ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

R – 2008

B.TECH. PETROLEUM REFINING AND PETRO-CHEMICALS

III - VIII SEMESTERS CURRICULUM AND SYLLABI

SEMESTER III

CODE	COURSE TITLE	L	T	P	C
THEORY					
MA 9211	Mathematics III	3	1	0	4
CY 9211	Organic Chemistry	3	0	0	3
CH 9204	Basic Mechanical Engg.	3	0	0	3
CH 9205	Process Calculations	3	0	0	3
PP 9201	Fluid and Solid Operations	3	1	0	4
PP 9202	Petroleum Engineering	4	0	0	4
PRACTICAL					
CY 9212	Organic Chemistry Lab	0	0	4	2
EE 9214	Electrical Engineering Lab	0	0	4	2
CH 9257	Mechanical Engineering Lab	0	0	4	2
	TOTAL	**19**	**2**	**12**	**27**

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
CY 9213	Instrumental Methods of Analysis	3	0	0	3
PP 9252	Chemical Engg Thermodynamics	3	1	0	4
CH 9255	Heat Transfer	3	0	0	3
PP 9251	Natural Gas Engineering	3	0	0	3
PRACTICAL					
CY 9262	Technical Analysis Lab	0	0	4	2
PP 9257	Fluid And Solid Operations Lab	0	0	4	2
	TOTAL	**18**	**2**	**8**	**24**

SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CH 9304	Mass Transfer I	3	0	0	3
CH 9305	Chemical Reaction Engineering I	3	1	0	4
PP 9303	Petroleum Refining I	3	0	0	3
CH 9353	Process Instrumentation Dynamics and Control	3	0	0	3
GE 9261	Environmental Science and Engg.	3	0	0	3
	Elective I	3	0	0	3
PRACTICAL					
GE 9371	Communication Skills and Soft Skills Lab	0	0	2	1
CH 9308	Heat Transfer Lab	0	0	3	2
PP 9305	Petroleum Testing Lab I	0	0	4	2
	TOTAL	**18**	**1**	**9**	**24**

SEMESETER VI

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PP 9351	Equilibrium Staged Operations	3	1	0	4
PP 9352	Catalytic Reaction Engineering	3	0	0	3
PP 9353	Petroleum Refining II	3	0	0	3
PP 9354	Petrochemicals	4	0	0	4
CH 9354	Plant Safety and Risk Analysis	3	0	0	3
	Elective II	3	0	0	3
PRACTICAL					
PP 9357	Process Control Lab	0	0	4	2
PP 9358	Petroleum Testing Lab II	0	0	4	2
CH 9356	Computational Chemical Engg.Lab	0	0	4	2
PP 9359	Technical Seminar	0	0	2	1
	TOTAL	**19**	**1**	**14**	**27**

SEMESETER VII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CH 9401	Transport Phenomena	3	1	0	4
PP 9401	Petroleum Equipment Design	3	1	0	4
CH 9403	Chemical Process Design	3	0	0	3
PP 9402	Petroleum Refining III	3	0	0	3
CH 9404	Process Economics	3	0	0	3
	Elective III	3	0	0	3
PRACTICAL					
CH 9405	Mass Transfer Lab	0	0	4	2
CH 9355	Chemical Reaction Engineering Lab	0	0	3	2
PP 9403	Comprehension	0	0	2	1
PP 9404	Industrial Training+*	-	-	-	1
	TOTAL	**18**	**2**	**9**	**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
THEORY					
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
PRACTICAL					
PP 9451	Project Work	0	0	12	6
	TOTAL	**6**	**0**	**12**	**12**

LIST OF ELECTIVES

CODE	COURSE TITLE	L	T	P	C
PP9021	Petroleum Chemistry	3	0	0	3
PP9022	Drilling and Well Engineering	3	0	0	3
PP9023	Reservoir Engineering	3	0	0	3
PP9024	Enhanced Oil Recovery	3	0	0	3
PP9025	Production Engineering	3	0	0	3
PP9026	Multicomponent Distillation	3	0	0	3
PP9027	Fluidization Engineering	3	0	0	3
PP9028	Multiphase Flow	3	0	0	3
PP9029	Petroleum Economics	3	0	0	3
PP9030	Corrosion Engineering	3	0	0	3
PP9031	Environmental Impact Assessment	3	0	0	3
CH 9021	Optimization of Chemical Processes	3	0	0	3
CH9022	Modern Separation Techniques	3	0	0	3
CH9024	Process Modeling and Simulation	3	0	0	3
CH9025	Process Plant Utilities	3	0	0	3
CH9026	Supply Chain Management	3	0	0	3
CH9027	Energy Technology	3	0	0	3
GE9021	Professional Ethics in Engineering	3	0	0	3

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

(Common to all branches of B. E / B. Tech programmes) **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**

(Common to Chemical, Textile, Leather, Petroleum Refining & Petrochemicals and Apparel Technology) **L T P C 3 0 0 3**

AIM

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

OBJECTIVES

- 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 STRUCTURE , REACTION AND THEIR MECHANISM 15

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

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 II 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 III 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 IV SYNTHETIC ORGANIC CHEMISTRY 7

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.

UNIT V APPLIED ORGANIC CHEMISTRY 7

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).

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 ", Tata McGraw Hill, 1973.
3. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
4. Khurmi R.S., and Gupta J.K, "Thermal Engineering", S.Chand & Company (P) Ltd.,2001.
5. 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.

OBJECTIVES

- 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).

PP9201 **FLUID AND SOLID OPERATIONS** **L T P C**
3 1 0 4

AIM

To understand the principles and applications of fluid mechanics and mechanical operations.

OBJECTIVES

- To impart to the student knowledge on fluid properties, fluid static and dynamic characteristics flow metering and transport, particle mechanics, techniques of solid – fluid separation

UNIT I **15**

Properties of fluid - Newtonian fluids Classification of fluid motion Fluid statics – equilibrium of fluid element – pressure variation in a static fluid – Differential analysis of fluid motion – continuity, Euler's and Bernoulli equation

UNIT II **15**

Reynolds number regimes, Flow through pipes – pressure drop under laminar and turbulent flow conditions; boundary layer concepts; different types of flowmeters; Valves, pumps, compressors – characteristics and sizing; Agitation and Mixing;

UNIT III **6**

General characteristics of solids, techniques of size analysis; Laws of size reduction, equipments for size reduction

UNIT IV **12**

Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds. Filtration – batch and continuous, filtration equipments - selection, operation

UNIT V **12**

Screening, gravity separation - sedimentation, thickening, elutriation, classifiers. Centrifugal separation - continuous centrifuges, cyclones and hydro cyclones, electrostatic and magnetic separators

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

TEXT BOOKS

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

REFERENCES

1. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, V Edition, 2001
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

PP9202 **PETROLEUM ENGINEERING** **L T P C**
4 0 0 4

AIM
To obtain an overview of petroleum engineering

OBJECTIVE
- To learn petroleum geology, drilling and well engineering, reservoir engineering and production operations

UNIT I **14**
Origin and interior of earth; Classification of rocks and properties; plate tectonics and structure; Geological time scales; Types of Stratigraphy; Origin, migration and accumulation of petroleum; occurrence of petroleum; Formation, Classification and properties of reservoir rock; Porosity and permeability; Types of reservoir traps and sedimentary basins; geophysical exploration methods

UNIT II **14**
Types of drilling operation and components; Formation pore pressure and fracture resistance; Casing design; Drill bits; bit operation; Drill string components; Drilling fluids; Drilling cements; cementing equipments and methods; well control

UNIT III **12**
Classification of reservoirs; Properties of reservoir fluids; Rock properties; Reservoir fluid flow - flow regimes, fluid flow equations;

UNIT IV **12**
Performance of oil reservoirs and gas well; Mechanisms of oil recovery; water influx; water flooding – enhanced oil recovery;

UNIT V **8**
Elements of production operations – basic well head and tubing operational parameters; sucker rod pumping, stimulation and remedial operations; petroleum economic evaluation

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

TEXT BOOK
1. Lyons, W. C., Plisga, G. J. Standard Handbook of Petroleum and Natural Gas Engineering Elsevier, 2005

REFERENCE
1. Mian, M.A., “Petroleum Engineering Handbook for the Practicing Engineer”, Gulf Professional Publishing, 2005

CY9212 **ORGANIC CHEMISTRY LAB** **L T P C**

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

OBJECTIVE

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

Analysis of nature of organic compounds – To identify aliphatic/aromatic, saturated/unsaturated compounds.

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.

Analysis of an unknown organic compound and preparation of suitable solid derivatives.

Analysis of carbohydrates.

Analysis of proteins.

Methodology of filtration and recrystallization.

Introduction to organic synthetic procedures:

Acetylation – Preparation of acetanilide from aniline.

Hydrolysis – Preparation of salycilic acid from methyl salyciliate.

Substitution – Conversion of acetone to iodoform.

Nitration – Preparation of m-dinitrobenzene from nitrobenzene.

Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

TOTAL : 60 PERIODS

REFERENCE

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

OBJECTIVES

To impart practical knowledge on

- Characteristic of different machines
- Method of speed control of machines
- Measurement of various electrical parameters

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

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 *

Port timing diagram
Valve timing diagram
Study of 2,4 stroke I C Engines
Load test on 4-stroke petrol engine
Performance test on 4-stroke single cylinder diesel engine
Performance test on 4-stroke twin cylinder diesel engine
Heat balance test on diesel engines
Tension test
Compression test
Deflection test
Hardness test (Rockwell and Brinell)
Spring test
Torsion test
Impact test

TOTAL : 60 PERIODS

* Minimum 10 experiments shall be offered

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.

OBJECTIVES

- 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 CHEMISTRY

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

L T P C
3 0 0 3

AIM

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

OBJECTIVES

- 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).

CY9213 **INSTRUMENTAL METHODS OF ANALYSIS** **L T P C**

(Common to Chemical, Textile, Leather, Ceramic and Petroleum Refining & Petrochemicals) **3 0 0 3**

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 Day R.A Underwood A.L Qualitative Inorganic analysis (A. I. Vogel).
5. V Edition, Prentice-Hall of India (P) Ltd, NewDelhi, Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House,1995
6. Kalsi .P.S. Spectroscopy of organic compounds, 6th Edition, New Age International Publishers,2006
7. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007
8. Sathya Narayana. D. N. Vibrational Spectroscopy, First Edition 2004 and Reprint 2005, New Age International publishers.

CH9255 HEAT TRANSFER L T P C
3 0 0 3

AIM

To understand the principles and applications of heat transfer.

OBJECTIVES

- 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 analogies; 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 gases 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. 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, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

PP9251 **NATURAL GAS ENGINEERING** **L T P C**
3 0 0 3

AIM

To know the production and processing of natural gas

OBJECTIVE

- To learn origin, properties, treatment, transportation, storage and liquefaction of natural gas

UNIT I **9**

Origin of natural gas; types of natural gas reserves; Physical Properties and composition; classification, combustion characteristics; Gas reservoir deliverability; well bore and choke performance; Well deliverability.

UNIT II **9**

Field operations, gas hydrates, inlet receiving, compression and cooling – compressor types and power calculations; removal of acid gas and dehydration by absorption, adsorption, cryogenic fractionation, membrane separation;

UNIT III **9**

Hydrocarbon recovery – the process and components, nitrogen rejection for gas upgrading and enhanced oil recovery; Removal of trace components like helium, mercury etc.,

UNIT IV **9**

Liquids processing – condensate and NGL, sulphur recovery; Transportation – pipe line and gathering system design, volumetric measurement; storage;

UNIT V **9**

Liquefied Natural Gas – gas treating, liquefaction cycles, storage and transportation; Sweetening and processing for Compressed Natural Gas; Capital costs

TOTAL : 45 PERIODS

TEXT BOOK

1. Kidnay, A. J., Parrish, W., "Fundamentals of Natural Gas Processing", CRC Press, 2006.

REFERENCE

1. Boyun, G., Ali, G., "Natural Gas Engineering Handbook" Gulf Publishing Company, 2005.

PP9252 CHEMICAL ENGINEERING THERMODYNAMICS L T P C
3 1 0 4

AIM

To impart knowledge on thermodynamic principles and their application

OBJECTIVE

- Students will learn PVT behaviour of fluids, laws of thermodynamics and their application, Solution thermodynamics, Phase and Reaction equilibria.

UNIT I **12**

Scope of thermodynamics; Concepts and Definitions; Zeroth law, temperature scales; Equations of state for ideal and real gases; First law, application to closed and open systems; Second law of thermodynamics, thermodynamic temperature scale, entropy and its calculation.

UNIT II **12**

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

UNIT III **12**

Partial molar properties, Chemical potential, fugacity and fugacity coefficient for pure species and species in solution, residual properties; Properties of solutions – ideal solutions, excess properties, Gibbs Duhem relation, excess Gibbs free energy models; Henry's law

UNIT IV **12**

Phase transition in pure substance, vapour pressure of pure substance; Gibbs phase rule, Qualitative behaviour of Vapour-liquid equilibrium in binary and multicomponent system, Ideal model for VLE, bubble point and dew point calculations.

UNIT V **12**

Reaction coordinate, criteria for chemical equilibrium, equilibrium constant, effect of temperature on equilibrium constant, equilibrium of homogeneous gas and liquid phase reactions.

L : 45; T : 15; TOTAL : 60 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

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).

PP9257 **FLUID AND SOLID OPERATIONS LAB** **L T P C**
0 0 4 2

AIM

To understand the concepts of fluid mechanics and mechanical operations through experiments

OBJECTIVES

- To learn experimentally to calibrate flowmeters, find pressure loss for fluid flows, determine pump characteristics, perform size reduction, sieve analysis and settling studies.

LIST OF EXPERIMENTS

1. Calibration of constant head meter
2. Open drum orifice and draining time
3. Flow through straight pipe
4. Characteristic curves of pump
5. Drag coefficient of solid particle
6. Hydrodynamics of fluidized bed
7. Sedimentation test
8. Size analysis
9. Size reduction using ball mill
10. Efficiency of cyclone separator
11. Filter press

EQUIPMENTS REQUIRED

1. Orifice meter
2. Open drum with orifice
3. Pipes and fittings
4. Centrifugal pump
5. Fluidized bed
6. Sedimentation column
7. Test sieves
8. Ball mill
9. Cyclone
10. Filter press.

TOTAL : 60 PERIODS

CH 9304 **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.

OBJECTIVES

- 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.

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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.

CH 9305 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.

PP 9303 **PETROLEUM REFINING I** **L T P C**

3 0 0 3

AIM

To impart detailed knowledge on petroleum refining operations, this course being the first part in a three parts series

OBJECTIVES

- Students learn the evaluation of oil stocks, petroleum testing methods, fractionation of crude and treatment techniques

UNIT I INTRODUCTION & EVALUATION OF OIL STOCKS **9**

Occurrence of Petroleum, formation of Petroleum by Physical and Biological Methods. Origin and Reserves and Deposits of World, Estimation of Reserves Exploration and Production of Petroleum. Composition of Petroleum. Global and Indian Refining Scenario. Overview of Refinery Products, Refinery Configuration and Development.Paraffinic, Mixed and Naphthenic Based Crude Oil, Characterization Factor, Viscosity Index and Correlation Index. Distillation Characteristics, Thermal Properties of Petroleum Fractions and Important Product Properties.

UNIT II TESTING **9**

Testing of Petroleum Crude, Laboratory Tests- Specific Gravity, Vapour Pressure, Flash and Fire Point, Colour, Cloud and Pour Points, Knock Characteristics, Test for Bitumens and Gum in Gasoline. Testing of Petroleum Products, Specification and their significance,

UNIT III FRACTIONATION OF PETROLEUM **9**

Dehydration and Desalting of Crudes - Settling and Electric Desalting, Heating of Crude - Pipe Still Heaters, Distillation of Petroleum - Arrangement of Towers, Atmospheric Distillation Unit and Vacuum Distillation Unit.

UNIT IV TOPPING OPERATION AND TREATMENT TECHNIQUES 9

Topping operations and Blending of Gasoline. Treatment Techniques: Physical and Chemical Impurities, Destruction of Sulphur Compounds and Catalytic Desulphurization, Dehydration of Gases and Sweetening Operations for Gases.

UNIT V TREATMENT OF GASOLINE, KEROSENE, LUBES AND WAX 9

Gasoline Treatment- Copper Chloride Process, Unisol Process, Merox Sweetening, Sulphuric Acid Treatment and Catalytic Desulphurization. Treatment of Kerosene. Treatment of Lubes- Sulphuric Acid Treatment, Clay Treatment and Solvent Treatment. Wax Purification, Dewaxing with Solvents.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Watkins, R. N "Petroleum Refinery Distillations", 2nd Edition, Gulf Publishing Company, Texas, 1981.

REFERENCES

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
2. Hobson, G. D "Modern Petroleum Refining Technology", 4th Edition, Institute of Petroleum, U. K. 1973.
3. ASTM Standards from Petroleum Product Testing, 1989.

CH 9353 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 conductivities, 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.

GE 9261 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

AIM

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 they participate.

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 LABORATORY 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.

OBJECTIVE

- 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

CH 9308 HEAT TRANSFER LABORATORY L T P C
0 0 3 2

AIM

To impart knowledge on heat transfer operation by practice

OBJECTIVES

- 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

EQUIPMENTS 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

PP 9305	**PETROLEUM TESTING LAB I**	**L T P C** **0 0 4 2**

AIM

To impart practical knowledge on different petroleum testing methods

OBJECTIVES

- Students learn the determination of flash point, cloud point, smoke point, viscosity etc.

LIST OF EXPERIMENTS

1) Determination of flash point using Abel's Flash Point Apparatus.
2) Determination of flash point using Pensky Marten Flash Point Apparatus.
3) Determination of viscosity using Red Wood Viscometer
4) Determination of viscosity using Engler Viscometer.
5) Determination of viscosity using Saybolt Viscometer.
6) Determination of Cloud and Pour Point
7) Determination of Smoke Point
8) Penetration Test
9) Copper Strip Corrosion Test
10) Junker's Gas Calorimetery

EQUIPMENTS REQUIRED

1. Abel's Flash Point Apparatus
2. Pensky Marten Flash Point Apparatus.
3. Pensky Marten Flash Point Apparatus
4. Red Wood Viscometer
5. Engler Viscometer.
6. Saybolt Viscometer.
7. Junker's Gas Calorimeter

TOTAL : 60 PERIODS

PP 9351 EQUILIBRIUM STAGED OPERATIONS L T P C
3 1 0 4

AIM

To impart knowledge on the design of different staged operations using the concept of equilibrium.

OBJECTIVES

- The students will learn in detail the unifying theory and design of different staged operations like absorption, distillation, extraction and adsorption.

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. Desing of azeotropic and extractive distillation columns.

UNIT III MULTICOMPONENT DISTILLATION 12

Fundamental principles involved in the separation of multi component mixtures –equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux. Calculation of minimum reflux ratio. Determination of number of trays

UNIT IV LIQUID-LIQUID EXTRACTION 10

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 V ADSORPTION & MEMBRANE SEPARATION PROCESS 14

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.

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. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley, 2006.

REFERENCES

1. W.L McCabe J.C.Smith, and Harriot. P., " Unit Operations of Chemical Engineering ", sixth edition McGraw-Hill. International Edition, 2001
2. C.Judson King " Separation Processes ", Tata McGraw-Hill 1974.
3. R.F.Strigle (jr), Packed Tower Design and Application, 2nd Edn Gulf Publishing company U.S.A. 1994.

PP 9352 CATALYTIC REACTION ENGINEERING L T P C
3 0 0 3

AIM

To impart detailed knowledge on catalytic reaction engineering

OBJECTIVES

- Students learn the kinetics of catalytic reactions, synthesis and characterization of catalysts, analysis and design of heterogeneous catalytic reactors.

UNIT I CATALYSIS AND CATALYTIC KINETICS 8

General definition of catalysts, illustration of a catalytic process, Design for catalysts – Primary constituents, secondary constituents; Catalyst supports – choice of support material, texture and strength of support materials; Chemical interaction, Deactivation steps involved in global catalytic rate

UNIT II ABSORPTION-DIFFUSION AND HETEROGENEOUS CATALYSIS 8

Absorption and Heterogeneous Catalysis – the geometrical factor in Catalysis; Electron structure of catalysts; Chemical properties of surfaces; Theories and Adsorption; semi conduction and catalysts; Defect structure in crystal lattices, Thermodynamic basics of catalysis; Adsorption studies – Fischer-Tropsh catalysts, synthetic ammonia catalysts, methanol synthesis catalyst. Diffusion and Heterogeneous Catalysis

UNIT III PRODUCTION OF SOME CATALYSTS 8

Precipitation method- Alumino silicate catalyst, Barium alumino vanadium contact mass, production of tabletted chromium catalysts for the conversion of CO., Production of Cadmium – Calcium Phosphate catalysts for the synthesis of acetaldehyde from acetylene. Mechanical missing method Fused-skeleton contact masses – Platinum network catalysts of Ammonia oxidation, iron catalysts of Ammonia synthesis, fused vanadium pentoxide, catalysts of natural clays, zeolite catalysts

UNIT IV METHODS OF STUDYING CATALYSTS 7

Methods of determining catalysts activity – static methods, flow (dynamic) method; Study of structure – adsorption for determining catalyst surface and pore radii; Mercury porosimetry, determination of true and apparent densities of catalysts; Structural study of electron microscopy, determination of mechanical strength of catalysts-static methods, dynamic methods; Methods of thermal analysis.

UNIT V ANALYSIS AND DESIGN OF HETEROGENEOUS CATALYTIC REACTORS 14

Fixed bed reaction, continuity equations, reactor parameters. Reaction significance of dimensionless parameters, Chemical and dimensionless parameters; physical dimensionless parameters, radial peciet number for heat and mass transfer, Biot numbers Adiabatic fixed bed reactor. Reactor yields, non-isothermal, non-adiabatic fixed bed. Fluidized bed catalytic reactor; slurry reactors – Analysis of first order slurry reaction systems; Selectivity in slurry reactors; catalytic – gauze reactor, trickle bed reactors, batch fluid bed reactor, moving bed continuous fluid bed reactor

TOTAL : 45 PERIODS

REFERENCES

1. Carbery – J.J. “Chemical and Catalytic, Reaction Engineering”, McGraw Hill Book Co, NY 1986
2. Fogler S., “Elements for Chemical Reaction Engineering” Prentice- Hall NJ, 1992

PP 9353 **PETROLEUM REFINING II** **L T P C**
3 0 0 3

AIM

To impart detailed knowledge on petroleum refining operations, this course being the second part in a three parts series

OBJECTIVE

- Students learn the refining operations like cracking, reforming, alklylation, isomerization and coking

UNIT I CRACKING 9

Need and significance, types and functions of Secondary Processing. Cracking, Thermal Cracking and Visbreaking. Different Feed Stocks, Products Yields, Qualities and Recent Development. Catalytic Cracking, Commercial Catalyst, Feedstock and Catalytic Cracking Conditions, Types and Processes- Fixed Bed Cracker, Fluid Catalytic Cracking (FCC), Flexi Cracking.

UNIT II CATALYTIC REFORMING 9

Theory, Reaction Conditions and Catalyst for Catalytic Reforming, Platforming, Houdri Forming, Rhein Forming, Power Forming, Selecto Forming. Ultra Forming and Rex Forming.Naphtha Cracking, Feedstock Selection and Effect of Steam.

UNIT III ALKYLATION AND ISOMERIZATION 9

Feed Stocks and Reactions for Alkylation Process- Cascade Sulphuric Acid Alkylation, Hydrofluoric Acid Alkylation. Isomerization Process- Isomerization with Platinum Catalyst and Aluminium Chloride Process.

UNIT IV COKING 9

Methods of Petroleum Coke Production – Koppers, Thermal Cracking, Delayed Coking, Fluid Coking and Contact Coking. Hydro Cracking- principles, reactions in Hydro Cracking, Catalyst, Hydro Cracking Reaction Conditions, Iso Max Processes and Hydro Desulphurization Processes.

UNIT V ASPHALT TECHNOLOGY 9

Source of Asphalt (Bitumen), Chemical Structure of Asphalt, Action of Heat on Asphalt, Types of Asphalts. Air Blowing of Bitumen and Upgradarion of Heavy Crudes. Specialty Products: Industrial Grease- Manufacture of Calcium Grease, Liquid Paraffin and Petroleum Jellys.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L “Petroleum Refinery Engineering”, McGraw Hill Publishing Company Limited, 1985.
3. Watkins, R. N “Petroleum Refinery Distillations”, 2nd Edition, Gulf Publishing Company, Texas, 1981.

REFERENCES

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
2. Hobson, G. D “Modern Petroleum Refining Technology”, 4th Edition, Institute of Petroleum, U. K. 1973.

PP 9354 **PETROCHEMICALS** **L T P C**
4 0 0 4

AIM
To impart detailed knowledge on different petrochemicals

OBJECTIVE
- Students learn the sources and production methods of petrochemicals and the methods of manufacture of different petrochemicals from additives to electronic chemicals.

UNIT I **4**
Overview of petrochemical industrial growth in India. Economics, feedstock selection for petrochemicals.

UNIT II **14**
Production Methods - Reforming and cracking; Sources : Chemicals from synthesis gas, olefins and aromatics – ethylene, propylene, C4 hydrocarbons, higher olefins, benzene, toluene, xylene.

UNIT III **14**
Acrylonitrile, ammonia, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride

UNIT IV **14**
Acrylonitrile butadiene styrene, polyethylene, PVC, SAN, ABS, SBR, PAN, nylon, PVT and polycarbonates.

UNIT V **14**
Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, surfactants, paint, healthcare and pharmaceuticals

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

REFERENCES

1. Brownstein, A.M. “Trends in Petrochemical Technology”, Petroleum Publishing Company, 1976.
2. Sittig, M. “Aromatic Hydrocarban, Manufacture and Technology”, Noyes Data Corporation, 1976.
3. Hatch, F and Sami Matar “From Hydrocarbon to petrochemicals”, Gulf publishing Company, TEXAS, 1998.

CH 9354 **PLANT SAFETY AND RISK ANALYSIS** **L T P C**
3 0 0 3

AIM
To get awareness on the importance of plant safety and risk analysis

OBJECTIVE
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.

PP 9357 **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

PP 9358 PETROLEUM TESTING LAB II L T P C
0 0 4 2

AIM
To impart practical knowledge on different petroleum testing methods

OBJECTIVE
Students learn petroleum testing, determination of aniline point, softening point, carbon residue, foaming characteristics, sulphur content etc.

LIST OF EXPERIMENTS
1) Petroleum testing using Distillation Apparatus
2) Moisture estimation using Dean and Stark Apparatus
3) Determination of Aniline Point
4) Determination of Softening Point
5) Determination of Conradson Carbon Residue
6) Determination of Binder Content using Bitumen Apparatus.
7) Determination of foaming Characteristics
8) Determination of Congealing Point of Wax.
9) Determination of H_2S and Sulphur Content
10) Determination of Aromatic Content Determination

TOTAL : 60 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.

OBJECTIVE
- 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.

PP 9359 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.

CH 9401 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.

OBJECTIVE
- 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 7

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 15

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

TOTAL : 45 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.

PP 9401 PETROLEUM EQUIPMENT DESIGN L T P C
3 1 0 4

AIM

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

OBJECTIVE

- Students learn to do in detail process and mechanical design and engineering drawing of different equipments generally used in petroleum industry

UNIT I 14

Fired heaters, Heat Exchangers, Condensers, Evaporators, Reboilers,

UNIT II 10

Cooling Tower, Dryers

UNIT III **16**

Absorption column, Distillation Column, Multicomponent Distillation Column, Extraction Column

UNIT IV **14**

Packed bed Reactors, FCC units, Pressure Vessel, Storage Vessel

UNIT V **6**

Design of Plant Layout, Pipe Lines and Pipe Layouts, Design 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.

CH 9403 **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

PP 9402 PETROLEUM REFINING III L T P C
3 0 0 3

AIM

To impart detailed knowledge on petroleum refining operations, this course being the last part in a three parts series

OBJECTIVES

- Students learn about the petroleum additives, support systems, safety measures, environmental, quality and economic aspects.

UNIT I **9**

Octane Improver – TEL, MTBE, Viscosity Index Improver, Pour Point Depressor, Anti Oxidants and others.

UNIT II **9**

Support systems – control systems, offsite systems, safety systems

UNIT III **9**

Components of Fire, Classification of Fires and Fire Extinguishment, Fire Hazards and Control, Causes of Refinery Fires and Explosion Hazards, Safety in Handling and Storage, Emergency Preparation.

UNIT IV **9**

Environmental control and engineering – aqueous wastes, emission to the atmosphere, noise pollution,

UNIT V **9**

Quality control of products, Refinery operation planning, process evaluation and economics

TOTAL : 45 PERIODS

TEXT BOOKS

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L “Petroleum Refinery Engineering”, McGraw Hill Publishing Company Limited, 1985.
3. Watkins, R. N “Petroleum Refinery Distillations”, 2nd Edition, Gulf Publishing Company, Texas, 1981.

REFERENCES

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
2. Hobson, G. D “Modern Petroleum Refining Technology”, 4th Edition, Institute of Petroleum, U. K. 1973.

CH 9404 **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.

CH 9405 **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

CH 9355 **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 Reactor.
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

EQUIPMENTS 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

PP 9403 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.

PP 9404 INDUSTRIAL TRAINING - - - 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.
The students are expected to undergo training in an industry for four weeks. After successful completion of the training, the students submit a detailed technical report.

PP 9451 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.

PP9021 PETROLEUM CHEMISTRY L T P C
3 0 0 3

UNIT I **9**
Composition of Petroleum – separation by molecular weight, type; Composition maps; Petroleum analysis and evaluation – ASTM evaluation, spectroscopic methods

UNIT II **9**
Metals and heteroatoms in heavy crude oil – hetroatoms concentrations, structure of heteroatom functions; Asphaltenes and structure of petroleum

UNIT III **9**
Thermal chemistry of petroleum constituents – visbreaking, coking, hydrotreating, hrdocracking

UNIT IV **9**
Heavy oil upgradation processes- carbon rejection, hydrogen addition; Hydrocracking – reactions, catalysts, process configurations

UNIT V **9**
Instability of petroleum products – distillate and residual products; Incompatibility in refining operations

TOTAL : 45 PERIODS

TEXT BOOK
1. Speight, J.G., Petroleum chemistry and refining Taylor and Francis, London, 1998

REFERENCE
1. Speight, J.G., The chemistry and technology of petroleum, Marcel Dekker, New York, 1998

PP 9022 DRILLING AND WELL ENGINEERING L T P C
3 0 0 3

UNIT I DRILLING GEOLOGY, OIL AND GAS MIGRATION **9**
Rock Strengths and Stresses, Hydrostatic Pressure Forced by a Fluid. Rock Properties, Primary Migration, Reservoir Rock, Seal Rock and Secondary Migration. Reservoir Drives, Problems Related Fluids in the Reservoir.

UNIT II PLANNING AND DRILLING OF WELL **9**
Well Proposal, Gathering Data, Designing the Well, Drilling the Well and Testing the Well. Planning of Well, Hole and Casing Sizes and Drilling the Well. Selecting a suitable Drilling Rig, Classification of Drilling Rig, Rig Systems and Equipments.

UNIT III DRILL BITS AND DRILLING FLUIDS **9**
Roller Cone Bits, Fixed Cutter Bits and Cone Bits. Optimizing Drilling Parameters- Grading the Dull Bit and Bit Selection. Functions of Drilling Fluid, Basic Mud Classification Designing the Drilling Fluid.

UNIT IV DIRECTIONAL DRILLING, CASING, CEMENTING AND EVALUATION **9**
Controlling the Well Path of a Deviated Well, Horizontal Wells and Multi Lateral Well. Importance of Casing in a Well, Designing the Casing String, Role of the Cement Outside the Casing, Mud Removal, Cement Design, Running and Cement Casing and other Cement Jobs. Evaluation Techniques, Physical Sampling at Surface and Downhole, Electrical Logging and Production testing.

UNIT V MANAGING DRILLING OPERATIONS, SAFETY AND ENVIRONMENTAL ISSUES 9

Personnel involved in Drilling Operation, Decision Making at the Well site and in the Office, Estimating the Well Cost. Safety Meetings, New Comers on the Rig, Training and Certification, Permit to Work Systems, Safety Alerts, Safety Equipments, Minimizing Spills and Environmental Impact Studies.

TOTAL : 45 PERIODS

REFERENCES

1. Devereux, S., "Drilling Technology", PennWell Publishing Company, 1999.
2. Azar, J.J. and G. Rabello Samuel, "Drilling Engineering", PennWell Corporation, 1937.
3. Devereux, S., "Practical Well Planning and Drilling", PennWell Corporation, 1998.

PP 9023 RESERVOIR ENGINEERING L T P C
3 0 0 3

UNIT I RESERVOIR FLUID BEHAVIOR AND PROPERTIES 9

Classification of Reservoir and Reservoir Fluids. Properties of Natural Gases. Direct Calculation of Compressibility Factors. Methods of Calculating Viscosity of Natural Gases, Properties of Crude Oil Systems. Methods of Calculating Viscosity of the Dead Oil. Properties of Reservoir Water.

UNIT II ANALYSIS OF RESERVOIR FLUID AND ROCK PROPERTIES 9

Composition of Reservoir Fluid, Separation Test, Laboratory Analysis of Gas Condensate System, Porosity and Capillary Pressure. Rock Compressibility, Reservoir Heterogeneity. Dynamic Pseudo-Relative Permeabilities, Two Phase and Three Phase Relative Permeability.

UNIT III FUNDAMENTALS OF RESERVOIR FLUID FLOW 9

Reservoir Geometry, Fluid Flow Equations, Steady State and Unsteady State Flow, Constant Terminal Pressure Solution. Horizontal and Vertical Oil Well and Gas Well Performance.

UNIT IV RECOVERY MECHANISM AND MATERIAL BALANCE 9

Primary Recovery Mechanism, Material Balance Equation, Performance prediction Methods and Relating Reservoir Performance to Time. Volumetric Method and the Material Balance Equations as a Straight Line in Gas Reservoir.

UNIT V WATER FLOODING AND VAPOR LIQUID PHASE EQUILIBRIUM 9

Factors to consider in Water Flooding, Optimum Time to Water Flooding, Selection of Flooding Patterns, Overall Recovery Efficiency, Displacement Efficiency, Vertical Sweep Efficiency. Equilibrium Ratio, Flash Calculations, Equilibrium Ratios for Real Solution. Application of the Equilibrium Ratio in Reservoir Engineering.

TOTAL : 45 PERIODS

REFERENCES

1. Ahmed, T, "Reservoir Engineering Handbook", 3rd Edition, Elsevier, 2006.
2. Slip Slider, H.C. "World wide Practical Petroleum Reservoir Engineering Method", PennWell Publishing Company, 1983.
3. Gianluigichierici, "Principles of Petroleum Reservoir Engineering", Elsevier, 1994.

PP 9024 **ENHANCED OIL RECOVERY** **L T P C**
3 0 0 3

UNIT I FUNDAMENTALS OF ENHANCED OIL RECOVERY 9

Pore Geometry, Microscopic Aspects of Displacement. Residual Oil Magnitude and Mobilization. Buoyancy Forces and Prevention of Trapping, Wettability, Residual Oil and Oil Recovery. Macroscopic Aspect of Displacement.

UNIT II WATER FLOODING 9

Properties, sampling and analysis of Oil Field Water; Injection waters; Water flooding - Sweep Efficiency, Predictive Techniques, Improved Water Flood Processes, Performance of some Important Water Floods.

UNIT III ENHANCED OIL RECOVERY OPERATIONS-1 10

Flooding – miscible, CO_2, polymer, alkaline, surfactants, steam;

UNIT IV ENHANCED OIL RECOVERY OPERATIONS-2 10

Gas injection, in-situ combustion technology, microbial method

UNIT V PROBLEMS IN ENHANCED OIL RECOVERY 7

Precipitation and Deposition of Asphaltenes and Paraffins, Scaling Problems, Formation of Damage Due to Migration of Fines, Environmental factors.

TOTAL : 45 PERIODS

REFERENCES

1. Donaldson, E.C. and G. V. Chilingarian, T. F. Yen, “Enhanced oil Recovery – I & II”, Fundamentals and Analysis, Elsevier Science Publishers, New York, 1985.
2. Lake, L.W., “Enhanced oil recovery”, Prentice Hall, 1989.
3. Schumacher, M.M., “Enhanced oil recovery: Secondary and tertiary methods”, Noyes Data Corp., 1978.
4. Van Poollen, H.K. “Fundamentals of enhanced oil recovery”, PennWell Books, 1980.

PP 9025 **PRODUCTION ENGINEERING** **L T P C**
3 0 0 3

UNIT I 9

Petroleum production system, properties of oil and natural gas, reservoir deliverability

UNIT II 9

Wellbore performance, choke performance, well deliverability, forecast of well production, production decline analysis

UNIT III 9

Equipment design and selection – well tubing, separation and transportation systems

UNIT IV 9

Artificial lift methods - sucker rod pumping, gas lift, artificial lift methods

UNIT V **9**

Production enhancement – well problem identification, matrix acidizing, hydraulic fracturing, production optimization

TOTAL : 45 PERIODS

REFERENCE

1. Guo, B, Lyons, W.C. and Ghalambor, A., Petroleum production engineering: a computer-assisted approach, Gulf Professional Publishing, Burlington,

PP 9026 MULTICOMPONENT DISTILLATION L T P C
3 0 0 3

UNIT I THERMODYNAMIC PRINCIPLES **9**

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

UNIT II THERMODYNAMIC PROPERTY EVALUATION **9**

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM **9**

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of R_m for multi component distillation – Underwood method – Colburn method.

UNIT IV VARIOUS METHODS OF MCD COLUMN DESIGN **9**

Theta method of convergence – K_b method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.

UNIT V VARIOUS TYPES OF MCD COLUMNS **9**

Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Holland, C.D., “Fundamentals of Multi Component Distillation”, McGraw Hill Book Company,1981
2. Van Winkle, “Distillation Operations”, McGraw Hill Publications, 1987.

PP 9027 **FLUIDIZATION ENGINEERING** **L T P C**
3 0 0 3

UNIT I **9**
Introduction; Industrial Applications of Fluidized Beds; Fluidization and Mapping of Regimes.

UNIT II **9**
The Dense Bed: Distributors, Gas Jets, and Pumping Power; Bubbles in Dense Beds; Bubbling Fluidized Beds.

UNIT III **9**
Entrainment and Elutriation from Fluidized Beds; High-Velocity Fluidization; Solid Movement: Mixing, Segregation, and Staging; Gas Dispersion and Gas Interchange in Bubbling Beds.

UNIT IV **9**
Particle-to-Gas Mass and Heat Transfer; Conversion of Gas in Catalytic Reactions; Heat Transfer between Fluidized Beds and Surfaces; The RTD and Size Distribution of Solids in Fluidized Beds; Circulation Systems.

UNIT V **9**
Design for Physical Operations; Design of Catalytic Reactors; The Design of Non catalytic Gas-Solid Reactors.

TOTAL : 45 PERIODS

TEXT BOOK
1. Kunii, D. and O. Levenspiel, "Fluidization Engineering", Butterworth – Heinmann Edn. 2, 1991.

REFERENCES
1. Rowe, P.N. and J.F. Davidson, "Fluidization", Academic Press, 1971
2. Leva, M., "Fluidization", McGraw Hill Book Co. New York, 1959.
3. Perry, R.H.; Green, D.W. (Eds.) "Chemical Engineers Handbook", Edn. 7, McGraw Hill Book Co. Singapore, 1997

PP 9028 **MULTIPHASE FLOW** **L T P C**
3 0 0 3

UNIT I MULTIPHASE FLOW **9**
Scope and significance of multiphase flows, Dimensionless numbers in multiphase flows; Flow Pattern and Flow Regimes : Fluid-Solid System, Fluid-Fluid Systems, Solid-Fluid-Fluid systems.

UNIT II FLOW CLASSIFICATION **9**
Two-phase Co-current flow of Gas-Liquid, Gas-Solid and Liquid-Liquid, Upward and Downward Flow in Vertical pipes. Suspensions of Solid and their transport in Horizontal Pipes. Drag Reduction Phenomena, Laminar, Turbulent and Creeping Flow Regimes.

UNIT III MIXING POWER CORRELATIONS **9**
Theories of Intensity and Scale of Turbulence. Calculation of Circulation Velocities and Power Consumption in Agitated Vessels for Newtonian and Non-Newtonian Fluids. Blending and Mixing of Phases. Power requires for aeration to suspend to an Immiscible Liquid or Solids in Slurry Reactors, Prediction of optimum speed of Impeller Rotor and Design Criteria for Scale up.

UNIT IV QUANTIFICATION OF FLOW SYSTEM 9

Prediction of Holdup, Pressure Drop and bubble size in pipe flow, Lockhart – Martinelli Parameters, Bubble Column and its Design aspects; Flow through Packed Bed and Fluidized Bed, Minimum Carryover Velocity. Holdup Ratios, Pressure Drop and Transport Velocities and their prediction. Solid-Fluid Conveying and Settling.

UNIT V FLOW IN THREE - PHASE SYSTEMS 9

Gas, solid and Liquid Composites Slurries in Horizontal Pipes, Flow through Porous Media of Composite Mixtures, Prediction of Holdup, Pressure Drop and throughput velocities in three – phase system. Design of Multiphase Contactors involving Solids, Liquids and Gases.

TOTAL : 45 PERIODS

REFERENCES

1. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972.
2. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York, 1969.
3. Brodkey, R. S., "The Phenomena of Fluid Motions", Addision – Weseley, New York, 1967.
4. Hestroni, G., (Ed.) "Hand book of Multiphase systems", Hemisphere Publishing, Washington, 1982.

PP 9029 PETROLEUM ECONOMICS L T P C
3 0 0 3

UNIT I 9

Petroleum Macro Economics : Supply and demand, Energy economics, Impact of economic growth on energy, Affects of fiscal and monetary policy, International and national impacts; Petroleum Micro Economics : Theory of the firm in the petroleum sector, Revenue concepts – cash flow and revenue, Cash flow versus profits, Fixed costs versus variable costs, Marginal costs, How costs, revenues and profits vary with output

UNIT II 9

Capital Markets And Finance ; Company financing, Investment alternatives, Cost of capital, Market assessment of oil and gas stocks, Times earnings; Capital Budgeting In The Petroleum Industry : Building blocks: reserves, resources and production forecasts, Estimating project revenues over time Estimating costs and cash outlays over time, net cash flows

UNIT III 9

External Factors Affecting Project Analysis : Economic growth of economies, Oil prices, Inflation rates, Interest rates, Interest rate yield curves, Government takes ; Risk And Uncertainty In Decision Making : Identifying project risks in -Revenues -Production flows -Oil prices -Costs - Interest rates

UNIT IV 9

Crude oil supply and demand – the market, cost of exploration and production, tax and legal aspects

Economics of crude oil transportation, Finished products supply, Demand and marketing of petroleum products

UNIT V **9**

Petrochemicals industry – economic characteristics, economics of steam cracker and reformer. Market of principal finished products; Natural gas – supply, transportation, market

TOTAL : 45 PERIODS

REFERENCES

1. Masseron, J., Petroleum economics, Editions Technip 1990
2. Abdel-Aal, H.K., Bakr, B. A. and Al-Sahlawi, M. A., Petroleum economics and engineering, Marcel Dekker, 1992.

PP 9030 **CORROSION ENGINEERING** **L T P C**
3 0 0 3

UNIT I TYPES OF CORROSION AND TESTING METHODS **9**

Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevis, pitting, selective leaching, erosion, stress-corrosion, cracking – Cavitation phenomena & their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt-spray testing.

UNIT II CORROSION PROTECTION METHODS **9**

Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoteric coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT III CORROSION IN SPECIFIC ENVIRONMENTS **9**

Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT IV CORROSION IN SPECIFIC CASES AND CONTROL **12**

Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT V CORROSION AND COUNTRY'S ECONOMY **6**

Corrosion protection management – process maintenance procedures under corrosion environments

TOTAL : 45 PERIODS

TEXT BOOK

1. Fontana , M.G., "Corrosion Engineering", Edn 3, McGraw Hill, 1989

REFERENCE

1. Roberge, P.R., Handbook of Corrosion Engineering, McGraw-Hill,2000

PP 9031 ENVIRONMENT IMPACT ASSESSMENT L T P C
3 0 0 3

UNIT I **9**

Introduction and need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies – collection of data and analysis, cost benefit analysis.

UNIT II **9**

Application of Impact assessment methods in specific developmental projects, disadvantages of different methods, applicability of specific methods with examples.

UNIT III **9**

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

UNIT IV **9**

Ranking of impacts, concepts and contents of environmental management plan.

UNIT V **9**

Environmental audits, waste audit, life cycle assessment, industrial symbiosis.

TOTAL : 45 PERIODS

REFERENCES

1. Wathern, P, Environment Impact Assessment- theory and practice, Unwin Hyman Ltd., 1988.
2. Environmental Health and Safety Auditing Handbook, 1994, McGraw Hill, Inc., New York.
3. Carter, L.W. Environment Impact Assessment, McGraw Hill book Co., 1997.
4. Glasson, J, Therivel, R and Chadwick, A. Introduction to environmental impact assessment, Taylor and Francis, 2005
5. Petts, J., Handbook of Environmental Impact Assessment: Environmental impact assessment, Blackwell Science, 1999

CH 9021 OPTIMIZATION OF CHEMICAL PROCESSES L T P C
3 0 0 3

UNIT I INTRODUCTION **2**

Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.

UNIT II SINGLE VARIABLE OPTIMIZATION **6**

Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.

UNIT III MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS **20**

Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.

UNIT IV OTHER OPTIMIZATION METHODS **10**

Introduction to geometric, dynamic and integer programming and genetic algorithms.

UNIT V APPLICATIONS OF OPTIMIZATION 7

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.

CH 9022 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.

CH 9024 PROCESS MODELING AND SIMULATION L T P C
3 0 0 3

UNIT I INTRODUCTION 5

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 9

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.

CH 9025 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.

CH 9026 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. E Business & 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

CH 9027 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.

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)