and Settle,F.A., Instrumental methods of analysis, Sixth edition, CBS publishers,1986
2. Skoog D.A and West D.M, Fundamentals of Analytical Chemistry, Saunders -college Publishing, 1982.
3. Banwell, G.C., Fundamentals of molecular spectroscopy, TMH,1992.
4. A.I. Vogel's Quantitative Inorganic analysis . V Edition
5. Day R.A Underwood A.L Qualitative Inorganic analysis (A. I. Vogel).
6. V Edition, Prentice-Hall of India (P) Ltd, NewDelhi
7. Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House,1995
8. Kalsi .P.S. Spectroscopy of organic compounds, 6th Edition, New Age International Publishers,2006
9. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007
10. Sathya Narayana. D. N. Vibrational Spectroscopy, First Edition 2004 and Reprint 2005, New Age International publishers.

CH9203 MECHANICS OF SOLIDS L T P C

3 0 0 3

AIM

To given them knowledge on structural, Mechanical properties of Beams, columns.

OBJECTIVE

- The students will be able to design the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – forces on solids and supports – equilibrium and stability – strength and stiffness – tension, compression and shear stresses – Hooke's law and simple problems – compound bars – thermal stresses – elastic constants and poission's ratio – welded joints – design.

UNIT II TRANSVERSE LOADING ON BEAMS 9

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.& B.M. diagrams.

UNIT III DEFLECTIONS OF BEAMS 9

Double integration method – Macaulay's method – Area – moment theorems for computation of slopes and deflections in beams – conjugate beam method

UNIT IV STRESSES IN BEAMS 9

Theory of simple bending – assumptions and derivation of bending equation (M/I = F/Y = E/R) – analysis of stresses in beams – loads carrying capacity of beams – proportioning beam sections – leaf springs – flitched beams – shear stress distribution in beams – determination of shear stress in flanged beams.

UNIT V TORSION 9

Torsion of circular shafts – derivation of torsion equation (T/J = C/R = G0/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends – stresses in helical springs – deflection of springs – spring constant

COLUMNS

Axially loaded short columns – columns of unsymmetrical sections – Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Junarkar, S.B., Mechanics of Structure Vol. 1, 21st Edition, Character Publishing House, Anand, Indian, (1995)
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series. McGraw Hill International Editions, Third Edition, 1994.

REFERENCE

1. Elangovan, A., Thinma Visai Iyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

CH9204 BASIC MECHANICAL ENGINEERING L T P C
3 0 0 3

AIM

To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

OBJECTIVE

- Students should learn thermodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines etc., Students should be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms

UNIT I LAWS OF THERMODYNAMICS 10

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Equivalence entropy; Reversibility: Entropy charts; Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES 6

Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III AIR STANDARD CYCLES 6

Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND STEAM TURBINES 12

Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.

Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle.

Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALANCING 11

Definition of Kinematic Links, Pairs and Kinematic Chains; Working principle of Slider Crank mechanism and inversions; Double slider crank mechanism and inversions.

Flywheel-Turning moment Diagram; Fluctuation of Energy.

Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types.

Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Nag, P.K., " Engineering Thermodynamics ", II Edition, Tata McGraw Hill Publishing Co., Ltd., 1995.
2. Rajput, R .K, “Thermal Engineering”, Laxmi publications (P) Ltd, 2001.
3. Khurmi R.S., and Gupta J.K, “Theory of Machines”, Eurasia Publishing House (P) Ltd., 2004.

REFERENCES

1. Smith, " Chemical Thermodynamics ", Reinhold Publishing Co., 1977.
2. Bhaskaran, K.A., and Venkatesh, A., " Engineering Thermodynamics ",
3. Tata McGraw Hill, 1973.
4. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
5. Khurmi R.S., and Gupta J.K, “Thermal Engineering”, S.Chand & Company (P) Ltd.,2001.
6. Kothandaraman and Dhomkundwar,”: A course in Thermal Engineering (SI Units)”, Dhanpat Rai and Sons, Delhi (2001)

CH9205 PROCESS CALCULATIONS L T P C
3 0 0 3

AIM

The aim of this course is to give fundamental knowledge on material and energy balances and steady state simulation.

OBJECTIVE

- To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I 6

Units, dimensions and conversion; Process variables and properties; Degree of freedom.

UNIT II 11

Concept of material balance Material balance calculations not involving and involving single and multiple reactions including combustion Material balance calculations involving phase change.

UNIT III **11**

Heat capacity; Calculation of enthalpy changes without phase change; Energy balance calculations without and with reactions including combustion.

UNIT IV **11**

Simultaneous material and energy balance calculations for Humidification, vaporization, condensation, mixing, crystallization.

UNIT V **6**

Material balance and energy balance calculations for network of units without and with recycle. Demonstration of ASPEN Process Simulator

TOTAL : 45 PERIODS

TEXT BOOKS

1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering ", EEE Sixth Edition, Prentice Hall Inc., 2003
2. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition,Tata McGraw-Hill (2004)
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",3rd Edn., John Wiley & Sons, New York, 2000.

REFERENCE

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers (1973).

CH9206 **FLUID MECHANICS** **L T P C**
3 0 0 3

AIM

To understand the principles and applications fluid mechanics.

OBJECTIVE

- To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries

UNIT I **6**

Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II **9**

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometry – Differential analysis of fluid motion – continuity, Euler's and Bernoulli equation

UNIT III **9**

The principle of dimensional homogeneity – dimensional analysis, the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV **12**

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V **9**

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

TOTAL : 45 PERIODS

TEXT BOOKS

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).
2. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5th Edition“, John Wiley, 2006

REFERENCES

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, “Fluid Mechanics for Chemical Engineers’ Prentice Hall PTR (International series in Chemical Engineering) (1999)
3. McCabe W.L, Smith, J C and Harriot. P “Unit operations in Chemical Engineering”, McGraw Hill, V Edition, 2001

CY9212 **ORGANIC CHEMISTRY LAB** **L T P C**
0 0 4 2

(Common to Chemical and Petroleum Refining & Petrochemicals)

OBJECTIVE

To learn basic principles involved in analysis and synthesis of different organic derivatives.

LIST OF EXPERIMENTS

1. Analysis of nature of organic compounds – To identify aliphatic/aromatic, saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions: a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) amide i) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
4. Analysis of carbohydrates.
5. Analysis of proteins.
6. Methodology of filtration and recrystallization.
7. Introduction to organic synthetic procedures:
    i. Acetylation – Preparation of acetanilide from aniline.
    ii. Hydrolysis – Preparation of salycilic acid from methyl salyciliate.
    iii. Substitution – Conversion of acetone to iodoform.
    iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
    v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

TOTAL : 60 PERIODS

REFERENCE MANUAL

1. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Department, A.C.Tech, Anna University (2007).

EE9214 ELECTRICAL ENGINEERING LABORATORY L T P C
0 0 4 2

AIM

To provide the practical knowledge and control methods of electrical machines

OBJECTIVE

- To impart practical knowledge on
- Characteristic of different machines
- Method of speed control of machines
- Measurement of various electrical parameters

LIST OF EXPERIMENTS

1. Study of DC & AC Starters
2. Study of Transducers
3. Wheatstone Bridge and Schering Bridge
4. ADC and DAC Converters
5. Speed Control of DC Shunt Motor
6. Load Test on DC Shunt Motor
7. OCC & Load Characteristics of DC Shunt Generator
8. Load Test on Single-Phase Transformer
9. Load Test on Three-Phase Induction Motor
10. Load Test on Single-Phase Induction Motor.

TOTAL : 60 PERIODS

MA9262 NUMERICAL METHODS L T P C
3 1 0 4

AIM

This course gives a complete procedure for solving numerically different kinds of problems occurring in engineering and technology.

OBJECTIVE

- The students would be acquainted with the basic concepts of numerical methods and their applications.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 +3

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton-Raphson method – Solution of linear system of equations – Gauss Elimination method – Pivoting – Gauss-Jordan methods – Matrix Inversion by Gauss-Jordan method – Iterative methods of Gauss-Jacobi and Gauss-Seidel – Eigenvalues of a matrix by Power method and by Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION 9 + 3

Interpolation with unequal intervals – Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines – Interpolation with equal intervals – Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION 9 + 3

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Single step-methods – Taylor's series method – Euler's method – Fourth order Runge-Kutta method for solving first and second order equations – Multi-step methods – Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science", 6th Edition, Khanna Publishers, New Delhi, (2004).
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers', 3rd Edition Prentice Hall of India Private Ltd., New Delhi, (2007).

REFERENCES

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, New Delhi, (2007).
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, (2006).
3. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson Education Asia, New Delhi, (2007).

CY9261 PHYSICAL CHEMSITRY L T P C
3 0 0 3

(Common to Chemical, Textile, Leather and Petroleum Refining & Petrochemicals)

AIM

To know the basic concepts of physical chemistry and its applications.

OBJECTIVE

- To acquire knowledge in the field of electrochemistry, solubility behaviour, chemical reaction kinetics, photochemical reactions and colloidal chemistry towards different applications.

UNIT I ELECTROCHEMISTRY 9

Electrical conductance – Specific conductance – Equivalent conductance – variation with dilution – Kohlrausch's law – Transport number – Galvanic cells – EMF and its measurement – Reference electrode – Standard Hydrogen electrode – Nernst equation - Electrochemical series – Applications of EMF measurements: Fuel cells – Hydrogen -Oxygen fuel cell – Chemical and electrochemical corrosion – Corrosion control – Different methods.

UNIT II IONIC EQUILIBRIA 9

Acids and bases – Arrhenius concept – Lewis concept – Dissociation of weak acid, weak base – Ionic product of water – Buffer solutions – calculation of pH – Henderson's equation – Hydrolysis of salts – Degree of hydrolysis – Determination – acid-base indicators – their applications – solubility product principle – Ionic equilibria involving complex ions.

UNIT III CHEMICAL KINETICS 9

Order of a reaction – Zero order, First order, Second order and Third order reactions – Molecualrity of a reaction – Unimolecular and Bimolecular reactions – Experimental methods of determining order of a reaction – Kinetics of parallel and opposing reactions – Concept of activation energy – Arrhenius equation – Collision theory of reaction rates – Theory of absolute reaction rates – Kinetics of enzyme catalyzed reactions.

UNIT IV PHOTOCHEMISTRY 9

Laws of Photochemistry, Quantum efficiency, Photochemical reactions, Actinometry, Kinetics and mechanism of Hydrogen – Bromine reaction, Hydrogen – Chlorine reaction – Photosensitization, Chemiluminscence.

UNIT V COLLOIDS 9

Introduction to colloids – properties of colloids – coagulation of solutions – Origin of charge on colloidal particles – Determination of size of colloidal particles – Donnan Membrane equilibrium – Emulsions – Gels – Applications of colloids – Nanoparticles (Au, Ag, Pt) – Preparation – Characterization – Properties – Application in catalysis and drug delivery systems.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Kund and Jain, Physical Chemistry, S.Chand and Company, New Delhi (1996).
2. Puri B.H. Sharma L.R. and M.S.Prathama, “Principles of Physical Chemisry”, S.Chand and Company, New Delhi (2001).
3. B.S.Bahl, Arun Bahl and G.D.Tuli, “Essentials of Physical Chemistry”, S.Chand and Company, New Delhi (2005).

REFERENCES

1. Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (1998).
2. Peter Atkins & Julio de Paula, Atkins’ Physical Chemistry, 7th Edition, Oxford university press. (2002).

CH9253 CHEMICAL ENGINEERING THERMODYNAMICS- I L T P C
3 0 0 3

AIM

To introduce fundamental thermodynamic principles and their application

OBJECTIVES

- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I 6

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. zeroth law; temperature scales

UNIT II 7

PVT behaviour of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state

UNIT III **12**

Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV **12**

Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams

UNIT V **8**

Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, jet and rocket engines, refrigeration – vapour compression and absorption refrigeration cycles; liquefaction processes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, 2003
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004

REFERENCES

1. Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 1999.
2. Elliott J.R., Lira, C.T., "Introductory chemical engineering thermodynamics", Prentice Hall, 1998
3. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2005

CH9254 **MECHANICAL OPERATIONS** **L T P C**
3 0 0 3

AIM

To impart knowledge on solid handling and solid liquid separation

OBJECTIVE

- The students will learn characterization of solids, size reduction, techniques of solid – fluid separation and mixing

UNIT I **9**

General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II **9**

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT III **9**

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV **9**

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V **9**

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL : 45 PERIODS

TEXT BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 1994.

REFERENCE

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

CH9255 **HEAT TRANSFER** **L T P C**
3 0 0 3

AIM

To understand the principles and applications heat transfer

OBJECTIVE

- To learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I **9**

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.

UNIT II **9**

Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn 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.

UNIT III **9**

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 gasses on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV **9**

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, Stefan - Boltzman law, Plank's law, radiation between surfaces,

UNIT V **9**

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

TOTAL : 45 PERIODS

TEXT BOOKS

1. Holman, J. P., 'Heat Transfer ', 8th Edn., McGraw Hill, 1997.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.

REFERENCES

1. Cabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

CH9259 MATERIAL SCIENCE AND TECHNOLOGY **L T P C**
3 0 0 3

AIM

To impart knowledge in material properties and manufacturing methods

OBJECTIVE

- Students will be able to understand various material and its properties and manufacturing methods

UNIT I INTRODUCTION **10**

Selection criteria and processes: General criteria of selection of materials in process industries. Properties: Mechanical, Thermal, Chemical, Electrical, Magnetic and Technological properties. Processing of Metals and Alloys- Casting, Hot and cold rolling, Forging, Extrusion, Deep drawing.

UNIT II MECHANICAL BEHAVIOUR **8**

Elastic, Anelastic and Viscoelastic Behaviour – Plastic Deformation by Slip: Critical resolved shear stress, Mechanism of Creep, Creep Resistant Materials – Fracture: Ductile and Brittle , Fatigue fracture, Griffith's theory, S-N curves , Fracture toughness

UNIT III PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 8

Gibb's Phase rule : Uniary and Binary phase diagrams , Al_2O_3 - Cr_2O_3 , Pb-Sn, Ag-Pt and Iron- Iron Carbide Phase Diagram – Lever rule – Invariant reactions- TTT diagrams – Micro structural changes – Nucleation and growth – Martensitic transformations – Solidification and Crystallization – Glass transition – Recrystallization and Grain growth

UNIT IV FERROUS, NON-FERROUS METALS AND COMPOSITES 10

Pig iron, Cast iron, Mild Steel-properties, Applications and Manufacturing methods; Stainless steels, Special Alloy steels-properties and uses; Heat treatment of plain-carbon steels. Manufacturing methods of Lead, Tin and Magnesium. Properties and applications in process industries.FRP-Fiber Reinforced Plastics (FRP), Different types of manufacturing methods; Asphalt and Asphalt mixtures; Wood.

UNIT V NANOMATERIALS 9

Introduction to Nanotechnology- Zero Dimensional Nano Structures – Nano particles – One Dimensional Nano Structures- Nano wires and Nano rods – Two Dimensional Nano Structures, Films – Special Nano Materials - Nano Structures fabricated by Physical Techniques – Characterisation and Properties of Nano Materials – Applications of Nano Structures.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Khanna O P, "Material Science and metallurgy" Dhnapat Rai Publications (1995)
2. Raghavan V, "Materials and Engineering" Prentice Hall of India, Newdelhi (2006)
3. Brenner D, "Hand book of Nanoscience and technology" (2002)

REFERENCES

1. Henry R Clauster, "Industrial and Engineering materials" McGraw Hill Book Co. (1975)
2. Kingery W D and Bowen H K and Unimann D R, "Introduction to Ceramics" Jhon Wiley and sons, Second edition (1991)
3. Fahrner W R, "Nanotechnology and Nanoeletronics" Springer International edition(2005)
4. Budinsky K G and Budinsky K M " Engineering materials- Properties and Selection" Prentice Hall of India (2002)
5. Arumugam M, " Material Science" Anuradha technical book publishers (1997)

CY9262 TECHNICAL ANALYSIS LAB L T P C

(Common to Chemical and Petroleum Refining & Petrochemicals) **0 0 4 2**

OBJECTIVE

- To learn basic principles involved in estimation and characterization of industrially important materials.

I. Soap Analysis
   a. Estimation of total fatty acid
   b. Estimation of percentage alkali content

II. Oil Analysis
   a. Estimation of free acid
   b. Determination of Saponification value
   c. Determination of iodine value

III. Cement Analysis
   a. Estimation of Silica content
   b. Estimation of mixed oxide content
   c. Estimation of calcium oxide content
   d. Estimation of calcium oxide by rapid method

IV. Coal Analysis
   a. Estimation of Sulphur present in coal
   b. Ultimate analysis of coal
   c. Proximate analysis of coal

V. Analysis of Bleaching Powder
   a. Estimation of available chlorine

VI. Analysis of Glycerol
   a. Estimation of purity of glycerol

VII. Analysis of fuels
   a. Flash point b. Fire point c. Cloud point d. Pour point e. Aniline point.

TOTAL : 60 PERIODS

REFERENCE MANUAL

1. Technical Analysis Manual, Chemistry Division, Chemical Engineering Department, A.C.Tech, Anna University (2007).

CH9257 MECHANICAL ENGINEERING LAB L T P C
0 0 4 2

AIM

To impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

OBJECTIVES

- Students will be able to understand Power-generating units such as engines and operate IC engines and conduct tests. They will be able to appreciate the theory behind the functioning of engines. Material properties, their behavior under different kinds of loading and testing can be visualized.

LIST OF EXPERIMENTS *

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

TOTAL : 60 PERIODS

* Minimum 10 experiments shall be offered

CH9258 **FLUID MECHANICS LAB** **L T P C**
0 0 4 2

AIM
To understand the concepts of fluid mechanics through experiments

OBJECTIVE
- To learn experimentally to calibrate flowmeters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS
1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

EQUIPMENT REQUIRED
1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

TOTAL : 60 PERIODS

CH9301 **CHEMICAL TECHNOLOGY** **L T P C**
3 0 0 3

AIM
To present the stages involved in the large scale manufacture of different chemicals.

OBJECTIVES
- To gain knowledge on unit processes and unit operations involved in the manufacture of different chemicals in different industries like chloro-alkali, petroleum, pharmaceutical, fertilizer etc.

UNIT I **3**
Introduction to chemical processing; symbolic representation of different unit operations and unit processes to build a flowsheet

UNIT II **10**
Chlor-Alkali- Industries, Cement, Glass and ceramics, Pulp and paper.

UNIT III **12**
Oil, Soap and Detergent, Petroleum Refining, Petrochemicals, Polymers

UNIT IV **10**
Pharmaceuticals, Chemical Explosives, Paints and Pigments.

UNIT V **10**
Dyes and intermediates, Fertilizers, Sugar, Food Products

TOTAL : 45 PERIODS

TEXT BOOKS

1. Dryden, C. E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M. Sittig, Second Edition, Affiliated East-West press, 1993.
2. Austin, G. T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw Hill, Singapore, 1984.

CH9302 CHEMICAL ENGINEERING THERMODYNAMICS II **L T P C**
3 0 0 3

AIM

To present thermodynamic principles from a chemical engineering viewpoint.

OBJECTIVE

- The Students will be well versed with the behavior of fluids under PVT conditions and also apply them for practical purpose. Main advantage will be to deal with power production and refrigeration processes. The study further provides a comprehensive exposition to theory and application of solution thermodynamics.

UNIT I PROPERTIES OF SOLUTIONS **10**
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures.

UNIT II PHASE EQUILIBRIA **14**
Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA **12**
Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV CHEMICAL REACTION EQUILIBRIA **14**
Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

UNIT V REFRIGERATION **10**
Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles.

L : 45, T : 15 , TOTAL: 60 PERIODS

TEXT BOOKS

1. Smith, J.M., VanNess, H.C., & Abbot M.C, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill VII Edition 2004.
2. Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" Prentice Hall of India Pvt. Ltd. 2001.

REFERENCES

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., "Chemical Process Principles Part II", Thermodynamics, John Wiley, 1970.
2. Dodge, B.F., "Chemical Engineering Thermodynamics", McGraw-Hill, 1960.
3. Sandler, S.I., "Chemical and Engineering Thermodynamics", 2nd Edition, Wiley, 1989.

CH9304 MASS TRANSFER I L T P C
3 0 0 3

AIM

To impart knowledge on fundamentals of mass transfer phenomena and rate based mass transfer operations.

OBJECTIVE

- Students will learn to determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I **9**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II **10**

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients.

UNIT III **9**

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV **9**

Drying– Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.

UNIT V **8**

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Treybal, R.E., "Mass Transfer Operations", 3rd Edn, McGraw-Hill, 1981.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, Asian Books Pvt. Ltd., India, 1998.
3. J.D. Seader and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley, 2006.

CH9305 CHEMICAL REACTION ENGINEERING I L T P C
3 1 0 4

AIM

To impart knowledge to design different types of chemical reactors

OBJECTIVES

- Students gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I **10**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and temperature dependency; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II **10**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, size comparison of reactors.

UNIT III **7**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV **10**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V **8**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

L : 45, T : 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000.
2. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.
3. Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., IIIrd Edition, 2000.

REFERENCE

1. Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, 1979.

GE9261 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

AIM

The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional endeavour that they participates.

OBJECTIVE

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education (2004).
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, (2006).

REFERENCES

1. R.K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press (2005)

GE 9371 COMMUNICATION SKILLS AND SOFT SKILLS LAB L T P C
0 0 2 1

AIM

To enhance the overall capability of students and to equip them with the necessary Communication Skills and Soft Skills that would help them excel in their profession.

OBJECTIVES

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

1. PC based session

A. Career Lab (15 periods) Viewing and discussing audio-visual materials

1. **Resume / Report Preparation / Letter Writing:** (3)
   Letter writing – Job application with Resume - Project report - Email etiquette.

2. **Presentation skills:** (3)
Elements of effective presentation – Structure of presentation - Presentation tools – Body language.

3. **Soft Skills:** (3)
Time management – Stress management – Assertiveness – Negotiation strategies, Psychometrics - Analytical and logical reasoning.

4. **Group Discussion:** (3)
Group discussion as part of selection process, Structure of group discussion – Strategies in group discussion – Mock group discussions.

5. **Interview Skills:** (3)
Kinds of interviews – Interview techniques – Corporate culture – Mock interviews.

TOTAL : 45 PERIODS

II. Class Room Session

1. **Resume / Report Preparation / Letter writing**: Students prepare their own resume and report. (9)
2. **Presentation Skills:** Students make presentations on given topics. (12)
3. **Group Discussion**: Students participate in group discussions. (12)
4. **Interview Skills**: Students participate in Mock Interviews (12)

Note: Classroom sessions are practice sessions.

REFERENCES

1. Prakash P, **Verbal and Non-Verbal Reasoning**, Macmillan India Ltd., 2nd Edition, New Delhi, 2004.
2. John Seely, **The Oxford Guide to Writing and Speaking**, Oxford University Press, New Delhi 2004.
3. Paul V Anderson, **Technical Communication**, Thomson Wadsworth , 6th Edition, New Delhi, 2007.
4. Edgar Thorpe and Showick Thorpe, **Objective English**, Pearson Education, 2nd Edition, New Delhi 2007.
5. David Evans, **Decision maker**, CUP, 1997

Lab Requirement:

1. Teacher console and systems for students.
2. English Language Lab Software
3. Tape recorders

CH9307 MECHANICAL OPERATIONS LABORATORY L T P C
0 0 4 2

AIM

To impart knowledge on mechanical operations by practice

OBJECTIVES

- Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press

4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

EQUIPMENT REQUIRED

1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

TOTAL : 60 PERIODS

CH9308 HEAT TRANSFER LABORATORY L T P C
0 0 3 2

AIM

To impart knowledge on heat transfer operation by practice

OBJECTIVE

- Students develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS

1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Heat transfer in Open Pan Evaporator
4. Boiling Heat Transfer
5. Heat Transfer through Packed Bed
6. Heat Transfer in a Double Pipe Heat Exchanger
7. Heat Transfer in a Bare and Finned Tube Heat Exchanger
8. Heat Transfer in a Condenser
9. Heat Transfer in Helical Coils
10. Heat Transfer in Agitated Vessels

EQUIPMENT REQUIRED

1. Cooling Tower
2. Tray Dryer
3. Open Pan Evaporator
4. Boiler
5. Packed Bed
6. Double Pipe Heat Exchanger
7. Bare and Finned Tube Heat Exchanger
8. Condenser
9. Helical Coil
10. Agitated Vessel.

TOTAL : 45 PERIODS

MA9267 STATISTICS AND LINEAR PROGRAMMING L T P C
3 1 0 4

AIM

This course aims at providing the required skill to apply the statistical and Linear Programming tools for engineering problems.

OBJECTIVES

- The students will have a fundamental knowledge of the concepts of statistical inference
- Have the knowledge of applying Linear programming tools in management problems.

UNIT I TESTING OF HYPOTHESIS 9 + 3

Sampling distributions - Tests for single mean , proportion and difference of means (large and small samples) – Tests for single variance and equality of variances – χ^2-test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

UNIT II DESIGN OF EXPERIMENTS 9 + 3

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design.

UNIT III STATISTICAL QUALITY CONTROL 9 + 3

Control charts for measurements ($\overline{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling

UNIT IV LINEAR PROGRAMMING 9 + 3

Formulation – Graphical solution – Simplex method – Big-M method - Transportation and Assignment models

UNIT V ADVANCED LINEAR PROGRAMMING 9 + 3

Duality – Dual simplex method – Integer programming – Cutting-plane method.

L: 45, T: 15, TOTAL: 60 PERIODS

TEXT BOOKS

1. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, (2007).
2. Taha, H.A., "Operations Research", Pearson Education, Asia, 8th edition, (2007).

REFERENCES

1. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th edition, (2007).
2. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson Brooks/Cole, International Student Edition, 7th edition, (2008).
3. Winston, W.L.,"Operations Research – Applications and Algorithms",Thomson, 1st Indian Reprint, 4th edition, (2007).

CH9351 MASS TRANSFER II L T P C
3 1 0 4

AIM

To impart knowledge on mass transfer operations

OBJECTIVES

- Students will learn fundamentals of absorber and stripper, distillation column, extraction and leaching equipments and adsorber.

UNIT I ABSORPTION 12

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II DISTILLATION 12

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 12

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV LEACHING 12

Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS 12

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

L : 45 , T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS

1. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.
2. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES

1. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006.
2. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
3. King, C. J., "Separation Processes ", Tata McGraw-Hill 1974.

CH9352 CHEMICAL REACTION ENGINEERING - II L T P C
3 0 0 3

AIM
To introduce non-ideal behavior of reactors and heterogeneous reactors

OBJECTIVES
- The objective is to study the non-ideal behavior of homogeneous reactors, gas-solid catalytic and non-catalytic reactors and gas-liquid reactors.

UNIT I CATALYSTS 7
Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

UNIT II HETEROGENEOUS REACTORS 10
Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps,

UNIT III GAS-SOLID CATALYTIC REACTORS 10
Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 9
Models for explaining kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidized and static reactors.

UNIT V GAS-LIQUID REACTORS 9
Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

TOTAL : 45 PERIODS

TEXT BOOKS
1. Levenspiel, O., "Chemical Reaction Engineering ", III Edition, John Wiley, 1999.
2. Fogler. H. S. " Elements of Chemical Reaction Engineering ", III Edition., Prentice Hall of India, 1999.

REFERENCE
1. Smith J.M., " Chemical Engineering Kinetics ", III Edition, McGraw-Hill, New York, 1981.

CH9353 PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL L T P C
3 0 0 3

AIM
To familiarize the students with concepts of process dynamics and control leading to control system design.

OBJECTIVE
- To introduce dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION 6

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 11

Laplace transformation, application to solve ODEs. 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; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 10

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, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Stephanopoulos, G., “Chemical Process Control“, Prentice Hall of India, 2003.
2. Coughnowr, D., “ Process Systems Analysis and Control “, 2nd Edn., McGraw Hill, New York, 1991.

REFERENCES

1. Marlin, T. E., “ Process Control “, 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, 2nd Edn., John Wiley, New York, 1997.

CH9354 PLANT SAFETY AND RISK ANALYSIS L T P C

3 0 0 3

AIM

To introduce awareness on the importance of plant safety and risk analysis

OBJECTIVES

- Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I 9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II 9

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT III **9**

Over all risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV **9**

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

UNIT V **9**

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

TOTAL : 45 PERIODS

TEXT BOOKS

1. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.
2. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
3. Skeleton, B., Process Safety Analysis : An introduction, Institution of chemical Engineers, U.K., 1997.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004.

REFERENCES

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., " Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
4. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

CH9355 CHEMICAL REACTION ENGINEERING LAB* **L T P C**
0 0 3 2

AIM

To impart knowledge on reaction engineering by practice

OBJECTIVES

- Students develop a sound working knowledge on different types of reactors.

LIST OF EXPERIMENTS

1. Kinetic studies in a batch reactor
2. Kinetic studies in a plug flow reactor
3. Kinetic studies in a PFR followed by a CSTR
4. RTD studies in a PFR
5. RTD studies in a packed bed
6. RTD studies in CSTRs in series
7. Studies on micellar catalysis
8. Study of temperature dependence of rate constant using CSTR.

9. Kinetic studies in sono-chemical reactor
10. Batch reactive distillation
11. Kinetics of photochemical reaction
12. Demonstration of heterogeneous catalytic reaction
13. Demonstration of gas-liquid reaction

EQUIPMENT REQUIRED

1. Batch reactor
2. Plug flow reactor
3. CSTR
4. Sono-chemical reactor
5. Photochemical reactor

***Minimum 10 experiments shall be offered.**

TOTAL : 45 PERIODS

CH 9356 COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY L T P C
0 0 4 2

AIM

To give practice to students to solve chemical engineering problems through programming and using computational tools.

OBJECTIVES

- Students will solve chemical engineering problems from core courses using C and MATLAB programming and also using computational tools like Excel and Aspen.

Programming in C

C programs will be written to solve problems from core courses of chemical engineering.

Microsoft Excel Software

The computational, plotting and programming abilities in Excel will be used to solve different chemical engineering problems.

Programming in MATLAB

Chemical engineering problems will be solved using the powerful computational and graphical capability of MATLAB.

ASPEN Software

Individual process equipments and flowsheets will be simulated using Aspen Plus and property analysis and estimation will be done using Aspen Properties.

Evaluation

This lab course will have two or three online assessment tests and an online end semester examination in the Process Simulation Laboratory and assignments in all the above four units.

TOTAL : 60 PERIODS

REFERENCE

1. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.

CH9357 TECHNICAL SEMINAR L T P C
0 0 2 1

Students are expected to present two seminars along with report on any recent topic in chemical engineering.

CH9401 TRANSPORT PHENOMENA L T P C
3 1 0 4

AIM

To give an overview of mass, momentum and energy transport, present the fundamental equations and illustrate how to use them to solve problems.

OBJECTIVES

- To describe mass, momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.

UNIT I MOMENTUM TRANSPORT 8

Viscosity, temperature effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell balance method, pressure and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II EQUATIONS OF CHANGE AND TURBULENT FLOW 7

Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions.

UNIT III ENERGY TRANSPORT 8

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow, with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT IV EQUATIONS OF CHANGE FOR NONISOTHERMAL SYSTEM AND TEMPERATURE DISTRIBUTION IN TURBULENT FLOWS 9

Energy equations, special forms, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

UNIT V MASS TRANSPORT,EQUATIONS OF CHANGE FOR MULTICOMPONENT SYSTEMS AND CONCENTRATION DISTRIBUTION IN TURBULENT FLOWS 13

Diffusivity, temperature and pressure effect, Fick's law, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow : stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst.The equation of continuity, summary of equations of change and fluxes, use of equations of change, dimensional analysis, time smoothed equations of change, empirical expressions for turbulent mass flux.

L : 45 , T : 15 ,TOTAL : 60 PERIODS

TEXT BOOKS

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. W., "Transport Phenomena", 2nd Edn., John Wiley, 2002
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1988.

REFERENCES

1. Welty, J. R., Wilson, R. W., and Wicks, C. W., "Fundamentals of Momentum Heat and Mass Transfer ", 3rd Edn. John Wiley, New York, 1984.
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1992.

CH9402 **PROCESS EQUIPMENT DESIGN** **L T P C**
3 1 0 4

AIM

To give practice to students to design in detail different process equipments.

OBJECTIVES

- Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipments

UNIT I **14**

Heat Exchangers, Condensers, Evaporators

UNIT II **10**

Cooling Tower, Dryers

UNIT III **14**

Absorption column, Distillation Column, Extraction Column, Adsorption column

UNIT IV **14**

Packed bed Reactors, Pressure Vessel, Storage Vessel

UNIT V **8**

Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation, Materials of Construction and Selection of process equipments

L : 45 , T : 15 , TOTAL : 60 PERIODS

REFERENCES

1. Baranan, C.R., "Rules of Thumb for Chemical Engineers", Gulf Publishing Co, Texas, 1996.
2. R. K. Sinnott, "Coulson & Richardson's Chemical Engineering", Vol. 6, Butterworth Heinermann, Oxford, 1996.
3. Dawande, S. D., "Process Design of Equiments", 4th Edition, Central Techno Publications, Nagpure, 2005.
4. Green D. W., "Perry's Chemical Engineer's Handbook", 7th Edition McGraw Hill, 1997.

CH9403 **CHEMICAL PROCESS DESIGN** **L T P C**
3 0 0 3

UNIT I **9**

Process Design and Development: General Design Considerations; The Hierarchy of Chemical Process Design; The Nature of Process Synthesis and Analysis;

UNIT II **9**

Choice of reactor based on reactor performance, reactor conditions and reactor configuration. Reactor networks in process flow sheets:

UNIT III **9**

Choice of separation of heterogeneous and homogeneous mixtures - Attainable region Separation systems in process flowsheets: multicomponent distillation for ideal and non-ideal systems, distillation column sequences,

UNIT IV **9**

Heat exchange networks synthesis and utilities: Energy targets, Integration in distillation columns

UNIT V **9**

Introduction to optimization approaches to optimal design, role of simulations in process design, Design under uncertainty and failure tolerance, Engineering around variations, Introduction to process integration

TOTAL : 45 PERIODS

TEXT BOOKS

1. Smith, R., Chemical Process Design, McGraw Hill, New York, 1995.
2. Douglas, J., Conceptual Design of Chemical Processes, McGraw Hill, 1989.

REFERENCES

1. Rudd, D.F. and Watson, C.C., Strategy of Process Engineering, John Wiley, 1969.
2. Sinnot, R.K., an Introduction to Chemical Engineering Design, Pergamon Press, Oxford, 1989.
3. Seider, W.D. and J.D. Seader, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 2nd ed., John Wiley, 2004.

CH9404 **PROCESS ECONOMICS** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **5**

The themes of economics – scarcity and efficiency – three fundamental economic problems – society's capability – Production possibility fronties (PPF) – Productive efficiency Vs economic efficiency – economic growth & stability – Micro economies and Macro economies – the role of markets and government – Positive Vs negative externalities.

UNIT II CONSUMER AND PRODUCER BEHAVIOUR **10**

Market – Demand and Supply – Determinants – Market equilibrium – elasticity of demand and supply – consumer behaviour – consumer equilibrium – Approaches to consumer behaviour – Production – Short-run and long-run Production Function – Returns to scale – economies Vs diseconomies of scale – Analysis of cost – Short-run and long-run cost function – Relation between Production and cost function.

UNIT III PRODUCT AND FACTOR MARKET **10**

Product market – perfect and imperfect market – different market structures – Firm's equilibrium and supply – Market efficiency – Economic costs of imperfect competition – factor market – Land, Labour and capital – Demand and supply – determination of factor price – Interaction of product and factor market – General equilibrium and efficiency of competitive markets.

UNIT IV PERFORMANCE OF AN ECONOMY – MACRO ECONOMICS **10**

Macro-economic aggregates – circular flow of macroeconomic activity – National income determination – Aggregate demand and supply – Macroeconomic equilibrium – Components of aggregate demand and national income – multiplier effect – Demand side management – Fiscal policy in theory.

UNIT V AGGREGATE SUPPLY AND THE ROLE OF MONEY **10**

Short-run and Long-run supply curve – Unemployment and its impact – Okun's law – Inflation and the impact – reasons for inflation – Demand Vs Supply factors –Inflation Vs Unemployement tradeoff – Phillips curve –short- run and long-run –Supply side Policy and management- Money market- Demand and supply of money – money-market equilibrium and national income – the role of monetary policy.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Paul A. Samuelson and William D. Nordhaus, Economics, 18th edition, Tata McGraw Hill, 2005.
2. William Boyes and Michael Melvin, Textbook of economics, Biztantra, 2005.
3. N. Gregory Mankiw, Principles of Economics, 3rd edition, Thomson learning, New Delhi, 2007.
4. Richard Lipsey and Alee Charystal, Economics, 11th edition, Oxford University Press, New Delhi,2008.
5. Karl E. Case and Ray C. fair, Principles of Economics, 6th edition, Pearson Education Asia, New Delhi, 2002.

CH9405 MASS TRANSFER LAB L T P C
0 0 4 2

AIM

To impart knowledge on mass transfer by practice

OBJECTIVE

- Students develop a sound working knowledge on different types of mass transfer equipments.

LIST OF EXPERIMENTS

1. Separation of binary mixture using simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

EQUIPMENTS REQUIRED

1. Simple distillation setup
2. Steam distillation setup
3. Packed column
4. Liquid-liquid extractor
5. Vacuum Dryer
6. Tray dryer
7. Rotary dryer
8. Ion exchange column
9. Rotating disc contactor
10. Cooling tower
11. Absorption column

Minimum 10 experiments shall be offered.

TOTAL : 60 PERIODS

CH9406 PROCESS CONTROL LAB L T P C
0 0 4 2

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a level system
6. Open loop study on a flow system
7. Open loop study on a thermal system
8. Closed loop study on a level system
9. Closed loop study on a flow system
10. Closed loop study on a thermal system
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
15. Characteristics of different types of control valves

***Minimum 10 experiments shall be offered.**

TOTAL : 60 PERIODS

CH9407 COMPREHENSION L T P C
0 0 2 1

The objective of the comprehension test is to assess the overall level of proficiency and the scholastic attainment of the student in the various subjects studied during the degree programme.

TOTAL : 30 PERIODS

CH9408 INDUSTRIAL TRAINING L T P C
- - - 1

1. The main objective of this industrial training is to expose them to real time operations and relate the concepts learnt in theory with practical operations.
2. The students are expected to undergo training in an industry for four weeks.
3. After successful completion of the training, the students submit a detailed technical report.

CH9451 PROJECT WORK L T P C
0 0 12 6

AIM

To initiate the ability of doing a complete plant design.

OBJECTIVE

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.
- Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.
- Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, out side the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

CH9021 OPTIMIZATION OF CHEMICAL PROCESSES L T P C
3 0 0 3

UNIT I INTRODUCTION 5
Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.

UNIT II SINGLE VARIABLE OPTIMIZATION 9
Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.

UNIT III MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS 9
Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.

UNIT IV OTHER OPTIMIZATION METHODS 9
Introduction to geometric, dynamic and integer programming and genetic algorithms.

UNIT V APPLICATIONS OF OPTIMIZATION 13
Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Rao, S. S., Engineering Optimization - Theory and Practice, Third Edition, John Wiley & Sons, New York, 1996.
2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ", McGraw-Hill Book Co., New York, 1985.
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", John Wiley, New York, 1980.

CH9022 MODERN SEPARATION TECHNIQUES L T P C
3 0 0 3

UNIT I BASICS OF SEPARATION PROCESS 9
Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9
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, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9
Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL : 45 PERIODS

REFERENCES

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

CH9023 BIOCHEMICAL ENGINEERING L T P C
3 0 0 3

(Common for Food and Pharmaceutical Technology)

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions- mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod changeux wyman model, pH and temperature effect on enzymes & deactivation kinetics.

UNIT III ENZYME IMMOBILIZATION 6

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages.

UNIT IV OVERVIEW OF FERMENTATION PROCESSES 9

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes.

UNIT V RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 12

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

TOTAL: 45 PERIODS

TEXT BOOKS

1. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, 1986.
2. Blanch, H.W. and D.S. Clark "Biochemical Engineering", Marcal Dekker, Inc., 1997.
3. Lee, James M. "Biochemical Engineering", Prentice – Hall, 1992.

REFERENCES

1. Palmer, Trevor "Enzymes : Biochemistry, Biotechnology, Clinical Chemistry", Affiliated East-West Press Pvt. Ltd., 2004.
2. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
3. Wiseman, Alan "Handbook of Enzyme Biotechnology", 3rd Edition, Ellis Harwood
4. Publications, 1999.
5. Hartmeier, Winfried "Immobilized Biocatalysts : An Introduction", Springer – Verlag,1986.

CH9024 PROCESS MODELING AND SIMULATION L T P C
3 0 0 3

UNIT I INTRODUCTION 3

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 13

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling**.**

TOTAL : 45 PERIODS

TEXT BOOKS

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ", McGraw-Hill Book Co., 1973

REFERENCES

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.

CH9025 PROCESS PLANT UTILITIES L T P C
3 0 0 3

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

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

TOTAL : 45 PERIODS

REFERENCES

1. Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 1966.
2. P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 1986.
3. Perry R. H. Green D. W. “Perry's chemical Engineer's Handbook”, McGraw Hill, New York, 2007.
4. P. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi, 2007.

CH9026 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 6

Definition of Logistics and SCM: Evolution, Scope, Importance& Decision Phases – Drivers of SC Performance and Obstacles.

UNIT II LOGISTICS MANAGEMENT 10

Factors – Modes of Transportation - Design options for Transportation Networks-Routing and Scheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance – Warehouse Management - Case Analysis

UNIT III SUPPLY CHAIN NETWORK DESIGN 10

Distribution in Supply Chain – Factors in Distribution network design –Design options-Network Design in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.

UNIT IV SOURCING, AND PRICING IN SUPPLY CHAIN 9

Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

UNIT V COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN 10

Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work. eBusiness & SCM. Metrics for SC performance – Case Analysis

TOTAL : 45 PERIODS

REFERENCES

1. Supply Chain Management, Strategy, Planning, and operation – Sunil Chopra and Peter Meindl- PHI, Second edition, 2007
2. Logistics, David J.Bloomberg, Stephen Lemay and Joe B.Hanna, PHI 2002
3. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition
4. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002
5. Handbook of Supply chain management, James B.Ayers, St.Lucle Press, 2000

CH9027 ENERGY TECHNOLOGY L T P C
3 0 0 3

UNIT I ENERGY 8

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

UNIT II CONVENTIONAL ENERGY 8

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III NON-CONVENTIONAL ENERGY 10

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations.
Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV BIOMASS ENERGY 10

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

UNIT V ENERGY CONSERVATION 9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

TOTAL : 45 PERIODS

TEXTBOOKS

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

REFERENCES

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

CH9028 ELECTROCHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I **9**

Review basics of 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.

UNIT II **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.

UNIT III **10**

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.

UNIT IV **8**

Electro deposition –electro refining –electroforming –electro polishing –anodizing –Selective solar coatings, Primary and secondary batteries –types of batteries, Fuel cells.

UNIT V **9**

Electrodes used in different electrochemical industries: 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.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Picket, " Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., " Electrochemical systems ", Prentice Hall, 1973.

REFERENCES

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

CH9029 PETROLEUM REFINING AND PETROCHEMICALS L T P C
3 0 0 3

UNIT I **9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum – Atmospheric and Vaccum Distillation.

UNIT II **9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen.

UNIT III **9**

Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance, Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining.

UNIT IV **9**

Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, Catalytic Reforming of Petroleum Feed Stocks and Extraction of Aromatics.

UNIT V **9**

Production of Petrochemicals like Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York, 1985.
2. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.
3. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., Khanna Publishers, New Delhi, 1987.
4. Wiseman. P., Petrochemicals, UMIST Series in Science and Technology.
5. H. Steiner, Introduction to petrochemicals Industry', Pergamon, 1961.

CH9030 DRUGS AND PHARMACEUTICAL TECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION **9**

Development of drugs and pharamaceutical industry; organic therapeutic agents uses and economics

UNIT II DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS **9**

Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS **9**

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL 9

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 9

Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

TOTAL : 45 PERIODS

TEXT BOOK

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, Bailliere Tindall, London, 1977.

REFERENCES

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. “Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.

CH9031 POLYMER TECHNOLOGY L T P C
3 0 0 3

UNIT I GENERAL ASPECTS OF POLYMERS 9

Classification, mechanisms and methods of polymerization, Properties-Molecular weight, Glass transition temperature, Crystallinity, thermal, Electrical and Mechanical properties

UNIT II APPLICATION ORIENTED POLYMERS 9

Resins – PVC, Silicon Oil and resins, fibrous Polymers – Nylon 66, Polyacrylonitrile, adhesives-Epoxides, Phenol formaldehyde, Urea formaldehyde

UNIT III ELASTOMERS 9

Natural Rubber, Styrene – butadiene, Polyisopropane – Neoprene, Silicone rubber, Thermoplastic elastomers

UNIT IV PROCESSING OF POLYMERS 9

Processing additives, plasticizers, Antiaging additives, surface and optical properties, modifiers, fire retardants, additives for rubber and elastomers, various molding techniques

UNIT V PHYSICAL AND CHEMICAL TESTING OF PLASTICS 9

Mechanical properties, tensile strength and hardness, electrical properties, volume resistivety, dielectric strength, optical properties- glass, light transmission and refractive index, chemical analysis – elemental and functional analysis

TOTAL : 45 PERIODS

REFERENCES

1. Miles, D.C & Briston, J.H., “Polymer Technology”, Chemical Publishing Co. Inc, NY, 1979
2. Maturine Morton, “Rubber Technology”, 3rd Edition, Van Nostrand Re Inhold, NY, 1987
3. Mascic, L. “Thermoplastics Materials Engineering”, Applied Science Publishers Ltd, NY, 1986.
4. Raymond E. Seymour, “Engineering, Polymer Source Book”, McGraw Hill

CH9032 FRONTIERS OF CHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I PROCESS INTENSIFICATION 9
Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.

UNIT II CHEMICAL PRODUCT DESIGN 9
Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.

UNIT III RENEWABLE ENERGY 9
Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy

UNIT IV MATERIALS ENGINEERING 9
Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials

UNIT V BIOENGINEERING 9
Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

TOTAL : 45 PERIODS

REFERENCES

1. Keil, F. J., Modeling of Process Intensification Wiley-VCH Verlag GmbH & Co. KGaA2007
2. Cussler, E.l. and Moggridge, G.D., “Chemical product design” Cambridge University Press, Cambridge, 2001
3. Hoffmann,P, Tomorrow's energy: hydrogen, fuel cells, and the prospects for a cleaner planet, MIT Press, Sabon, 2002
4. Mitchell, B.S., An introduction to materials engineering and science for chemical and materials engineers, John Wiley and Sons Inc., New Jersey, 2004

GE9021 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

AIM
To sensitize the engineering students on blending both technical and ethical responsibilities.

OBJECTIVES
- Identify the core values that shape the ethical behavior of an engineer.
- Utilize opportunities to explore one’s own values in ethical issues.
- Become aware of ethical concerns and conflicts.
- Enhance familiarity with codes of conduct.
- Increase the ability to recognize and resolve ethical dilemmas.

UNIT I ENGINEERING ETHICS 9
Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal

UNIT IV RESPONSIBILITIES AND RIGHTS 9

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) - Discrimination

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, (2000).

REFERENCES

1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)