

ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024

Regulations 2008

Curriculum

B.TECH. CHEMICAL ENGINEERING

SEMESTER III

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	MA1201	Transforms and Partial Differential Equations	3	1	0	4
2	EE1205	Electrical Drives and Control	3	0	0	3
3	CH1201	Organic Chemistry	3	0	0	3
4	CE1214	Mechanics of Solids	3	0	0	3
5	CE1212	Fluid Mechanics	3	0	0	3
6	HS1201	Environmental Science and Engineering	3	0	0	3
Practical						
7	CH1202	Organic Chemistry Laboratory	0	0	3	2
8	EE1207	Basic Electrical Electronics Engineering Laboratory	0	0	3	2
9	CE1213	Fluid Mechanics Laboratory	0	0	3	2
Total						25

SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	MA1256	Probability and Statistics	3	1	0	4
2	HS1253	Physical Chemistry	3	0	0	3
3	HS1254	Instrumental Methods of Analysis	3	0	0	3
4	CH1251	Chemical Process Industries I	3	0	0	3
5	CH1252	Chemical Process Calculations	3	0	0	3
6	CH1253	Mechanical Operations	3	0	0	3
Practical						
7	CH1254	Chemical Analysis Laboratory	0	0	3	2
8	CH1255	Physical Chemistry Laboratory	0	0	3	2
9	CH1256	Mechanical Operations Laboratory	0	0	3	2
Total						25

SEMESTER V

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	MA1251	Numerical Methods	3	1	0	4
2	HS1302	Material Technology	3	0	0	3
3	CH1301	Process Instrumentation	3	0	0	3
4	CH1302	Chemical Thermodynamics Principles	3	0	0	3
5	CH1303	Chemical Process Industries II	3	0	0	3
6	CH1304	Energy Management in Chemical Industries	3	0	0	3
Practical						
7	CH1305	Environmental Engineering Laboratory	0	0	3	2
8	CH1306	Technical Analysis Laboratory	0	0	3	2
9	HS1301	Communication and Soft Skills Laboratory	0	0	3	2
Total						25

SEMESTER VI

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	GE1301	Professional Ethics and Human Values	3	0	0	3
2	CH1351	Applied Chemical Thermodynamics	3	0	0	3
3	CH1352	Heat Transfer Operations	3	0	0	3
4	CH1353	Mass Transfer Fundamentals	3	0	0	3
5	CH1354	Principles of Chemical Kinetics	3	0	0	3
6	CH1355	Process Dynamics and Control	3	0	0	3
Practical						
7	CH1356	Heat Transfer Laboratory	0	0	3	2
8	CH1357	Chemical Process Equipment Design and Drawing I	0	0	3	2
9	CH1358	Process Control and Simulation Laboratory	0	0	3	2
Total						24

SEMESTER VII

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	CH1401	Transport Phenomena	3	1	0	4
2	CH1402	Mass Transfer Operations	4	0	0	4
3	CH1403	Chemical Reaction Engineering	4	0	0	4
4	CH1404	Water Treatment and Management	4	0	0	4
5	CH1405	Process Utilities	3	0	0	3
6	E1****	Elective I	3	0	0	3
Practical						
7	CH1406	Mass Transfer Laboratory	0	0	3	2
8	CH1410	Chemical Reaction Engineering Laboratory	0	0	3	2
9	CH1411	Chemical Process Equipment Design and Drawing II	0	0	3	2
Total						28

SEMESTER VIII

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	MG1301	Total Quality Management	3	0	0	3
2	MG1453	Safety and Risk Management	3	0	0	3
3	E2****	Elective II	3	0	0	3
Practical						
4	CH1455	Project Work	0	0	12	6
Total						15

LIST OF ELECTIVES

S.No.	Subject Code	Subject	L	T	P	C
Elective I						
1	CH1001	Fertilizer Technology	3	0	0	3
2	PC1008	Petrochemical Technology	3	0	0	3
3	CH1002	Industrial Management	3	0	0	3
4	CH1003	Process Integration and Pinch Technology	3	0	0	3
Elective II						
5	CH1004	Process Modelling and Simulations	3	0	0	3
6	CH1005	Natural Gas Engineering	3	0	0	3
7	CH1006	Modern Separation Processes	3	0	0	3
8	CH1007	Fluidization Engineering	3	0	0	3

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Syllabus

B.TECH. CHEMICAL ENGINEERING

SEMESTER III

MA1201 – TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

UNIT I FOURIERSERIES 9

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORMS 9

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS 9

Formation of partial differential equations – Lagrange's linear equation – Solutions of standard types of first order partial differential equations – Linear partial differential equations of second and higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9

Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Insulated edges excluded) – Fourier series solutions in cartesian coordinates.

UNIT V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 9

Z transforms - Elementary properties – Inverse Z-transform – Convolution theorem – Formation of difference equations – Solution of difference equations using Z transform.

L: 45 T: 15 Total: 60

TEXT BOOK

1. Grewal B.S., “Higher Engineering Mathematics”, Fortieth Edition, Khanna Publishers, 2007.
2. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill Company Ltd., 2007.

REFERENCES

1. Bali.N.P and Manish Goyal, “A Textbook of Engineering Mathematic”, 7th Edition, Laxmi Publications(P) Ltd. (2007)
2. Ramana.B.V., “Higher Engineering Mathematics”, Tata Mc-GrawHill Publishing Company limited, New Delhi (2007).
3. Glyn James, “Advanced Modern Engineering Mathematics”, 3rd Edition, Pearson Education (2007).
4. Erwin Kreyszig, “Advanced Engineering Mathematics”, 8th edition, Wiley India (2007).

EE1205 – ELECTRICAL DRIVES AND CONTROL

L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Basic Elements – Types of Electric Drives – Factors influencing the choice of electrical drives – Heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

UNIT II DRIVE MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - Single phase and three phase induction motors.

UNIT III STARTING METHODS 8

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

UNIT IV CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES 10

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –Applications.

UNIT V CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES 10

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – Applications.

Total: 45

TEXT BOOKS

1. Vedam Subrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw-Hill, 2001
2. Nagrath.I.J. & Kothari.D.P, “Electrical Machines”, Tata McGraw-Hill, 1998

REFERENCES

1. Pillai.S.K “A first course on Electric drives”, Wiley Eastern Limited, 1998
2. M.D.Singh, K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 1998
3. H.Partab, “Art and Science and Utilisation of electrical energy”, Dhanpat Rai and Sons, 1994.

CE1214 – MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Forces on solids and supports – Equilibrium and stability – Strength and stiffness – Tension, compression and shear stresses – Hooke's law and simple problems – Compound bars – Thermal stresses – Elastic constants and Poisson's ratio – Welded joints – Design.

UNIT II TRANSVERSE LOADING ON BEAMS 9

Beams – Support conditions – Types of Beams – Transverse loading on beams – Shear force and bending moment in beams – Analysis of cantilevers, simply supported beams and over hanging beams – Relationships between loading, S.F. and B.M. In beams and their applications – S.F.& B.M. diagrams.

UNIT III DEFLECTIONS OF BEAMS 9

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

UNIT IV STRESSES IN BEAMS 9

Theory of simple bending – Assumptions and derivation of bending equation ($M/I = F/Y = E/R$) – Analysis of stresses in beams – Loads carrying capacity of beams – Proportioning beam sections – Leaf springs – Flitched beams – Shear stress distribution in beams – Determination of shear stress in flanged beams.

UNIT V TORSION & COLUMNS 9

Torsion of circular shafts – Derivation of torsion equation ($T/J = C/R = G\theta/L$) – Stress and deformation in circular and hollow shafts – Stresses and deformation in circular and hollow shafts – Stepped shafts – Shafts fixed at both ends – Stresses in helical springs – deflection of springs – Spring constant – Axially loaded short columns – Columns of unsymmetrical sections – Euler's theory of long columns – Critical loads for prismatic columns with different end conditions – Effect of eccentricity.

Total: 45

TEXT BOOKS

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

REFERENCE

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

CE1212 – FLUID MECHANICS

L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Nature of fluids - Laws of dimensional homogeneity – Physical properties of fluids – Types of fluids- Newtonian and Non Newtonian fluids- Viscosity and other secondary properties – Compressible and incompressible fluids-Hydrostatic pressure distributions- Laws of buoyancy Pressure measurements manometers

UNIT II KINEMATICS OF FLUID FLOW 9

Velocity potential– Concept of boundary layer, form drag, skin drag–Drag coefficient–Continuity, momentum and mechanical energy equations– Laminar and turbulent flow through closed conduits– Velocity profiles and friction factor for smooth and rough pipes

UNIT III DIMENSIONAL ANALYSIS AND MEASUREMENT OF FLUID FLOW 9

The principle of dimensional homogeneity - The Pi-theorem - Relationship between dimensional analysis and similitude - Use of dimensional analysis for scale up studies-Orifice meter, Venturimeter, Pitot tube, Rota meter, Weirs and notches- Principles and applications of Doppler effect in flow measurement

UNIT IV VISCOUS FLOW IN DUCTS AND BOUNDARY LAYER FLOW 9

Reynolds's number regimes–Internal versus external viscous flow– Flow in circular pipe –head loss, minor losses in pipe systems and multiple-pipe systems – Functions and pressure drag – Flow through packed and fluidized beds.

UNIT V FLOW MEASUREMENT AND TUBRO MACHINERY 9

Fluid moving machinery performance – Selection and specification– Air lift and diaphragm pump – Positive displacement pump – Reciprocating and rotary pumps – Centrifugal pump– Pump characteristics– Fans, blowers and compressors – Steam jet ejector.

Total: 45

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot .P., “Unit Operations in Chemical Engineering”, Mc-Graw-Hill, Sixth Edition, 2000.
2. Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, Second Edition, McGraw-Hill, 1991.

REFERENCES

1. Coulson J.M. and Richardson J.E., Chemical Engineering, Vol. 1 (3rd Edition) Pergamon Press.
2. White, F.M., “Fluid Mechanics”, 4th Edition, McGraw-Hill Inc., 1999.
3. Daugherty, R.L., Franzini, J.B and Finnemore, E.J., “Fluid Mechanics with Engineering Applications”, SI metric Edn., McGraw-Hill Book Company, 1989.
4. Darby, R. ”Chemical Engineering Fluid Mechanics”, Marcel Dekker, 1998.

HS1201 – ENVIRONMENTAL SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

9

Definition, Scope and Importance – Need For Public Awareness – Forest Resources – Use and Over – Exploitation – Deforestation – Case Studies – Timber Extraction – Mining – Dams and their Ground Water – Floods – Drought – Conflicts Over Water – Dams – Benefits and Problems – Mineral Resources – Use Effects on Forests and Tribal People – Water Resources – Use and Over-Utilization of Surface 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

UNIT II ECOSYSTEMS AND BIODIVERSITY

9

Concepts 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

UNIT III ENVIRONMENTAL POLLUTION

9

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 – Solid Waste Management:- Causes, Effects and Control Measures of Urban and Industrial Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – disaster Management:- Floods, Earthquake, Cyclone and Landslides

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

9

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 – 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 – Issues Involved in enforcement of Environmental Legislation – Public Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT

9

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.

Field Study of Local Area to Document Environmental assets – River/Forest/Grassland/Hill/Mountain.

Field Study of Common Plants, Insects and Birds - Field Study of Simple Ecosystems – Pond, River, Hill Slopes, etc.

Field Study of Local Polluted Site – Urban/Rural/Industrial/Agricultural

Total: 45

TEXT BOOKS

1. Masters, G.M., “Introduction to Environmental Engineering and Science”, 2nd Edition, Pearson Education, 2004.
2. Miller, T.G. Jr., “Environmental Science”, Wadsworth Pub. Co.
3. Townsend C., Harper, J. and Begon, M., “Essentials of Ecology”, Blackwell Science, 2003.
4. Trivedi, R.K., and Goel, P.K., “Introduction to Air Pollution”, Techno-Science Publications.

REFERENCES

1. Erach, B., “The Biodiversity of India”, Mapin Publishing Pvt. Ltd., Ahmedabad, India.
2. Trivedi, R.K., “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Vol-I and II, Envio Media.
3. Cunningham, Cooper, W.P. and Gorhani, T.H., “Environmental Encyclopedia”, Jaico Publishing House, Mumbai, 2001.
4. Wages, K.D., “Environmental Management”, W.B. Saunders Co., Philadelphia, USA, 1998.

CH1202 – ORGANIC CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

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

Total: 45

REFERENCES

1. Vogel's "Text Book of Practical Organic Chemistry", Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore (1989).
2. "Organic Chemistry Lab Manual, Chemistry Division", Chemical Engineering Department, A.C. Tech, Anna University (2007).

EE1207 – BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

LIST OF EXPERIMENTS

1. Open circuit and load test on shunt generators
2. Load test of D.C. shunt motor
3. Load test on single phase induction motor
4. Equivalent circuit of a transformer
5. Swinburn's test
6. Load test on 3-phase squirrel cage induction motor
7. Load test on 3-phase slip ring induction motor
8. Diode characteristics
9. Transistor amplifier
10. SCR application
11. Frequency Response Analysis
12. Characteristics of Transducers

Total: 45

LIST OF EQUIPMENTS

1. Shunt Generators
2. Shunt DC motors
3. Single phase Induction motor
4. Single phase transformer
5. Three phase Squirrel Cage induction Motors
6. Diodes and Amplifiers
7. Oscilloscope
8. Transducers

CE1213 – FLUID MECHANICS LABORATORY

L	T	P	C
0	0	3	2

LIST OF EXPERIMENTS*

1. Calibration of constant and variable Head meters
2. Calibration of Weirs
3. Drag reduction studies
4. Flow through straight pipe
5. Pressure drop studies in packed column
6. Pressure drop studies in Fluidized bed
7. Flow through fittings / valves
8. Open drum orifice and draining time
9. Flow through helical coil and spiral
10. Characteristic curves of centrifugal pump
11. Characteristic curves of Gear pump
12. Characteristic curves of Reciprocating pump
13. Viscosity measurement of non Newtonian fluids
14. Flow through annulus of horizontal concentric pipe

Total: 45

LIST OF EQUIPMENTS REQUIRED

1. Orifice Meter with U tube manometer
2. Venturi meter with U tube Manometer
3. V-notch and circular Notch weirs.
4. Straight pipes with U tube Manometers
5. Packed column with U tube manometer and with difference packing
6. Fluidized column with U tube manometer with different particles
7. Flow loops for pipes, fittings and valves.
8. Glass column with small spherical particles for fluidization.
9. Open drum orifice
10. Centrifugal pump with sump and pressure gauge Vertical discharge & horizontal discharge
Viscometer
11. Reciprocating pump with sump and pressure gauge Vertical discharge & horizontal discharge
Viscometer
12. Gear pump with sump and pressure gauge Vertical discharge & horizontal discharge
Viscometer
13. Horizontal double pipe (concentric pipes) with U tube Manometer

***Minimum 10 experiments shall be offered**

HS1253 – PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

UNIT I CHEMICAL KINETICS

9

Rate equations – Order of reaction – I order – II order – III order – Zero order – Pseudo order reactions – Effect of temperature on reaction rate – Concept of activation energy – Chain reactions – Branched chain reactions – Reactions in solutions – Influence of ionic strength in rates of reactions.

UNIT II ELECTROCHEMISTRY

9

Electrolytic conductance – Specific conductance – Equivalent conductance – Molar conductance – Variation with dilution – Kohlrausch's law – Applications of Kohlrausch's law – Molar ionic conductance – Conductometric titrations – Ostwald dilution law – Debye – Huckel theory of mean ionic activity coefficient.

UNIT III PHASE RULE AND DISTRIBUTION LAW

9

Definition of terms – One component system – Water – Sulphur – Two component system – Simple eutectic system – Reduced phase rule – Distribution – Chemical combinations – Applications – Applications of distribution law – Raoult's law-Henry's law-ideal and non-ideal solutions – Vapor pressure and boiling point.

UNIT IV SURFACE CHEMISTRY

9

Adsorption – Definition – Types – Isotherms – Theories of adsorption – BET method – Applications.

Catalysis – Homogeneous catalysis – Acid – Base – Enzyme catalysis autocatalysis mechanism and kinetics – Michaelis-Menten equation – Heterogeneous catalysis – Kinetics – Effect of temperature on surface reactions.

UNIT V MACRO MOLECULES

9

Colloids – Classification – Preparations – Coagulation – Flocculation – Determination of size of particles- Surfactants – Emulsions – Emulsifiers – Gels – Applications.

Polymers – Classification – Polymerization reactions – Molar masses of reactions – Determination of molar masses – Kinetic study.

Total: 45

TEXT BOOKS

1. Puri, B.H. and Sharma, L.R., "Principles of Physical Chemistry", S. Nagin Chand and Company, Delhi, 1994.
2. Soni, P.L., Dharmarha, O.P. and Dash, U.N., "Textbook of Physical Chemistry", Sultan Chand and Sons, 2009.

REFERENCES

1. Kund and Jain., "Physical Chemistry", S.Chand and Company, 1996.
2. Kuriakose, J.C. and Rajaram J., "Chemistry in Engineering and Technology" Vol. 1, Tata McGraw-Hills, 1984.
3. Bahl, B.S., Tuli G.D. and Arun Bahl., "Essentials of Physical Chemistry", S.Chand and Company Ltd., 1998.

HS1254 – INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

UNIT I FUNDAMENTALS OF SPECTRAL ANALYSIS 9

Electromagnetic Radiation: Regions and properties – Various energy levels – Interaction of photons with matter, absorbance, and transmittance and their relationship – Permitted energy levels for the electrons of an atom and simple molecules – Classification of instrumental methods based on physical properties.

Visible Spectroscopy and Colorimetry: Beer-Lambert's Law – Limitations – Deviations (Real, chemical and instrumental deviations) Nesslerimetry – Duboscq colorimetry – Estimation of inorganic ions such as Fe, Ni and Nitrite using Beer-Lambert's Law.

UV Visible and IR Spectroscopy: Instrumentation (Source, Optical parts and Detectors) – Various electronic transitions in organic and inorganic compounds effected by UV- Visible and infra red radiations – Woodward – Fischer rules for the calculation of absorption maxima (dienes and carbonyl compounds) – Effects of auxochromes and effects of conjugation on the absorption maxima – Multicomponent analysis – Photometric titration.

UNIT II ELECTROMETRIC METHODS 9

Conduct metric Titrations – Instrumentation – Types – Advantages – Application – Potentiometric Titrations – Instrumentation – Types – Advantages – Application – Measurement of pH – Instrumentation – Applications – Ion selective electrodes – Electrode setup-Applications – Amperometric titrations – Principle – Instrumentation – Application.

UNIT III X-RAY DIFFRACTION AND THERMAL ANALYSIS METHODS 9

XRD: Introduction – Mosley's law – Different emission and diffraction methods – Various X-ray detectors – Thermogravimetric analysis (TGA): Instrumentation – Factors affecting the shapes of thermo grams – Applications – Thermo grams of some important compounds ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ – $\text{CaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ etc.,) – Differential thermal analysis (DTA) and Differential scanning calorimetry (DSC): Principle – Instrumentation – Applications of DSC and DTA – Differences between DSC and DTA.

UNIT IV IMPORTANT SPECTROSCOPIC METHODS OF ANALYSIS 9

Atomic Absorption Spectroscopy (AAS): Principle – Instrumentation – Interference and Applications – Flame photometry and inductively coupled plasma atomic emission spectroscopy (ICP-AES): Principle – Instrumentation and applications.

Polarimetry: Principle – Instrumentation and Applications.

Refractometry: Principle – Instrumentation and Applications.

Nephelometry/Turbidimetry: Principle – Instrumentation and Applications.

UNIT V CHROMATOGRAPHIC METHODS 9

Chromatographic methods – Types (column, Thin layer, paper, gas, high performance liquid chromatographic methods) – Principle – Separation technique – Separation of organic compounds by column and thin layer – Amino acids and mixture of Cu, Co and Ni by Paper – Estimation of organic compounds by GC and HPLC.

Total: 45

TEXTBOOKS

1. Skoog, D.A. and West, D.M., "Fundamentals of Analytical Chemistry ", Saunders College Publishing, 1982.
2. Willard, H.H., Merritt. I.I., Dean J.A. and Settle, F.A., "Instrumental methods of analysis ", 6th Edition, CBS Publishers, 1986.

REFERENCES

1. Vogel, A.I., "Qualitative Inorganic analysis ", 5th Edition, Prentice-Hall of India (P) Ltd., 1991.
2. Sharma, B.K., "Instrumental Methods of Analysis ", Goel Publishing House, 1995.
3. Parikh V.M., "Absorption spectroscopy of organic molecules ", Addison Wesley Publishing Company, 1974.

CH1251 – CHEMICAL PROCESS INDUSTRIES I

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION AND CHLORO-ALKALI INDUSTRIES 9

Role of a chemical engineers in process industries – Introduction to common devices used in manufacturing processes – Block diagrams – Flow charts and standard symbols used for devices – Industrial safety and pollution – Outline of plant and equipment design – Manufacture of soda ash and Sodium bicarbonate, chlorine and caustic soda – Bleaching powder and related bleaching agents – Sodium chloride – By-products of common salt industry. .

UNIT II SULPHUR AND SULPHURIC ACID INDUSTRIES 9

Mining and manufacture of sulphur recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid, hydrochloric acid, sodium sulphate, sodium thiosulphate.

UNIT III SILICATE INDUSTRIES 9

Types and manufacture of portland cement – Manufacture of glasses and special glasses – Ceramics – Refractories.

UNIT IV NITROGEN AND PHOSPORUS INDUSTRIES 9

Synthetic ammonia – Nitric acid – Urea – Phosphate rock beneficiation – Phosphoric acid

UNIT V FERTILIZER INDUSTRIES 9

Growth elements – Functions – Ammonium sulphate, ammonium nitrate, ammonium phosphate, potassium chloride, potassium sulphate, single, triple super phosphate – Introduction to pesticides – Herbicides – Bio-fertilizers.

Total: 45

TEXT BOOKS

1. Austin, G.T., “Shreve’s Chemical Process Industries” 5th Edition, McGraw-Hill International Book Co, 1984
2. Dryden, C.E., “Outlines of Chemicals Technology”, 2nd Edition, Affiliated East-West Press, 1993.

REFERENCES

1. Shukla and Pandey, G.N., “Text book on Chemical Technology”, Vikas Publishing Company 1997.
2. Kirk and Othmer , “ Encyclopedia of Chemical Technology”, 3rd Edition, 2004.
3. Kent, J.A., “Riggel's Hand Book of Industrial Chemistry”, Van Nostrand Reinhold, 1974.

CH1252 – CHEMICAL PROCESS CALCULATIONS

L T P C
3 0 0 3

UNIT I UNITS AND GAS CALCULATIONS 9

Basic and derived units – Use of model units in calculations– Methods of expression–Compositions of mixture and solutions – Ideal and real gas laws – Gas constant – Calculations of pressure, volume and temperature using ideal gas law – Use of partial pressure – Pure component volume in gas calculations – Applications of real gas relationship in gas calculation.

UNIT II MATERIAL BALANCE 9

Stoichiometric principles– Application of material balance to unit operations like distillation – Evaporation, crystallisation, drying etc., – Material balance with chemical reaction – Limiting and excess reactants – Recycle – Bypass and purging – Unsteady state material balances.

UNIT III ENERGY BALANCE 9

Heat capacity of solids, liquids, gases and solutions – Use of mean heat capacity in heat calculations– Problems involving sensible heat and latent heats – Evaluation of enthalpy – Standard heat of reaction – Heats of formation – Combustion – Solution – Mixing etc., – Calculation of standard heat of reaction – Effect of pressure and temperature on heat of reaction – Energy balance for systems with and without chemical reaction – Unsteady state energy balances.

UNIT IV HUMIDITY AND SATURATION 7

Calculation of absolute humidity – Molal humidity – Relative humidity and Percentage humidity – Use of humidity in condensation and drying – Humidity chart – Dew point.

UNIT V FUELS AND COMBUSTION 6

Determination of composition by orsat analysis of products of combustion of solid, liquid and gas fuels – Calculation of excess air from orsat technique – Problems on sulphur and sulphur burning compounds.

Total: 45

TEXT BOOKS

1. Bhatt, B.L., and Vora, S.M., “Stoichiometry”, Tata McGraw Hill, 1976.
2. Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, 6th Edition, Prentice Hall Inc., 2003 (with CD containing programmes and problems).

REFERENCES

1. Anonymous, “Process Calculation for Chemical Engineering”, 2nd Edition, Chemical Engineering Education Development Centre, I.I.T., Madras, 1981.
2. Venkataramani, V. and Anantharaman, N., “Process Calculations”, Prentice Hall of India Pvt. Ltd., 2003.

CH1254 – CHEMICAL ANALYSIS LABORATORY

L T P C
0 0 3 2

LIST OF EXPERIMENTS

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 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 Power

- 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: 45

REFERENCES

1. Anonymous, "Technical Analysis Manual - Chemistry Division", Chemical Engineering Department, A.C. Tech. Anna University Chennai, 2007.
2. Griffin., "Hand book of Chemical Analysis", A.C Tech., Anna University Chennai, 2007.
3. Mendham, J., R., Denney, C., Barnes, J.D., Thomas M.J.K., "Vogel's Text Book of Quantitative Chemical Analysis" 6th Edition, 2002.
4. Day R.A., Underwood A.L., "Quantitative Analysis", 5th Edition, Prentice Hall of India (P) Ltd., 1998.
5. SudhaRani., "Laboratory Manual of Engineering Chemistry", Dhanpat Rai Publishing Company, 2001.

CH1255 – PHYSICAL CHEMISTRY LABORATORY

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0	0	3	2

LIST OF EXPERIMENTS

1. Determination of molecular weight of a polymer by viscosity method.
2. Determination of partition co-efficient of iodine between two immiscible solvents
3. Determination of partition co-efficient of benzoic acid between two immiscible solvents
4. Determination of K_a of the weak acid
5. Conductometric experiments- Verification of Oswald's Dilution Law
6. Titration of Strong Acid Vs Strong Base
7. Titration of mixture of Strong Acid Weak Acid Vs Strong Base
8. Titration of Weak Acid Vs Weak Base
9. Determination of Rate Constant (K)
10. Determination of Activation Energy (ΔE)
11. Estimation of Ferrous ion concentration by Potentiometric Titration
12. Determination of standard electrode potential (Zn, Cu, Ag)
13. Adsorption studies
14. .To study the adsorption of Acetic acid on charcoal and constructs the isotherm.
15. Determination of pH metric titration of Strong Acid Vs Strong Base
16. Enzyme catalytic reaction by varying pH.
17. Application of Phase Rule to Phenol-Water system
18. To study the inversion of cane sugar by polarimeter.
 - a. Polarimeter-Inversion of cane sugar
 - b. Refractometer

Total: 45

LIST OF EQUIPMENTS

1. Micro Calorimeter
2. Beckman Thermometers. Glasswares,
3. Thermometers 0 to 110 – 0°. Bottle Shakers .pH meters
4. Pressure Glass bottles. Standard Cells. Multimeters
5. Viscometers-Ostwald Cannan Ubbelholde. Voltage Stabiliser
6. Stalalmometer
7. Surface Tension Meter .Tape Heaters
8. Mantle Heaters
9. DC Power Supply. Thermostat. Cyrostats

CH1256 – MECHANICAL OPERATIONS LABORATORY

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LIST OF EXPERIMENTS

1. Study of crushing strength of solid materials using jaw crusher
2. Study of crushing strength of solid materials using crushing rolls
3. Study of crushing strength of solid materials using ball mill
4. Taylor sieves
5. Layer sieves
6. Study of characterization of filtration using to Filter Press.
7. Study of characterization of solid materials using leaf Filter.
8. Study of separation of fine particles using cyclone separator.
9. Study of separation of fine particles using sedimentation
10. Study of separation of fine particles using Elutriator.
11. Study of separation of solid particles using drum Filter.
12. Study of separation of fine particles using screens and determination of effectiveness of factor.

*** Minimum experiments shall be offered.**

Total: 45

SEMESTER V
MA1251 – NUMERICAL METHODS

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3 1 0 4

UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9

Linear interpolation methods (method of false position) – Newton’s method – Solution of linear system by Gaussian elimination and Gauss-Jordan methods – Iterative methods – Gauss Jacobi and Gauss-Seidel methods – Inverse of a matrix by Gauss-Jordan method – Eigen value of a matrix by power method

UNIT II INTERPOLATION AND APPROXIMATION 9

Lagrangian Polynomials – Divided differences – Interpolating with a cubic spline – Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9

Derivatives from difference tables – Divided differences and finite differences – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Double integrals using Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

Single step Methods – Taylor Series method – Euler’s method – Modified and Improved Euler’s method – Fourth order Runge-Kutta method for solving first and second order equations – Multi-step methods – Milne’s and Adam’s predictor and corrector methods.

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

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by implicit and explicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

L: 45 T: 15 Total: 60

TEXT BOOK

1. Gerald C.F. and Wheatley P.O., “Applied Numerical Analysis”, Sixth Edition, Pearson Education, 2005.

REFERENCES

1. Jain M.K., Iyengar S.R.K. and Jain R.K., “Numerical Methods for Scientific and Engineering Computation” Fourth Edition, New Age International Publishers, 2003.
2. Venkatraman M.K., ‘Numerical Methods’, National Publication Company, 1991.
3. Kandasamy P., Thilakavthy K. and Gunavathy K., “Numerical Methods”, Second Edition, S.Chand & Co., 2003.

HS1302 – MATERIAL TECHNOLOGY

L T P C
3 0 0 3

UNIT I NATURE OF MATERIALS 9

Micro and macro structures – Properties and definitions – Mechanical, thermal, chemical, electrical and magnetic properties – Processing of metals and alloys – Casting – Hot and cold rolling – Extrusion – Forging – Deep drawing – Plastic deformation of metal – Single crystals and poly crystalline metals – Recovery and recrystallization of plastically deformed metals.

UNIT II FERROUS AND NON-FERROUS METALS 9

Pure iron – Cast iron – Mild steel – Stainless steels – Special steels and alloys – High temperature steels – Iron carbide phase diagram – Heat treatment of plain steels – Carbon steels – Manufacture – Properties and application in chemical industries – Lead, tin and magnesium – Manufacturing methods – Properties and application in process industries.

UNIT III POLYMERIC AND CERAMIC MATERIALS 9

Polymeric Materials: Polymerization reactions – Industrial polymerization methods – Crystallinity and stereo-isomerism in some thermoplastics – Thermosetting elastomers – Creep and fracture of polymeric materials – **Composite Materials:** Fibre – Reinforced – Plastic composite materials – Manufacturing methods – Concrete – Asphalt and asphalt mixtures – Wood – Sandwich structures – **Ceramic Materials:** Ceramic crystal and silicate structures – Processing of ceramics – Properties of glasses and enamels.

UNIT IV INORGANIC MATERIALS 9

Manufacture of cement and its properties – Special cement – Cement concrete – Reinforced and prestressed concrete – Properties and applications – Mixing and curing.

UNIT V CORROSION AND COATING 9

Basic theories and mechanism of corrosion – Types of corrosion – Application of corrosion theories in equipment design and fabrication – Anti-corrosion methods – Organic paints and coatings – Metal coatings – Ceramic coatings – Lining.

Total: 45

TEXT BOOKS

1. Van Vlack L.H., “Elements of Material Science and Engineering”, Sixth Edition, Prentice Hall of India (P) Ltd., 1989.
2. Raghavan V., “Materials Science and Engineering: A First Course”, Fifth Edition, Prentice Hall of India (P) Ltd., 2004.

REFERENCES

1. William D. and Jr.Callister., “Materials Science and Engineering: An Introduction”, Seventh Edition, John Wiley & Sons, 2007.
2. Smith W F. and Hashemi J., “Foundations of Materials Science and Engineering” Third Edition, McGraw-Hill, 2003.
3. Clauster H.R., “Industrial and Engineering Materials ”, McGraw-Hill, 1975.

CH1301 – PROCESS INSTRUMENTATION

L T P C
3 0 0 3

UNIT I PHYSICAL PROPERTY MEASUREMENT 9

Density and specific gravity – Viscosity and consistency – Refractive index analyzers – Boiling point – Flash point analyzers – Thermal conductivity.

UNIT II TEMPERATURE MEASUREMENT 9

Differential expansion and fluid expansion types – Resistance thermometers – Thermoelectric pyrometers – Radiation pyrometers – Optical pyrometers – Pyrometric cones – Ultrasonic thin wire thermometer.

UNIT III PRESSURE MEASUREMENT 9

Absolute pressure – Gauge pressure or vacuum – Liquid types and spring balanced types – Differential pressure – Manometer types – Simple U tube and inclined tube manometer and sealed bell types – Pressure transmitters.

UNIT IV FLOW MEASUREMENT 9

Volumetric meters – Variable head meters – Orifice meter – Venturi meter – Pitot tube – Closed channel and open channel types – Variable area meters – Velocity and current meters – Anemo meter – Ultrasonic flowmeter – Mass meters.

UNIT V LEVEL MEASUREMENT 9

Measurement of head and level – Float methods – Hydrostatic pressure methods – Gauge Glass automatic detector – Ultrasonic probe – Electronic level gauge – Continuous capacitance gauge.

Total: 45

TEXT BOOKS

1. Nakra B.C. and Chaudhry K.K., “Instrumentation, Measurement and Analysis” Second Edition, Tata McGraw- Hill, 2004.
2. Singh S.K., “Industrial Instrumentation and Control”, Second Edition, Tata McGraw-Hill, 2007.

REFERENCES

1. Doebelin E.O., “Measurement system Application and Design”, Fourth Edition, McGraw Hill, 1998.
2. Patranabis D., “Principles of Industrial Instrumentation”, Second Edition, Tata McGraw-Hill, 2007.
3. Sawhney A.K., “A Course in Electrical, Electronics measurement and Instrumentation”, Dhanpat Rai and sons, 1999.

CH1302 – CHEMICAL THERMODYNAMICS PRINCIPLES

L T P C
3 0 0 3

UNIT I BASIC CONCEPTS 9

The terminologies of thermodynamics- The variables and quantities of thermodynamics- Categorization of systems and processes- Energy classifications- point and path properties- Energy in transition-Heat and work- Reversible and irreversible processes- Phase rule.

UNIT II FIRST LAW OF THERMODYNAMICS 9

The first law and internal energy- Statements of first law for the non flow and flow systems- Enthalpy and heat capacity - Limitations of the first law.

UNIT III SECOND LAW OF THERMODYNAMICS 9

Statements of the second law of thermodynamics- Available and unavailable energies- The entropy function-Applications of the second law.

UNIT IV THERMODYNAMIC FORMULATIONS 9

Measurable quantities-Basic energy relations- Maxwell relations- Thermodynamic formulations to calculate enthalpy- Internal energy and entropy as function of pressure and temperature-Other formulations involving C_p and C_v - Complex thermodynamic formulations- Thermodynamic properties of an ideal gas- Entropy change in reversible and irreversible process.

UNIT V THERMODYNAMIC PROPERTIES OF REAL GASES & COMPRESSION OF FLUIDS 9

The PVT behavior of fluids- Laws of corresponding states and equation of states approaches to the PVT relationships of non ideal gas Problems- Compressibility factors-Generalized equations of state-Property estimation via generalized equation of state- fugacity and fugacity coefficients of real gases- Thermodynamic aspects of compression process- Classification of compression processes-Basic equation for change of state of gases- The work expression for different situations- The effect of clearance volume- Multistage compression- Convergent divergent flow-Ejectors.

Total: 45

TEXT BOOKS

1. Smith, J.M., and Van Ness, H.C., "Introduction to Chemical Engineering Thermodynamics", Kogakushai 1976.
2. Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" Prentice Hall of India Pvt. Ltd. 2001.

REFERENCES

1. Dodge, B.F., "Chemical Engineering Thermodynamics", McGraw-Hill, 1960.
2. Sandler, S.I., "Chemical and Engineering Thermodynamics 2nd edn.", Wiley, 1989.
3. Kyle, B.G., "Chemical and Process Thermodynamics 2nd edn.", Prentice Hall of India Pvt. Ltd., 1990.

CH1303 – CHEMICAL PROCESS INDUSTRIES II

L T P C
3 0 0 3

UNIT I SUGAR AND STARCH INDUSTRIES 9

Raw and refined sugar- By products of sugar industries-Starch and starch derivatives.

UNIT II OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 9

Vegetable oils and animal fats-Their nature- Analysis and extraction methods-Hydrogenation of oils-Fatty acids and alcohols- Waxes- Soaps- Synthetic detergents.

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 9

Petroleum refining- Physical and chemical conversion products- Lubricating oils- Petrochemical precursors- Methane- Olefins- Acetylenes and aromatics and products obtained from them by various unit processes.

UNIT IV RUBBER AND POLYMERS 9

Monomers – Thermosetting and Thermoplastic materials – General properties and Applications of Resins – Polymerization processes – Different types - Natural rubber; Synthetic rubber such as SBR-NBR- CR - Fundamental methods of processing of synthetic Rubbers.

UNIT V SYNTHETIC FIBRE AND FILM INDUSTRIES 9

Natural and synthetic fibers – Properties of - Poly amides – Manufacture of Nylon 6. 6. Polyesters Fibers – Manufacturer of – Cellulose Fibers – Viscose Rayon production manufacture of films - Cellulose Acetate-PVC- Polyesters – Polyethylene.

Total: 45

TEXT BOOKS

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

REFERENCES

1. Kent, J.A.(ed), “Riggel's Hand Book of Industrial Chemistry”, Van Nostrand Reinhold, 1974.
2. CHEMTECH 1-4, “Chemical Engineering Education Development Centre”, I.I.T., Madras 1975-78.

CH1304 — ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

L	T	P	C
3	0	0	3

UNIT I ENERGY RESOURCES - A GLOBAL VIEW 9

Energy sources- Coal oil, natural gas- Nuclear energy- Hydro electricity- Other fossil fuels- Geothermal- Supply and demand-Depletion of resources of resources- Need for conservation- Uncertainties-National and international issues.

UNIT II ENERGY AND ENVIRONMENT 9

Energy- Various forms-Energy storage- Structural properties of environment- Bio-geo-chemical cycles-Society and environment population and technology.

UNIT III MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES 9

Chemical industries- Classification- Conservation in unit operation such as separation- Cooling tower- Drying- Conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries-Chloroalkali industries- Conservation using optimization techniques.

UNIT IV ENERGY ALTERNATIVES 9

Sources of continuous power- Wind and water- Geothermal- Tidal and solar power- MHD, fuel cells- Hydrogen as fuel.

UNIT V ECONOMIC BALANCE IN ENERGY CONSUMPTION 9

Cost analysis-Capacity- Production rate- System rate- System cost analysis- Corporate models- Production analysis and production using fuel inventories- Input-output analysis- Economics- Tariffs.

Total: 45

TEXT BOOKS

1. Jerrold H.Krentz; "Energy Conservation and Utilisation", Allyn and Bacur Inc., 1976.
2. Gemand M.Gramlay; "Energy", Macmillon Publishing Co., New York, 1975.

REFERENCES

1. Rused C.K., "Elements of Energy Conservation", McGraw-Hill Book Co., 1985.
2. Judson King; "Separation Processes", McGraw-Hill Book Co., 1985.

CH1305 – ENVIRONMENTAL ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

LIST OF EXPERIMENTS

1. Sampling and preservation methods and significance of characterization of Water and Wastewater.
2. Determination of
 - a. PH and turbidity
 - b. Hardness
3. Determination of Iron & Fluoride
4. Determination of residual Chlorine
5. Determination of Chlorides
6. Determination of Ammonia / Nitrogen
7. Determination of Sulphate
8. Determination of Optimum Coagulant Dosage
9. Determination of available Chlorine in Bleaching powder
10. Determination of dissolved Oxygen, TDS
11. Determination of suspended, volatile and fixed Solids
12. B.O.D test
13. C.O.D test
14. Introduction to Bacteriological Analysis (Demonstration only)

Total: 45

CH1306 – TECHNICAL ANALYSIS LABORATORY

L	T	P	C
0	0	3	2

LIST OF EXPERIMENTS

- Oil Analysis: (3 experiments)
 - Acid value
 - Saponification value
 - Iodine value
- Soap Analysis: (2 experiments)
 - Alkali Content
 - Fatty acid content of Soap
- Estimation of purity of glycerol: by Dichromatic method
- Analysis of water:
Determination chlorine demand in water: Estimation of residual chlorine in water by volumetric method
- Cement Analysis (3 experiments)
 - Estimation of silica content
 - Estimation of calcium oxide content
 - Estimation of mixed oxide content
- Fertilizer Analysis:

Estimation of Nitrozen in Urea by Kjeldals method

*** Minimum 10 experiments shall be offered**

Total: 45

HS1301 – COMMUNICATION AND SOFT SKILLS LABORATORY

L	T	P	C
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Common to All Branches of III Year B.E./ B.Tech students of Anna University Tiruchirappalli and affiliated colleges)

The aim of the course is two-fold: to enable the students to develop communication skills in the language laboratory and to arrange discussions for developing soft skills in the lab and/or the classroom. Each lab session shall last for three periods.

List of activities that are to be carried out: (15 sessions x 3 periods = 45)

Lab session # 1: Listening and speaking practice exercises with communicative functions. Learning material: the ACD of Spoken English: A Foundation Course for Speakers of Indian Languages (Orient Longman, 2008)

Lab session # 2: Practice with more advanced communicative functions. Learning material: the ACD of Spoken English: A Foundation Course for Speakers of Indian Languages (Orient Longman, 2008)

Lab session # 3: Pronunciation exercises with Oxford Advanced Learners' Dictionary of Current English or any other standard Dictionary

Lab session # 4: Making an oral presentation in English. Learning Material: Professional Presentations VCD (Cambridge University Press)

Lab session # 5: Listening to telephone conversations in English and completing the tasks. Learning material: Essential Telephoning in English ACD (Cambridge University Press)

Lab session # 6: Giving an exposure to and practice with model group discussion and interviews. Learning material: How to Prepare for Group Discussion and Interview Audio Cassette (McGraw-Hill)

Lab session # 7: Giving insights into the format and the task types in the IELTS (International English Language Testing System). Learning Material: Objective IELTS, Intermediate Level (CUP)

Lab session # 8: Understanding the format and the task types in the TOEFL (Test of English as a Foreign Language). Learning Material: Understanding the TOEFL (Educational Testing Services, Princeton)

Lab session # 9: Administering the BEC (Business English Certificate) Diagnostic Test. Learning Material: BEC Practice Materials (British Council, Chennai)

Lab session # 10: Completing the steps involved in Career, Life Planning and Change Management. Learning Material: Developing Soft Skills (Pearson Education)

Lab session # 11: Setting goals and objectives exercises. Learning Material: Developing Soft Skills (Pearson Education)

Lab session # 12: Prioritizing and time planning exercises. Learning Material: Managing Time Multimedia Program CD

Lab session # 13: Taking a Personality Typing/ Psychometric Test Learning Material: 200 Psychometric Test prepared by the CUIC, Anna University Chennai

Lab session # 14: Critical and creative thinking exercises.

Lab session # 15: Improving body language and cross-cultural communication with pictures. Learning material: Body Language (S. Chand and Co.)

For a detailed plan, refer to the topics given below;

UNIT I LISTENING AND SPEAKING PRACTICE IN COMMUNICATIVE FUNCTIONS

Introductions and meetings – Talking about studies and/ or job – Expressing likes and dislikes – Describing daily routines and current activities – Talking about past states and events – Talking about future plans and intentions – Expressing preferences – Giving reasons – Expressing opinions, agreement and disagreement – Seeking and giving advice – Making suggestions

UNIT II SPEAKING APPLICATIONS

Making an oral presentation – Preparing the presentation – Performing the presentation – Beginning – Language – Visual aids and body language – Voice – Ending – Questions – Telephone conversations – Group Discussion and Interview

UNIT III UNDERSTANDING AND PREPARING FOR INTERNATIONAL ENGLISH LANGUAGE EXAMINATIONS

Graded Examinations in Spoken English (GESE) – Spoken English for Work (SEW) – International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Business English Certificate (BEC)

UNIT IV SOFT SKILLS (1)

Preparing for and dealing with change – Motivation, goal-setting and self-esteem – Managing time and stress – Career and life planning – Team work – Leadership traits

UNIT V SOFT SKILLS (2)

Multiple Intelligences – Learning Styles and Personality typing – Critical and creative thinking – People, cultures and self – Intercultural Communication

RESOURCES

Kamalesh Sadanand and Susheela Punitha, “**Spoken English: A Foundation Course**” for Speakers of Indian Languages, Part 2 Audio CD, Hyderabad: Orient Longman, 2008

Malcome Goodale, “**Professional Presentations**”, (VCD) New Delhi: Cambridge University Press, 2005

Barbara Garside and Tony Garside, **Essential Telephoning in English** (Audio CD), Cambridge: Cambridge University Press, 2002

Hari Mohan Prasad and Rajnish Mohan, **How to Prepare for Group Discussion and Interview** (Audio Cassette) Tata McGraw-Hill Publishing

Graded Examinations in Spoken English and **Spoken English for Work** downloadable materials from Trinity College, London

International English Language Testing System Practice Tests, CUP

Business English Certificate Materials, Cambridge University Press

Personality Development (CD-ROM), Times Multimedia, Mumbai

Interactive Multimedia Programs on **Managing Time and Stress**

Robert M. Sherfield and et al “**Developing Soft Skills**” 4th edition, New Delhi: Pearson Education, 2009

SEMESTER VI

GE1351 – PROFESSIONAL ETHICS AND HUMAN VALUES

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3	0	0	3

UNIT I HUMAN VALUES 9

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - Variety of moral issued - Types of inquiry - Moral dilemmas - Moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy – Models of Professional Roles - Theories about right action - Self-interest - Customs and religion - Uses of ethical theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - Engineers as responsible experimenters - Codes of ethics - A balanced outlook on law - The challenger case study.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - Assessment of safety and risk - Risk benefit analysis and reducing risk - The three Mile Island and Chernobyl case studies- 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 - Environmental ethics - Computer ethics - Weapons development - Engineers as managers-Consulting engineers-Engineers as expert witnesses and advisors -Moral leadership-Sample code of Ethics (Specific to a particular Engineering Discipline).

Total: 45

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, “Ethics in engineering”, McGraw-Hill, New York 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “ Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES

1. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

CH1351 – APPLIED CHEMICAL THERMODYNAMICS

L T P C
3 0 0 3

UNIT I PROPERTIES OF SOLUTIONS 8

Partial molar properties- Ideal and non-ideal solutions- Standard states- Definition and choice- Gibbs-Duhem equation-Excess properties of mixtures.

UNIT II PHASE EQUILIBRIA 10

Criteria for equilibrium between phases in multi component, non-reacting systems in terms of chemical potential and fugacity- Application of phase rule- Vapor-Liquid equilibrium- Phase diagrams for homogeneous systems and for systems with a miscibility gap- Effect of temperature and pressure on Azeotrope composition- Liquid-Liquid equilibrium- Ternary Liquid-Liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 10

Activity coefficient-Composition models-Thermodynamic consistency of phase equilibria- Application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV CHEMICAL REACTION EQUILIBRIA 10

Definition of standard state-Standard free energy change and reaction equilibrium constant- Evaluation of reaction equilibrium constant-Prediction of free energy data- Equilibria in chemical reactors- Calculation of equilibrium compositions for homogeneous chemical reactors- Thermodynamic analysis of simultaneous reactions.

UNIT V REFRIGERATION & POWER PLANT OPERATIONS 7

Principles of refrigeration- Methods of producing refrigeration- Liquefaction process- Co-efficient of performance- Evaluation of the performance of vapor compression and gas refrigeration cycles – Vapor absorption refrigeration- Power plant thermodynamics- The Carnot vapor cycle – Rankine cycle – Cogeneration – Second law analysis of vapor power cycles.

Total: 45

TEXT BOOKS

1. Smith, J.M., Van Ness, H.C., “Introduction to Chemical Engineering Thermodynamics”, Kogakushai 1976.
2. Kyle, B.G., “Chemical and Process Thermodynamics 2nd edn.”, Prentice Hall of India Pvt. Ltd., 1990.

REFERENCES

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

CH1352 – HEAT TRANSFER OPERATIONS

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3	0	0	3

UNIT I BASIC CONCEPTS AND CONDUCTIVE HEAT TRANSFER 9

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Mean temperature difference-Concept of heat conduction - Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere - Heat conduction through a series of resistances - Analogy between flow of heat and flow of electricity - Effect of temperature on thermal conductivity- Conduction through liquids- Individual and overall heat transfer coefficients and the relationship between them - Transient heat conduction.

UNIT II CONVECTION 9

Concept of heat transfer by convection - Natural and forced convection - Application of dimensional analysis for convection - Equations for forced convection under laminar, transition and turbulent conditions - Equations for natural convection - Heat transfer from condensing vapors- Heat transfer to boiling liquids - Influence of boundary layer on heat transfer - Heat transfer to molten metals - Heat transfer in packed and fluidized beds.

UNIT III RADIATION 9

Concept of thermal radiations - Black body concept - Stefan Boltzman's law - Emissive power - Black body radiation – Emissivity - Plank's Law - Radiation between black surfaces - Gray surfaces - Radiation Shields - Radiation Applications

UNIT IV HEAT EXCHANGERS 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 and Wilson's plot - Design of various types of heat exchangers - Design of condensers.

UNIT V EVAPORATION 9

Types of evaporation - Single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation- Boiling Point Elevation - Effect of Liquid Head - Capacity and Economy of multiple effect evaporators - Evaporation Equipments.

Total: 45

TEXT BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill Recent Edn.
2. Binay K.Dutta "Heat Transfer Principles and Applications", Prentice Hall of India, 2001.

REFERENCES

1. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Vol. I., Pergamon and ECBS, 1970.
2. Kern, D.Q., "Process Heat Transfer", McGraw-Hill - Revised edition - 1999.
3. Hollman, "Heat Transfer", 8th Edn, McGraw Hill, NewDelhi, 1997.

CH1354 – PRINCIPLES OF CHEMICAL KINETICS

L	T	P	C
3	0	0	3

UNIT I REACTION KINETICS 9

Law of mass action-Rate equation-Elementary, non-elementary reactions and their mechanisms-Theories of reaction rate and temperature dependency-Analysis of experimental reactor data-Evaluation of rate equation- Integral and differential analysis for constant variable volume system-Fitting of data complex reaction mechanism.

UNIT II IDEAL REACTORS 9

Design for homogeneous systems- Batch, stirred tank and tubular flow reactor-Design of reactors for multiple reactions-Combination reactor system-Size comparison of reactors.

UNIT III CHOICE OF REACTORS 9

Factors affecting choice, optimum yield and conversion- Selectivity, reactivity and yield problems-Consecutive, parallel and mixed reactions- Recycle.

UNIT IV HEAT EFFECTS IN REACTORS & REACTOR STABILITY 9

Isothermal and Non isothermal homogeneous reactor systems- Adiabatic reactors- Rates of heat exchanges for different reactors- Design for constant rate heat input and constant heat transfer coefficient- Operation- Batch and continuous reactors- Optimum temperature progression- Criteria for stability of reactors-Limit cycles and oscillating reaction- Parameter sensitivity.

UNIT V REACTION EQUILIBRIA 9

Equilibrium in chemically reactive systems- Evaluation of reaction equilibrium constant-Effect of temperature on equilibrium-Application to system involving gaseous components- Computation of equilibrium composition.

Total: 45

TEXT BOOKS

1. Levenspiel.O, "Chemical Reaction Engineering", John Wiley, Second Edition, 1972.
2. Smith.J.M., "Chemical Engineering Kinetics", McGraw-Hill Third Edition, 1981.

REFERENCES

1. W. Fogler "Chemical Reaction Engineering", 3rd Edn., Prentice Hall of India, New Delhi, 1999.
2. S.D.Dawande, "Principles of Reaction Engineering", 1st Edn., Central Techno Publications,2001.
3. J.F. Richardson & D.G.Peacock, "Coulson Richardson, Chemical Engineering." Vol-3, 3rd Edn., Asian Books (P)Ltd

CH1355 – PROCESS DYNAMICS AND CONTROL

L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Laplace transformation- Transform of standard functions-Derivatives and integrals- Inversion-Theorems in Laplace transformation-Application-Open-loop systems.

UNIT II FIRST ORDER & HIGHER ORDER SYSTEMS 9

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- Transfer function for chemical reactors and dynamics.

UNIT III CLOSED LOOP CONTROL SYSTEMS 9

Closed loop control systems- Development of block diagram for feed-back control systems- Servo and regulator problems- Transfer function for controllers and final control element- Principles of pneumatic and electronic controllers-Transportation lag- 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- Bode diagram-Stability criterion- Tuning of controller settings.

UNIT V SPECIAL CONTROLS 9

Controller mechanism-Introduction to advanced control systems- Cascade control- Feed forward control- Control of distillation towers and heat exchangers- Introduction to microprocessors and computer control of chemical processes- Supervisory control.

Total: 45

TEXT BOOKS

1. Coughnowr and Koppel, "Process Systems Analysis and Control", McGraw-Hill, New York, 1986.
2. George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 1990.

REFERENCES

1. Thomas, E.Marlin, Process Control, 2nd Edn, McGraw-Hills International Edn. 2000.
2. Norman H.CEAGLSKE, Automatic process control for chemical engineers, John Wiley & Sons, Japan.
3. Patranabis.D, Principles of Process control, II edition, Tata McGraw-Hill Publishing Co. Ltd., 1981.
4. Peter Harriott, Processcontrol, Tata McGraw-Hill Publishing Co., Reprint 2004.

CH1356 – HEAT TRANSFER LABORATORY

L	T	P	C
0	0	3	2

1. Laminar Flow
2. Condenser (Vertical)
3. Condenser (Horizontal)
4. Convective Heat Transfer
5. Transient Heat Conduction
6. Agitated vessel
7. Natural Convection
8. Jacketed Kettle
9. Calculation of Graetz Number
10. Open Pan Evaporator
11. Temperature Control Loop
12. Characteristics of Temperature Measuring Device

Total: 45

CH1357 – CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING I

L T P C
0 0 3 2

UNIT I DESIGN OF PIPE FITTINGS & JOINTS 9

Design and drawing- Considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements- Pipe fittings.

UNIT II DESIGN OF REACTION VESSEL & STORAGE TANK 9

Design and drawing considerations of vessel supports such as bracket, saddle, skirt, etc-Storage Tanks for solids, liquids and gases.

UNIT III DESIGN OF HIGH PRESSURE SYSTEM 9

General design and drawing consideration of vessels subjected to internal pressure and external pressure-High pressure vessels.

UNIT IV DESIGN OF PHASE SEPARATION EQUIPMENT 9

Fundamental principles- Equations- general design and drawing considerations of cyclone separators centrifuges-Thickeners and filtration equipments.

UNIT V DESIGN OF CRYSTALLIZERS & HEATED VESSELS 9

General design and drawing considerations of crystallizers, agitated vessel, jacketed and coil heated vessels.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. R.S. Khurmi, "Machine design".
2. M.V. Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.

REFERENCES

1. S.D. Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
4. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operation of Chemical Engineering", McGraw-Hill, 2001.
5. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.
6. J.M. Coulson and J.Richardson, "Chemical Engineering", Vol. 6, Asian Books Printers Ltd.

NOTE

- Data book prepared by the faculty in charge and Perry's handbook can be allowed.

CH1358 – PROCESS CONTROL AND SIMULATION LABORATORY

L	T	P	C
0	0	3	2

1. ON-OFF control of thermal process
2. Simulation of Proportional Controller
3. Flow control loop and Flow Transmitter
4. Level Control loop and Level Transmitter
5. Pressure control loop and Pressure Transmitter
6. Control valve characteristics
7. Verifying the inherent characteristics of control valve
8. Flow co-efficient of control valve
9. Range ability of control valve
10. Verifying the response of Non-Interacting level System
11. Verifying the response of Interacting level System
12. Effect of PI controller on flow control System
13. The effect of a P controller on level process for set point and load changes
14. Effect of P, PI, PID Controller on Pressure Control Loop
15. Optimum controller setting using Zigler's Nichols Methods
16. Optimum Controller Tuning on Level Process Station

Total: 45

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

SEMESTER VII
CH1401 – TRANSPORT PHENOMENA

L T P C
3 1 0 4

UNIT I PHILOSOPHY AND FUNDAMENTALS OF TRANSPORT PHENOMENA 9

Importance of transport phenomena- Analogous nature of transfer process- Basic concepts- Conservation laws- Continuous concept- Field, reference frames, substantial derivative and boundary conditions- Methods of analysis- Differential, integral and experimental methods- Phenomenological laws of transport properties Newtonian and non Newtonian fluids- Rheological models- Theories of transport properties of gases and liquids- Effect of pressure and temperature.

UNIT II ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 9

General method of shell balance approach to transfer problems- Choosing the shape of the shell- Most common boundary conditions- Momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical- Forced and free convection- Mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT III EQUATIONS OF CHANGE AND THEIR APPLICATIONS 9

Conservation laws and equations of change-Development of equations of continuity motion and energy in single multicomponents systems in rectangular co-ordinates and the forms in curvilinear co-ordinates- Simplified forms of equations for special cases- Solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change-Scale factors- Applications in scale-up

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulent phenomena-Phenomenological relations for transfer fluxes- Time smoothed equations of change and their applications for turbulent flow in pipes-Boundary layer theory- Laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses- Analysis of flow over flat surface.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9

Importance of analogy-Development and applications of analogies between momentum and mass transfer- Reynolds, Prandtl, Von Karman and Colbum analogies.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. R.B. Bird, W.E. Stewart and E.W. Lighfoot, "Transport Phenomena", John Wiley, 1978
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn. 1988.

REFERENCES

1. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973.

CH1402 – MASS TRANSFER OPERATIONS

L	T	P	C
4	0	0	4

UNIT I **ABSORPTION** 12

Equilibrium and operating line concept in absorption calculations-Types of contactors- Design of packed and plate type absorbers-Operating characteristics of stage wise and differential contactors- Concepts of NTU, HTU and overall volumetric mass transfer coefficients- multicomponent absorption- Mechanism and model of absorption with chemical reaction- Thermal effects in absorption process.

UNIT II **DISTILLATION** 12

Vapour-liquid equilibria-Raoult's law and deviations from ideality- Methods of distillation- Fractionation of binary and multicomponent system- Design calculations by McCabe-Thiele and Ponchon-Savarit methods- Continuous contact distillation tower (packed tower) design- Extractive and azeotropic distillation -Low pressure distillation- Steam distillation.

UNIT III **LIQUID-LIQUID EXTRACTION** 12

Equilibrium in ternary systems- Equilibrium stage wise contact calculations for batch and continuous extractors-Differential contact extraction equipment - Spray, packed and mechanically agitated contactors and their design calculations- Pulsed extractors- Centrifugal extractors.

UNIT IV **SOLID-LIQUID EXTRACTION (LEACHING)** 12

Solid-liquid equilibria- Leaching equipment-Batch and continuous types- Calculation of number of stages.

UNIT V **ADSORPTION & OTHER SEPARATION PROCESSES** 12

Adsorption – Nature of adsorptions – Adsorption Isotherm – Design of Adsorption - Membrane separation process- Solid and liquid membranes- Concept of osmosis-Reverse osmosis- Electro dialysis- Their applications-Foam separation process- Thermal and sweep diffusion process.

Total: 60

TEXT BOOKS

1. R.E.Treybal, “Mass Transfer Operations”, McGraw-Hill, 1980.
2. M.Coulson & J.F. Richardson, “Chemical Engg.”, Vol-II, 3rd Edn., Pergamon Press, New York, 1987.

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. P.Wankat “Equilibrium Stage Separations”, Prentice Hall, 1993.

CH1403 – CHEMICAL REACTION ENGINEERING

L	T	P	C
4	0	0	4

UNIT I NON-IDEAL REACTORS 12

The residence time distribution as a factor performance- Residence time functions and relationship between them in reactor- Basic models for non-ideal flow- Conversion in non-ideal reactors.

UNIT II HETEROGENEOUS PROCESS AND SOLID CATALYSIS 12

Rate equations for heterogeneous reactions nature of catalysis-Adsorption isothermal and rates of adsorption- Desorption and surface reaction analysis of rate equation and rate controlling steps- Surface area and pore-volume distribution- Catalyst preparation.

UNIT III GAS-SOLID CATALYTIC REACTORS 12

Diffusion within catalyst particle effective thermal conductivity mass and heat transfer within catalyst pellets; effective factors, Thiele Modulus, fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 12

Models for explaining the kinetics-Volume and surface models- Controlling resistances and rate controlling steps- Time for complete conversion for single and mixed sizes- Fluidized and static reactors.

UNIT V GAS-LIQUID REACTIONS 12

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

Total: 60

TEXT BOOKS

1. Fogler. H.S., "Elements of Chemical reaction engineering" 3rd edition, Prentice Hall of India Pvt. Ltd., 1999 (Indians Reprint 2003)
2. Levenspiel, O; "Chemical Reaction Engineering", 2nd Edition, John Wiley, 1972.

REFERENCES

1. Smith J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw-Hill, New York, 1981.
2. Heinrich, H.W. Dan Peterson, P.E. and Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
3. Blake, R.P., Industrial Safety, Prentice Hall Inc., New Jersey – 3rd Edn. 1963.

CH1404 – WATER TREATMENT AND MANAGEMENT

L	T	P	C
4	0	0	4

UNIT I INTERNAL TREATMENT PROCESS 12

Character and properties – Water problem and solution – Water Sedimentation - Coagulation – Filtration – Disinfection – Theory, necessity, process, equipment, application, location, limitation.

UNIT II EXTERNAL TREATMENT PROCESS 12

Softening by Ion – exchange process, Demineralization – Cation exchange materials – Removal of ion, Manganese, odour, colour taste – Deaeration – Oxidation – Fluoridation – Dealkalisation – Desalination by Reverse osmosis.

UNIT III BOILER WATER AND COOLING WATER 12

Concept – Importance – Location – Commonly used desalination process – Distillation – Electrodialysis – Reverse osmosis – Freezing – Solar distillation- Purpose – Problem associated with water quality and equipment – Steam system fundamentals – Hot water closed system – Measurement and control of pH, corrosion, fouling – Microbial analysis – Ozone control – Study of microorganism – Energy efficient operations and maintenance.

UNIT IV WASTE WATER TREATMENT 12

Waste water in Industry- Home and Agriculture – Various waste water treatment processes – Optimization – Benefits and costs – Microbial and sanitation water treatment – Biofilm formation and removal – Microbial trend analysis – Pretreatment system and equipment.

UNIT V WATER MANAGEMENT IN INDIA 12

Water resources and planning – Water policy – Indian scene – Main aspects of water management – Hydrological cycle – Hydrosphere – Water transport – Water exchange – Causes and problems in irrigation, rural water, urban water – Water conservation resource management – Rain Harvesting.

Total: 60

TEXT BOOKS

1. P.C.Bansil “Water Management in India”, Concept Publishing company, New Delhi, First Edition, 2004.
2. G.S.Bridie and J.S.Bridie “Water Supply and Sanitary Engineering”, Dhanpat Raj Publishing company (P) Ltd., New Delhi, 7th Edition, 2003.

REFERENCES

1. Austin G.T., “Shreve’s Chemical Process Industries”, Fifth Edition, McGraw Hill, 1998.
2. S.C. Rangwala, “Water supply and Sanitary Engineering”, Eighteenth Edition, Charotar Publishing House, 2003.
3. Pandey G.N., “Text Book of Chemical Technology”, Vikas Publishing House Pvt. Ltd., New Delhi, 1992.

CH1405 – PROCESS UTILITIES

L	T	P	C
3	0	0	3

UNIT I WATER 9

Water resources- Treatment and cooling- Storage and distribution of water- Reuse and conservation of water.

UNIT II COMPRESSED AIR & VACUUM 9

Compressors and vacuum pumps – Performance characteristics of compressors and vacuum pumps – Boosters – Air receivers – Piping systems – Air leaks – Lubricating oil and moisture removal.

UNIT III REFRIGERATION 9

Refrigeration systems and their characteristics – Production of cryogenic temperatures.

UNIT IV AIR CONDITIONING & VENTILATION 9

Characteristics of Air –water systems - Humidification and Dehumidification equipment – Exhaust ventilation.

UNIT V STEAM 9

Steam generation in chemical process plants – Problems of steam boiler and power generation equipment – Steam engines and turbines – Steam handling and distribution of steam economy – Electric power distribution in process plants.

Total: 45

TEXT BOOKS

1. Bhasin, S.D, “Project Engineering of Process Plants”, Chemical Engineering Education
2. Development Centre, I.I.T., Madras, (1979)
3. Davidson,P.J.& West, T.F, “ Services for the chemical industry” , Pergamon press, Oxford, (1968)

REFERENCES

1. R.S.Kumar & J.K.Gupta, “ A Text Book of Refrigeration & Air Conditioning “ , S.Chand & Co., 1987.
2. Cremer, H.W. & Davis (Editors), “hemical Engineering Practice”, Vol.10., Butterworths, London, (1960).
3. “Process utilities” , Chemical Engineering Development centre, I.I.T., Madras, (1968)

CH1406 – MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	2

1. Simple distillation
2. Steam distillation
3. Packed column distillation
4. Bubble cap distillation
5. Diffusivity measurements
6. Liquid-liquid extraction
7. Vacuum Dryer
8. Tray dryer
9. Rotary dryer
10. Surface Evaporation
11. Stage wise Leaching
12. Vapor-Liquid Equilibrium
13. Ternary Liquid
14. Sublimation of Naphthalene
15. Wetted Wall Column

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

Total: 45

CH1410 – CHEMICAL REACTION ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

1. Kinetic studies in a batch reactor
2. Kinetics in a plug flow reactor
3. Kinetics in a PFR followed by a CSTR
4. RTD in a PFR
5. RTD in a packed bed
6. RTD in CSTRs in series

Total: 45

CH1411 – CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING II

L	T	P	C
0	0	3	2

(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted for the students during the Examination.)

UNIT I DESIGN OF COOLING TOWER, EVAPORATORS, DRIERS 9

Fundamental principles- Equations - General design and drawing considerations of cooling towers, evaporators and driers.

UNIT II DESIGN OF HEATEXCHANGER 9

Heat exchangers, condensers and reboilers.

UNIT III DESIGN OF DISTILLATION COLUMN 9

Distillation columns- sieve tray, and bubble cap tray columns and packed column.

UNIT IV DESIGN OF ABSORPTION & ADSORPTION 9

Equipments for absorption and adsorption of gases.

UNIT V DESIGN OF EXTRACTION 9

Equipments for liquid-liquid extraction and solid-liquid extraction.

Total :45

TEXT BOOKS

1. M.V.Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.
2. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.

REFERENCES

1. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
2. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
3. W.L.McCabe, J.C.Smith and Harriet, "Unit Operation of Chemical Engineering", McGraw-Hill.
4. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.
5. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.

SEMESTER VIII

MG1301 – TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION

9

Definition of quality – Dimensions of quality – Quality planning – Quality costs – Analysis techniques for quality costs – Basic concepts of total quality management – Historical review – Principles of TQM – Leadership – Concepts – Role of senior management – Quality council, quality statements – Strategic planning – Deming philosophy – Barriers to TQM implementation.

UNIT II TQM PRINCIPLES

9

Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation – Empowerment – Teams – Recognition and reward – Performance appraisal – Benefits, continuous process improvement – Juran trilogy – PDSA cycle – 5S, kaizen – Supplier partnership – Partnering, sourcing – Supplier selection – supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure.

UNIT III STATISTICAL PROCESS CONTROL (SPC)

9

The seven tools of quality, statistical fundamentals – Measures of central tendency and dispersion, population and sample, normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.

UNIT IV TQM TOOLS

9

Benchmarking – Reasons to benchmark – Benchmarking process – Quality function deployment (QFD) – House of quality, QFD process – Benefits, taguchi quality loss function – Total productive maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS

9

Need for ISO 9000 and other quality systems, ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation, quality auditing – QS 9000, ISO 14000 – Concept, requirements and benefits.

Total: 45

TEXT BOOKS

1. Besterfield, D.H., “Total Quality Management”, Prentice Hall of India Pvt. Ltd., 3rd Edition, 2007.
2. Kanishka Bedi, “Quality Management”, Oxford Press, 2006.

REFERENCES

1. Shridhara Bhat, K., “Total Quality Management”, Himalaya Publishing House, 1st Edition, 2002.
2. Lal, H., “Total Quality Management – A Practical Approach”, New Age International Publishers, 2004.
3. Nagarajan, R.S., “Total Quality Management”, New Age International Publishers, 2005.

MG1453 – SAFETY AND RISK MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I INDUSTRIAL SAFETY 9

Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam.

UNIT II HAZARD IDENTIFICATION AND CONTROL 9

HAZOP, job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Plant inspection – Past accident analysis.

UNIT III RISK MANAGEMENT 9

Overall risk analysis – Chapains model, E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

UNIT IV SAFETY PROCEDURES 9

Safety in plant design and layout – Safety provisions in the factory act 1948 – Indian explosive act 1884 – ESI act 1948 – Advantages of adopting safety laws.

UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS 9

Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

Total: 45

TEXT BOOKS

1. Blake, R.P., “Industrial Safety”, Prentice Hall, 1953.
2. Lees, F.P., “Loss Prevention in Process Industries”, 2nd Edition, Butterworth Heinemann, 1996.

REFERENCES

1. Geoff Wells, “Hazard Identification and Risk Assessment”, I.ChE.
2. John Ridley and John Channing, “Safety at Work”, 6th Edition. Butterworth-Heinemann, 2003.
3. Raghavan, K.V. and Khan, A.A., “Methodologies in Hazard Identification and Risk Assessment”, Manual by CLRI, 1990.

CH1455 – PROJECT WORK

L	T	P	C
0	0	12	6

The project may be considered as the ultimate exercise presented to the final semester student before graduation to measure accumulated engineering knowledge and experience. At the same time, the project itself should provide the students with some new skills and information, and strengthen acquired ones.

The project programme consists of different assignment, allotted time, submission of report under internal faculty guidance and evaluation by external member along with internal faculty.

The activities performed during a project may cover one or more of the following;

Data collection

Critical literature review

Laboratory experience and tests

Mathematical modeling

Software application

Industrial visits

Design and/or assembly

Process analysis

The mini and major project may be assigned to a group of two or three students. The project topic allotted may be of theoretical, experimental or industrial projects to be carried out under the supervision of a internal and external suites (in case of industrial projects). The same topic may be done as phase-I as mini project and its continuous Phase-II as Major project work or different topic may be taken as mini and major project work.

Both mini and major projects are to be executed strictly as per the project schedule prepared during VII & VIII semesters. A committee of departmental faculty members comprising the project guide, one more faculty member and the head of department will monitor and review the progress achieved by the student at various stages. The internal assessment will be done by the committee based on the progress achieved on completion of the project work, each student has to prepare a project report and submit the same in triplicate to the department.

Extension and completion of project work started in the previous semester. On completion of the project work, each student has to prepare a project report and submit the same to the department. In the Phase II, the project work and the report will be evaluated by the internal assessment committee for a total of 50 marks. The external university examination, which carries a total of 100 marks, will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner appointed by the university

Total: 45

PC1008 – PETROCHEMICAL TECHNOLOGY

L T P C
3 0 0 3

UNIT I PETROCHEMICAL PRECURSORS 10

Principal raw materials and their sources-Petrochemical precursors and their production methods - Methane synthesis gas - Ethane, ethylene, acetylene, propane - Propylene, butane, butylenes, pentane and pentene -Benzene, toluene - Xylene – Naphthalene

UNIT II CHEMICALS FROM C₁ 6

Ammonia- Oxo products - Methanol – Formaldehyde- Chlorinated methanes- Carbon disulphide- Hydrogen cyanide.

UNIT III CHEMICALS FROM C₂ 12

Synthetic ethanol- Acetaldehyde and acetic acid-Vinyl acetate- Butraldehyde-2-ethyl hexanol and dop- Ethylene oxide- Ethylene glycols- Acrylonitrile- Poly ethers- Ethanolamines- Ethylchloride- Ethylene dichloride-Vinyl chloride- Ethylbenzene-Styrene.

UNIT IV CHEMICALS FROM C₃ & C₄ 12

Isopropanol- Acetone- Glycerol- Propylene oxide- Propylene glycols- Polyethers- Acetylchloride; Epichlorohydrine- Isopropane- Cumene- Butadiene- Butane epoxides and butanolamines, butanol- Butyl acetate- Methyl ethyl ketone- Isoprene- Amyl alcohol.

UNIT V CHEMICALS FROM AROMATICS 15

Monochloro and dichlorobenzene- BHC- Nitrobenzene- Phenol- Aniline- Dodecyl benzene- Benzaldehyde- Benzoic acid- Nitrotoluene- Toluene diamines and toluene disocyanate- Phthalic anhydride- Isophathalic acid- Terephthalic acid and Dimethyl terephthalic- Maleic anhydride- Caprolactum-Adipic acid- Hexamethylene, diamine

Total: 45

TEXT BOOKS

1. B.K.Bhaskara Rao, "A Text on Petrochemicals", Khanna Publishers, New Delhi,2000.
2. Sukumar Maiti, "Indroduction to Petrochemicals", 2nd Edn., Oxford & IBH Publishers, New Delhi, 2002.

REFERENCES

1. Hahn, A.V.G.; " The Petrochemical Industry ", McGraw Hill, 1970.
2. Waddams, A.L.; " Chemicals from Petroleum ", Chemical Publishing Co., 1969.
3. Popchiev, A.V.; Naigyev M.F.; Shakhakhtinskii T.N.; "Synthetic Materials from Petroleum Pergamon Press, London, 1963.

CH1002 – INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I PERSONNEL MANAGEMENT 9

Principles and functions – Handling union – Negotiation process – Labour legislation in India – Managerial decision making process, tools and techniques – Role of employee through empowerment – Industrial management program – Public relation.

UNIT II TQM TOOLS AND TECHNIQUES 9

Bench marking process – Concept, reason, application – Quality function deployment and its benefits – Study of manufacturing costs and techniques for financial control – Tools and techniques for six sigma philosophy – Tacuchi law functions – Statistical process control.

UNIT III QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEMS 9

Philosophy of total quality management – ISO registration procedure and benefits – Concepts of ISO 9000, 14000, 18000 standards – Internal quality audit – Quality improvement and customer satisfaction – Importance of documentation procedure – Plant safety and industrial hygiene.

UNIT IV ENGINEERING ECONOMICS 9

Micro and macro economics – Accounting procedures and preparation of financial statements – Principles of lean manufacturing philosophy – Study of global market – Methods to overcome competitiveness.

UNIT V PROCESS ECONOMICS 9

Amortisation – Capital recovery – Depreciation – Economics of selecting alternatives – Rate of return and payout time – Budgeting – Operation management – Strategic analysis – Problem solving techniques – Preparation of technical reports – Process Improvement.

Total: 45

TEXT BOOKS

1. Peters and Timmer haus, “Plant Design and Economics for Chemical Engineering”, 4th Edition, McGraw Hill Book Co., 1991.
2. Arun Monappa and Mirza S. Saiyadain, “Personnel Management”, 2nd Edition, Tata McGraw – Hill Publishing Company Ltd.

REFERENCES

1. Kermath Case, J.A. and David prat., “ Principle of Engineering Economics”, 4th Edition, John - Wiley publishers, 1997.
2. Schwyer H.E., “Process Engineering Economics”, 1st Edition, McGraw Hill Book Co., 1962.
3. Shridharan Bhat,K., “ Total Quality Management”, 1st Edition, Himalaya Publishing house, 2002.

CH1003 – PROCESS INTEGRATION AND PINCH TECHNOLOGY

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3	0	0	3

UNIT I PINCH TECHNOLOGY 9

Basic concepts of Pinch Technology – Stream Networks - Locating the pinch- Significance of pinch – Selection of pinch Temperature Differences – Tabular Method – Stream Splitting – Process retrofit – Case studies.

UNIT II TARGETING 9

Heat Exchanger Networks, Energy Targeting, Area targeting, unit targeting, shell targeting, cost targeting, continuous targeting.

UNIT III PINCH METHODOLOGY 9

Problem representation- Temperature enthalpy diagram- Simple match matrix- Heat content diagram- Temperature interval diagram, and Heuristic approach & PDM- Weighted flow rate specific heat method (WFCPM)- Tree searching.

UNIT IV PINCH DESIGN AND OPTIMIZATION 9

Networks for maximum energy recovery- Pinch design method- Flexibility criteria of the pinch- Cp table- The tick of the heuristic- Case studies- Optimization of heat exchanger network optimality for a minimum area network-Sensitivity analysis.

UNIT V ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES AND MASS EXCHANGE NETWORK 9

Batch process- Flexible process- Distillation process- Evaporation process- Reaction process- Process using mass separating unit- Heat pipes and heat pumps- MEN network- Waste minimization by using mass separating agents.

Total: 45

TEXT BOOKS

1. V.Udhay Shenoy, “Heat exchanger network synthesis” Gulf publishing Co,USA,1995.
2. D.W.Linnhoff et al., “ User guide on process Integration for the feeicient use of Energy”,Institution of Chemical Engineers,U.K., 1994.

REFERENCES

1. James M.Douglas “Conceptual design of chemical process”,Mc Graw Hill,New york,1198.
2. Anilkumar, “Chemical Process synthesis and engineering Design”, Tata Mcgraw Hill,New delhi,1977.
3. Robin Smith, “Chemical Process Design”, McGraw Hill, International Edition, New york, 1995.

ELECTIVES II

CH1004 – PROCESS MODELLING AND SIMULATIONS

L	T	P	C
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UNIT I BASIC MODELLING 10

Introduction to modeling- Uses of mathematical models- Scope of coverage- Principles of formation- Review on algebraic, ordinary and partial differential equations- Solutions of the above equations- Linearization- Probabilization models- Development of models by experiment and statics- Regression and correlation analysis.

UNIT II MATRIX MODELS 10

Elementary matrix concepts- Simple array models- Multi-component distillation- Dynamic simulation of distillation column- Solution techniques for matrix differential equations- Matrix formation of distributed parameter system- Flow pattern in stirred tanks- Design of mixers.

UNIT III LUMPED PARAMETER MODEL 8

Introduction to lumped parameter system- Mathematical description of multiphase transfer process- Non isothermal reactors etc- Axial dispersion in packed beds- Reactor design from response curves- Reactor effectiveness factor- Computer aided modeling of reaction networks.

UNIT IV DISTRIBUTED PARAMATER MODEL 7

Formation and solution of one dimensional unsteady state problem in heat transfer and mass transfer systems; multidimensional problems; application in heat and mass transfer equipments.

UNIT V OPTIMISATION AND SIMULATIONS 10

Introduction; application; analytical and numerical techniques for multivariable problems; techniques for constrained optimization; simulation; introduction; discrete event and continuous simulation; dynamic simulation of reactors, distillation columns, absorbers, evaporators and crystallizers; simulation in process control.

Total: 45

TEXT BOOKS

1. Ramirez, W.; "Computational Methods in Process Simulation", Butterworths Publishers, New York, 1989.
2. Edgar, T.F.; Himmelblau, D.M.; "Optimisation of Chemical Processes", McGraw-Hill Book Co., New York, 1989, Wiley inter science, New York, 1972.

REFERENCES

1. Luyben, W.L., "Process Modelling Simulation and Control", McGraw-Hill Book Co., 1973.
2. Myers, A.L., Seider, W.D.; "Introduction to Chemical Engineering and Computer Calculations", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
3. Chemical Engineering Refresher Series on "Process Dynamics", McGraw-Hill Publications, 1983.
4. Mickley, H.S.; Sherwood, T.S.; Reed C.E.; "Applied Mathematics for Chemical Engineers", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1989.

CH1007 – FLUIDIZATION ENGINEERING

L T P C
3 0 0 3

UNIT I BASICS OF FLUIDIZATION

9

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES

9

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT III DESIGN ASPECTS

9

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS

9

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT V OTHER TYPES OF FLUIDIZATION

9

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

Total: 45

TEXT BOOKS

1. Levenspiel, “Fluidization Engineering”, 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, “Perry’s Chemical Engineer’s Hand Book”, 7th Edition, Mc Graw Hill – International, 1997.

REFERENCES

1. Rowe and Davidson, “Fluidization”, Academic Press, 1971.
2. Leva, M., “Fluidization”, McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., “Handbook of Fluidization and Fluid-Particle Systems”, Marcel Dekker Inc, 2003.