ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024
Regulations 2007
Curriculum

B.TECH. PETROCHEMICAL TECHNOLOGY

SEMESTER III

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**MA1201**	Mathematics III	3	1	0	100
2	**HS1202**	Organic Chemistry	3	1	0	100
3	**HS1206**	Material Technology	4	0	0	100
4	**CH1201**	Industrial Chemical Technology	4	0	0	100
5	**EE1208**	Electrical Machines and Drives	3	1	0	100
6	**CS1201**	Data Structures	3	1	0	100
Practical						
7	**HS1204**	Organic Chemistry Laboratory	0	0	3	100
8	**EE1209**	Electrical Machines Laboratory	0	0	3	100
9	**CS1204**	Data Structures Laboratory	0	0	3	100

SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**MA1251**	Numerical Methods	3	1	0	100
2	**CH1255**	Physical Chemistry	3	1	0	100
3	**HS1201**	Environmental Science and Engineering	4	0	0	100
4	**CH1252**	Process Calculations	3	1	0	100
5	**CH1203**	Fluid Flow Operations	3	1	0	100
6	**CH1256**	Mechanical Operations	3	1	0	100
Practical						
7	**CH1257**	Physical Chemistry Laboratory	0	0	3	100
8	**CH1258**	Fluid Flow Operations Laboratory	0	0	3	100
9	**CH1259**	Mechanical Operations Laboratory	0	0	3	100

SEMESTER V

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**MA1302**	Special Functions	3	1	0	100
2	**CH1310**	Heat Transfer	4	0	0	100
3	**PC1301**	Mass Transfer Fundamentals	4	0	0	100
4	**ME1309**	Engineering Thermodynamics	4	0	0	100
5	**PC1302**	Natural Gas Engineering	4	0	0	100
6	**PC1303**	Petroleum Exploration and Exploitation Techniques	3	1	0	100
Practical						
7	**CH1311**	Heat Transfer Laboratory	0	0	3	100
8	**PC1304**	Technical Analysis Laboratory	0	0	3	100
9	**HS1301**	Communication and Soft Skills Laboratory	0	0	3	100

SEMESTER VI

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**CH1360**	Process Dynamics and Control	4	0	0	100
2	**CH1361**	Mass Transfer Operations	3	1	0	100
3	**PC1351**	Principles of Chemical Kinetics	4	0	0	100
4	**PC1352**	Equipment Design and Drawing I	2	0	2	100
5	**PC1353**	Petrochemical Unit Processes	4	0	0	100
6	**PC1354**	Petroleum Crude Processing Technology	4	0	0	100
Practical						
7	**PC1355**	Process Dynamics and Control Laboratory	0	0	3	100
8	**PC1356**	Petroleum Physical Properties Testing Laboratory	0	0	3	100
9	**PC1362**	Mass Transfer Laboratory	0	0	3	100

SEMESTER VII

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**PC1401**	Equipment Design and Drawing II	2	0	2	100
2	**PC1402**	Chemical Reaction Engineering	3	1	0	100
3	**PC1403**	Petrochemical Derivatives	4	0	0	100
4	**PC1404**	Petroleum Secondary Processing Technology	4	0	0	100
5	**CH1404**	Water Treatment and Management	4	0	0	100
6	**E1******	Elective I	4	0	0	100
Practical						
7	**PC1405**	Petrochemical Analysis Laboratory	0	0	3	100
8	**PC1406**	Petroleum Product Testing Laboratory	0	0	3	100
9	**PC1407**	Chemical Reaction Engineering Laboratory	0	0	3	100

SEMESTER VIII

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**MG1352**	Total Quality Management	4	0	0	100
2	**MG1453**	Safety and Risk Management	4	0	0	100
3	**E2******	Elective II	4	0	0	100
Practical						
7	**PC1455**	Project Work	0	0	12	100

ELECTIVES FOR VII SEMESTER

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**CH1008**	Process Modelling and Simulation	4	0	0	100
2	**CH1009**	Transport Phenomena	4	0	0	100
3	**PC1001**	Process Instrumentation	4	0	0	100
4	**PC1002**	Fluidization Engineering	4	0	0	100
5	**PC1003**	Petroleum Process Equipment Auxiliaries	4	0	0	100
6	**CH1002**	Industrial Management	4	0	0	100

ELECTIVES FOR VIII SEMESTER

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**CH1004**	Energy Management in Chemical Industries	4	0	0	100
2	**PC1004**	Novel Separation Process	4	0	0	100
3	**CH1001**	Fertilizer Technology	4	0	0	100
4	**PC1005**	Multicomponent Distillation	4	0	0	100
5	**PC1006**	Combustion and Furnace Design	4	0	0	100
6	**PC1007**	Polymer Technology	4	0	0	100

ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024

Regulations 2007

Syllabus

B.TECH. PETROCHEMICAL TECHNOLOGY

SEMESTER III

MA1201 – MATHEMATICS III

	L	T	P
	3	1	0

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT II FOURIER SERIES 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 III BOUNDARY VALUE PROBLEMS 9

Classification of second order Quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

UNIT IV FOURIER TRANSFORM 9

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

UNIT V Z-TRANSFORM AND DIFFERENCE EQUATIONS 9

Z-Transform – 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.

REFERENCES

1. Churchill R.V. and Brown J.W., “Fourier Series and Boundary Value Problems”, Fourth Edition, McGraw-Hill, 1987.
2. Veerarajan T., “Engineering Mathematics III”, Third Edition, Tata McGraw-Hill Education, 2007.
3. Kandasamy P., Thilagavathy K. and Gunavathy K., “Engineering Mathematics”, Vol-III, S. Chand & Company Ltd., 2007.

HS1202 – ORGANIC CHEMISTRY

L	T	P
3	1	0

UNIT I ALIPHATIC HYDROCARBONS AND ALCOHOLS 9

Alkanes – General methods of preparation – Physical and chemical properties – Alkenes – General methods of preparation – Physical and chemical properties – Markovnikov's rule – Peroxide effect – Bayer's test – Alkynes – General methods of preparation and properties monohydric alcohols – Saytzeff rule – Methods of distinguishing the three classes of alcohols – Lucas test – Dichromate test.

UNIT II ALDEHYDES, KETONES AND ACIDS 9

General methods of preparation – Physical and chemical properties – Aldol condensation – Clemmensen reduction – Wolf-Kishner reduction – Haloform reaction – Cannizzaro reaction – Reformatsky reaction – Wittig reaction – Saturated monocarbozylic acids – Methods of preparation – Physical and chemical properties – Hell-Volhard-Zelinsky reaction – Amino acids – Methods of preparation – Physical and chemical properties.

UNIT III CARBOHYDRATES 9

Classification of carbohydrates – Monosaccharides – Reactions of glucose and fructose – Open chain and cyclic structures of glucose and fructose – Mutarotation – Epimerization – Killiani-Fisher synthesis – Ruff degradation – Conversion of aldoses to ketoses and ketoses to aldoses – Disaccharides – Properties and structure of sucrose – Polysaccharides – Properties and structure of starch and cellulose – Derivatives of cellulose – Carboxy methyl cellulose and gun cotton.

UNIT IV AROMATIC HYDROCARBON, AMINE AND DIAZONIUM SALT 9

Benzene – Aromaticity – Huckel rule – General methods of preparation of benzene – Electrophilic substitution reactions – Directive effects of substituents – Aromatic amino compounds – General methods of preparation – Physical and chemical properties – Carbylamines reaction – Aryldiazonium salts – Preparation and synthetic applications.

UNIT V DYES AND DYEING 9

Colour and constitution – Synthesis – Azodyes – Methyl orange – Methyl red and Congo red – Triphenylmethane dyes – Malachite green – Para-rosaniline – Alizarin – Eosin – Introduction to natural and reactive dyes.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Morrison R.T. and Boyd R.N., "Organic chemistry", Sixth Edition, Prentice Hall of India (P) Ltd., 2003.
2. Arun Bahl and Bahl B.S., "Advanced Organic Chemistry", Sixteenth Edition, S.Chand & Company Ltd., 2002.

REFERENCES

1. March J., "March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure", Fifth Edition, John Wiley, 2001.
2. Finar I.L., "Organic chemistry" Vol-I, Sixth Edition, Pearson Education, 2002.
3. Sharma B.K., "Industrial Chemistry", Twelfth Edition, Goel Publishing house, 2001.

HS1206 – MATERIAL TECHNOLOGY

L	T	P
4	0	0

UNIT I NATURE OF MATERIALS 12

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 12

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 ATERIALS 12

Polymeric Materials: Polymerization reactions – Industrial polymerization methods – Crystallinity and stereo-isomerism in same 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 12

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 12

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: 60

TEXT BOOKS

1. ¨Van Vlack L.H.., “Elements of Material Science and Engineering", Sixth Edition,PrenticeHall, 1989.
2. ¨Raghavan V., “Materials Science and Engineering: A First Course”, Fifth Edition, PrenticeHall 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.

CH1201 – INDUSTRIAL CHEMICAL TECHNOLOGY

L	T	P
4	0	0

UNIT I ALKALIES **12**

Chloro–alkali industries – Manufacture of Soda ash – Caustic Soda – Chlorine.

UNIT II ACIDS **12**

Manufacture of Sulphuric acid – Hydrochloric acid – Phosphoric acid.

UNIT III GLASSES **12**

Manufacture of glasses – Special glasses – Ceramics and Refractories – Paints and Pigments.

UNIT IV INDUSTRIAL GASES **12**

Carbon dioxide – Nitrogen – Hydrogen – Oxygen and acetylene.

UNIT V FERTILIZERS **12**

Nitrogen fertilizers – Synthetic ammonia – Urea – Ammonium chloride – CAN – Ammonium sulphate – Phosphorous fertilizers – Phosphate rock – Super phosphate – Triple Super Phosphate – MAP and DAP – Potassium fertilizers – Potassium chloride – Potassium sulphate.

Total: 60

TEXT BOOKS

1. Austin G.T., “Shreve’s Chemical Process Industries”, Fifth Edition, McGraw Hill, 1998.
2. Gopala Rao M. and Sittig M., “Dryden’s Outlines of Chemical Technology for the 21st Century”, Third Edition, Affiliated East-West press, 2007.

REFERENCES

1. Shukla S.D. and Pandey G.N., “Text book of Chemical Technology” Vol-I, Vikas publishing house (P) Ltd.,1977.
2. Sharma B.K., “Industrial Chemistry”, Twelfth Edition, Goel Publishing house, 2001.
3. Pandey G.N., “Text Book of Chemical Technology” Vikas publishing house (P) Ltd., 1992.

EE1208 – ELECTRICAL MACHINES AND DRIVES

L	T	P
3	1	0

UNIT I D.C. CIRCUITS 9

Basics of electricity – Electric energy and power – Circuit elements and sources – Kirchhoff's laws – Series and parallel combination of resistances – Mesh analysis – Nodal analysis – Superposition theorem – Thevenin's theorem – Norton's theorem – Maximum power transfer theorem.

UNIT II STEADY STATE ANALYSIS OF SINUSOIDAL EXCITATION 9

Sinusoidal excitation – RMS, average and peak values – Phasor representation – RC, RL and RLC circuits – Complex power – Resonance – Three phase circuits – Line and phase values.

UNIT III D.C. MACHINES AND TRANSFORMER 9

D.C. Machines – Constructional features – EMF and torque – Characteristics of D.C. motors – Speed control – Transformers – Constructional features – Transformer operation – Voltage regulation – Efficiency.

UNIT IV A.C. MACHINES 9

Alternators – Principles of operations – Synchronous machines – Circuit model – Armature leakage reactance – Synchronous reactance – Voltage regulation – Induction machines – Construction – Circuit model – Power across air gap, torque and power output – Torque-slip characteristics – Starting arrangements – Speed control of induction motor – Single phase induction motors – A.C. series motor.

UNIT V ELECTRIC DRIVES 9

Concept of electric drives – D.C. motors starters – Induction motor starters – Industrial applications – Rolling mill drives – Cement mill – Electric traction – Coalmines – Paper mill – Machine tool drives – Textile mills.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Kothari D.P. and Nagrath I.J., 'Basic Electrical Engineering', Tata McGraw-Hill, Second Edition, 2002.
2. Nisit K.De. and Sen P.K., 'Electric Drives', Prentice Hall of India, Tenth Edition, 2007.

REFERENCES

1. Theraja B.L. and Theraja A.K., 'A Textbook of Electrical Technology', Vol-I & II, S.Chand & Company Ltd., 2005.
2. Tewari J.P., 'Basic Electrical Engineering', New Age International Publishers, 2003.

CS1201 – DATA STRUCTURES

	L	T	P
	3	1	0

UNIT I PROBLEM SOLVING 9

Problem solving – Top-down Design – Implementation – Verification – Efficiency – Analysis – Sample algorithms.

UNIT II LISTS, STACKS AND QUEUES 9

Abstract Data Type (ADT) – The List ADT – The Stack ADT – The Queue ADT.

UNIT III TREES 9

Binary Trees – The Search Tree ADT – Binary Search Trees – AVL Trees – Tree Traversals – Hashing – General Idea – Hash Function – Separate Chaining – Open Addressing – Linear Probing – Priority Queues (Heaps) – Model – Simple implementations – Binary Heap.

UNIT IV SORTING 9

Insertion Sort–Shell Sort – Heap Sort – Merge Sort – Quick Sort – External Sorting.

UNIT V GRAPHS 9

Topological Sort – Shortest Path Algorithms – Unweighted Shortest Paths – Dijkstra's Algorithm – Minimum Spanning Tree – Prim's Algorithm – Applications of Depth-First Search – Undirected Graphs – Biconnectivity – Introduction to NP Completeness.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Dromey R. G., "How to Solve it by Computer" (Chapters 1 -2), Prentice-Hall of India, 2002.
2. Weiss M.A., "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2002.

REFERENCES

1. Langsam Y. Augenstein M. J. and Tenenbaum A. M., "Data Structures using C", Pearson Education, 2004
2. Gilberg R.F. and Forouzan B.A., "Data Structures - A Pseudocode Approach with C", Thomson Brooks / COLE, 1998.
3. Aho J. E. Hopcroft and J. D. Ullman, "Data Structures and Algorithms", Pearson education, 1983.
4. Harowitz, Sahani, Anderson-Freed, "Fundamentals of Data Structures in C", Second Edition, Universities Press, 2007.

HS1204 – ORGANIC CHEMISTRY LABORATORY

L	T	P
0	0	3

1. Estimation of Alcohol
2. Estimation of Aldehydes & Ketones
3. Estimation of Phenol
4. Pigment Analysis
5. Ore/Alloys analysis
6. Estimation of Amines
7. Estimation of Glucose
8. Preparation of Asprin
9. Preparation of Methyl orange
10. Preparation of Schiff's base
11. Synthesis of Porphyrin
12. Qualitative analysis of simple Organic compounds.
13. Polymer Analysis
14. Hydrolysis of Sucrose.
15. Industrial Waste Water analysis

Total: 45

EE1209 – ELECTRICAL MACHINES LABORATORY

L	T	P
0	0	3

1. Open circuit and load characteristics of separately excited and self excited D.C. generator
2. Load test on D.C. shunt motor
3. Load test on D.C. series motor
4. Speed control of D.C. shunt motor
5. Load test on single phase transformer and open circuit and short circuit test on single phase transformer
6. Regulation of three phase alternator by E.M.F. and M.M.F. methods
7. Load test on three phase induction motor
8. No load and blocked rotor tests on three phase induction motor (Determination of equivalent circuit parameters)
9. Load test on single- phase induction motor
10. Study of D.C. motor and induction motor starters

Total: 45

CS1204 – DATA STRUCTURES LABORATORY

L	T	P
0	0	3

Implement the following exercises using C

1. Array implementation of List ADT
2. Linked list implementation of List ADT
3. Cursor implementation of List ADT
4. Array implementation of Stack ADT
5. Linked list implementation of Stack ADT

6. The following three exercises are to be done by implementing the following source files
   a. Program for 'Balanced Paranthesis'
   b. Array implementation of Stack ADT
   c. Linked list implementation of Stack ADT
   d. Program for 'Evaluating Postfix Expressions'

   An appropriate header file for the Stack ADT should be included in (a) and (d)

   I. Implement the application for checking 'Balanced Paranthesis' using array Implementation of Stack ADT (by implementing files (a) and (b) given above)

   II. Implement the application for checking 'Balanced Paranthesis' using linked list implementation of Stack ADT (by using file (a) from experiment 1 and implementing file (c))

   III. Implement the application for 'Evaluating Postfix Expressions' using array and linked list implementations of Stack ADT (by implementing file (d) and using file (b) - and then by using files (d) and (c))

7. Queue ADT
8. Search Tree ADT – Binary Search Tree
9. Heap Sort
10. Quick Sort

Total: 45

SEMESTER IV

MA1251 – NUMERICAL METHODS

L	T	P
3	1	0

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-Jordon 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.

CH1255 – PHYSICAL CHEMISTRY

L	T	P
3	1	0

UNIT I GASEOUS STATE 9

Van der Waals equation – Law of equipartition principle – Translational, Rotational and vibrational energies of molecules – Joule-Thomson effect – liquefication of gases – Critical constants.

UNIT II CHEMICAL REACTION EQULIBRIA 9

Law of Mass Action – Van't Hoff reaction isotherm – Standard free energy change – Le Chatelier's principle – Application to selected systems – Biological activity – The thermodynamics of ATP.

UNIT III CHEMICAL KINETICS 9

Rate of reaction – Order – Molecularity – Integrated rate law – Kinetics of parallel and opposing reactions – Concept of activation energy – Arrhenius equation – Theory of absolute reaction rates – Kinetics of Enzyme catalyzed reactions.

UNIT IV SOLUTIONS 9

Ideal and non-ideal solutions – Solubility of gases in liquids – Henry's law – Completely miscible liquids – Raoult's law – Vapour pressure and boiling point diagrams – Partially miscible liquids – Critical solution temperature – Completely immiscible liquids – Nernst distribution law – Dilute solution and their colligative properties – Molecular weight determination using these properties.

UNIT V ELECTRICAL CONDUCTANCE 9

Electrolytes – Strong electrolytes and weak electrolytes – Arrhenius theory of electrolytic dissociation – Debye-Huckel Onsager theory – Ostwald's dilution law – Solubility of electrolytes and solubility product – Common ion effect – Acids – Bases – Definitions based on proton transference – Dissociation constant – Amphoteric electrolyte – pH – Buffer solutions.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Atkins P.W. and Paula J.D., "Physical Chemistry", Eighth Edition, W H Freeman & Company, 2006.
2. Puri B.R.and Sharma L.R., "Principles of Physical Chemistry", S.Chand & Company Ltd., 1998.

REFERENCES

1. Mortimer R.G., "Physical Chemistry", Second Edition, Academic press, 2000.
2. Soni P.L., "Text Book of Physical Chemistry ", S.Chand & Company Ltd., 1970.
3. Bahl B.S., Tuli G.D. and Arun Bahl., "Essentials of Physical Chemistry", S.Chand & Company Ltd., 1998.

HS1201 – ENVIRONMENTAL SCIENCE AND ENGINEERING

L	T	P
4	0	0

UNIT I IMPORTANCE OF ENVIRONMENTAL STUDIES 12

Scope and Importance – Need for Public Awareness – Forest resources – Water resources – Mineral resources – Land resources – Energy resources – Food resources – Equitable use of resources for sustainable lifestyles.

UNIT II ECOSYSTEMS AND BIODIVERSITY 12

Concept of ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem – Food chains – Food webs – Ecological Pyramids – Definition of Biodiversity – Biogeographical classification in India – Value of biodiversity – Biodiversity at Global – National and local levels – India as a mega diversity nation – Hot spots of biodiversity – Threats to biodiversity – Conservation of biodiversity.

UNIT III ENVIRONMENTAL POLLUTION 12

Causes and effects of environmental pollution – Air pollution – Water pollution – Soil pollution – Marine pollution – Noise pollution – Thermal pollution – Nuclear hazards – Solid waste management – Societal role in pollution prevention – Environmental disasters and management.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 12

Unsustainable to sustainable development – Concept of conservation – Water and energy conservation – Rain water harvesting – Climate change – Global warming – Acid rain – Ozone layer depletion – Nuclear accidents and holocaust – Environmental protection Act – Issues involved in Enforcement of Environmental legislation – Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 12

Population growth – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV / AIDS – Women and child welfare – Role of IT in Environment and human health.

Total: 60

TEXT BOOKS

1. Venugopala Rao P., “Principles of Environmental Science and Engineering”, Prentice Hall of India (P) Ltd., 2006.
2. Masters G.M., “Introduction to Environmental Engineering and Science”, Third Edition, Prentice Hall of India (P) Ltd., 2007.

REFERENCES

1. Davis M.L. and Masten S.J., “Principles of Environmental Engineering and Science”, McGraw-Hill, 2004.
2. Bharucha E., “Text book of Environmental Studies”, University Press, 2005.
3. Trivedi R.K., “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Vol-I & II, Enviro Media, 1996.

CH1252 – PROCESS CALCULATIONS

L	T	P
3	1	0

UNIT I STOICHIOMETRY 9

Introduction – Units and Dimensions – Stoichiometric principles – Composition relations – Density and specific gravity.

UNIT II IDEAL GASES AND VAPOR PRESSURE 9

Behavior of Ideal gases – Application of ideal gas law – Gaseous mixtures – Volume changes with change in composition – Vapor pressure – Effect of Temperature on vapor pressure – Vapor pressure plots – Vapor pressure of immiscible liquids – Solutions.

UNIT III HUMIDITY AND SOLUBILITY 9

Humidity – Saturation – Vaporization – Condensation – Wet and dry bulb thermometry – Solubility and Crystallization – Dissolution – Solubility of gases.

UNIT IV MATERIAL BALANCE 9

Material Balance – Processes involving chemical reaction – Combustion of coal, fuel gases and Sulphur – Recycling operations – Bypassing streams – Degree of conversion – Excess reactant – Limiting reactant.

UNIT V ENERGY BALANCE 9

Thermo chemistry – Calculation of Heat of reaction at other temperatures – Hess's law – heat of summation – Heat of formation – Heat of reaction – Heat of mixing – Heat of combustion – Mean specific heat – Theoretical flame Temperature.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Bhatt B.I. and Vora S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishers Ltd., 2005.
2. Hougen O.A., Watson K.M. and Ragatz R.A., "Chemical Process Principles", Vol-I, CBS Publishers and Distributors, 1995.

REFERENCES

1. Venkataramani V. and Anantharaman N., "Process calculations", Prentice Hall of India (P) Ltd., 2003.
2. Himmelblau D., "Basic Principles and Calculations in Chemical Engineering", Sixth Edition, Prentice Hall of India (P) Ltd., 2000.
3. Chopey N.P. and Hicks T.G., "Handbook of Chemical Engineering Calculations", Second Edition, McGraw-Hill Inc., 1984.

CH1203 – FLUID FLOW OPERATIONS

L	T	P
3	1	0

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE 9

Introduction – Nature of fluids – Physical properties of fluids – Types of fluids – Fluid static-Pressure – Density – Height relationships – Pressure Measurement – Units and Dimensions – Dimensional analysis – Similarity – Forces arising out of physical similarity – Dimensionless numbers.

UNIT II MOMEMTUM BALANCE AND ITS APPLICATIONS 9

Kinematics of fluid flow – Stream line – Stream tube – Velocity potential – Newtonian and non-Newtonian fluids – Time dependent fluids – Reynolds number experiment and significance – Momentum balance – Forces acting on stream tubes – Potential flow – Bernoulli's equation – Correction for fluid friction – Correction for pump work.

UNIT III FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS 9

Flow of incompressible fluids in pipes – Laminar and turbulent flow through closed conduits – Velocity profile and friction factor for smooth and rough pipes – Head loss due to friction in pipes and Fittings – Introduction to compressible flow – Isentropic flow through convergent and divergent nozzles and sonic velocity.

UNIT IV FLOW OF FLUIDS THROUGH SOLIDS 9

Form drag – Skin drag – Drag co-efficient – Flow around solids and packed beds – Friction factor for packed beds – Ergun's Equation – Motion of particles through fluids – Motion under gravitational and centrifugal fields – Terminal settling velocity – Fluidization – Mechanism – types – general properties – Applications.

UNIT V TRANSPORTATION AND METERING 9

Measurement of fluid flow – Orifice meter – Venturi meter – Pitot tube – Rotameter – Weirs and notches – Wet gas meter and dry gas meter – Hot wire anemometers – Transportation of fluids – Fluid moving machinery – Performance – Selection and specification – Air lift and diaphragm pumps – Positive displacement pumps – Rotary and Reciprocating pumps – Centrifugal pumps – Performance and characteristics.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. McCabe W.L., Smith J.C. and Harriott P., "Unit operations of Chemical Engineering", Seventh Edition, McGraw-Hill, 2004.
2. Coulson J.M., and Richardson J.F., "Coulson and Richardson's Chemical Engineering", Vol-I, Third Edition, Butterworth – Heinemann Publishers, 2004.

REFERENCES

1. Bansal R.K., "Fluid Mechanics and Hydraulic machines", Laxmi Publications (P) Ltd., 1995.
2. Nevers N.D., "Fluid Mechanics for Chemical Engineers", McGraw-Hill, 1991.
3. De Nevers L., "Fluid Mechanics for Chemical Engineers", McGraw-Hill, 1994.

CH1256 – MECHANICAL OPERATIONS

L	T	P
3	1	0

UNIT I CHARACTERISTICS OF PARTICULATE SOLIDS, SIZE REDUCTION AND SCREENING 9

Properties and characterization of particulate solids – Analysis, technical methods for measurement of size and surface area distribution of powder – Introduction to size reduction equipment – Determination of energy and power requirement in milling operations – Computer simulation techniques for mill performance – Mechanical classifiers – Screening equipment – Capacity and effectiveness.

UNIT II FILTRATION 9

Filtration equipments – Filtration media and filter aids – Principles of filtration and clarification – Estimation of filtration parameters for compressible and incompressible cakes and calculations – Centrifugal filtration equipment and principles of operation.

UNIT III SETTLING AND SEDIMENTATION 9

Separation based on the motion of particles through fluids – Gravity settling processes – Sedimentation – Kynch theory of sedimentation – Sedimentation thickeners – Rate of sedimentation and sedimentation zones in continuous thickeners – Design of thickeners and clarifiers – Principles of centrifugal sedimentation.

UNIT IV AGITATION AND MIXING 9

Agitation and mixing of liquids – Agitation equipment – Axial and radial flow impellers and flow patterns in agitated vessels – Prevention of swirling – Power consumption in agitated vessels – Blending and mixing – Dispersion operations – Mixing of solids and pastes – types of mixers.

UNIT V STORAGE AND CONVEYING OF SOLIDS 9

Storage and conveying of solids – Bins, Hoppers and silos – Flow out of bins – Design consideration of bins – Loading and unloading of solids – Bucket elevators – Apron conveyors – Belt conveyors – Types of belt conveyors – Selection considerations.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. McCabe W.L., Smith J.C. and Harriott P., "Unit operations of Chemical Engineering", Seventh Edition, McGraw Hill, 2004.
2. Badger W.L., and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

REFERENCES

1. Raymond A. Kulweic., "Materials Handling Handbook", Third Edition, Wiley-Interscience Publications, 1985.
2. Richardson J.F. and Harker J.H., "Coulson and Richardson's Chemical Engineering", Vol-II, Fourth Edition, Butterworth Heineman, 2004.
3. Bhattacharaya., "Mechanial Operations", Khanna publishers, 2001.

CH1257 – PHYSICAL CHEMISTRY LABORATORY

L	T	P
0	0	3

1. Molecular weight determination of Polymer by using
   a) Rast's Method
   b) Viscometer
2. Partition Coefficient Studies
   For Benzene – Water system
3. Phase rule Studies
   Simple Eutectic system
4. Conductivity Studies
   a) Precipitation Titration
   b) Mixtures of acid – Strong Base Titration
5. EMF Studies
   Estimation of Fe^{2+} by Potentiometric Titration
6. Kinetic Studies
   a) Kinetic studies of Persulphate – Iodide reaction
   b) Kinetic studies of Iodination of Acetone.
   c) Determination of Rate constant of Acid catalyst hydrolysis of an Ester.
7. Polarimetry Studies - Kinetic study of Inversion of Cane sugar.
8. Adsorption Studies - Freundlich Adsorption Isotherm
9. Determination of Transition Temperature.
10. Determination of Critical solution temperature for the Phenol - Water system.
11. Determination of Saponification value of an oil.
12. To determine the moisture & volatile contents in a given coal sample by proximate analysis.
13. P^H metric measurements
    a) To prepare buffer solutions and standardization of P^Hmeter (P^H4 and 9)
    b) Determine the molarity of HCI by pH-metrically, using 0.1 M Sodium Hydroxide.

Total: 45

CH1258 – FLUID FLOW OPERATIONS LABORATORY

L	T	P
0	0	3

1. To verify Hagen-Poiseuille Equation.
2. To relate Reynolds Number and Friction factor.
3. To study the effect of coil diameter on Friction factor.
4. To evaluate the performance of Centrifugal pump and Reciprocating Pump
5. To verify Ergun's equation.
6. To determine the discharge coefficient of Orifice meter, Venturimeter and Rotameter.
7. To evaluate the performance of Weirs and Notches.
8. To characterize the behavior of Fluidized bed.
9. Losses due to friction in pipe lines and fittings
10. Reynold's Apparatus
11. Bernoulli's Theorem Apparatus
12. Efflux time Apparatus.
13. Calibration Test Rig for Pitot Tube
14. Flow Through Pipes, Minor Losses due to sudden expansion, Sudden Contraction

Total: 45

CH1259 – MECHANICAL OPERATIONS LABORATORY

L	T	P
0	0	3

1. Screen Effectiveness
2. Jaw Crusher and Smooth roll crusher
3. Ball Mill
4. Vacuum Leaf Filter
5. Plate and Frame Filter press
6. Batch Sedimentation
7. Cyclone Separator
8. Terminal settling velocity - Stokes law Verification.
9. Rod mill
10. Hammer Mill
11. Vibrating Screen
12. ContiniousThickener
13. Plate & Frame Filter press
14. Belt conveyor
15. Drop weight crusher
16. Beaker Decantation

Total: 45

SEMESTER V

MA1302 – SPECIAL FUNCTIONS

L	T	P
3	1	0

UNIT I IMPROPER INTEGRALS AND SERIES SOLUTIONS 9

Improper integrals - Gamma and Beta functions - Series solutions - Ordinary point - Regular singular point of second order linear ordinary differential equation - Series solution to a second order linear ordinary differential equation about an ordinary point and a regular singular point.

UNIT II BESSEL FUNCTIONS 9

Bessel's equation - Bessel functions - Recurrence relations - Orthogonality property - Generating function - Equations reducible to Bessel's equation - Modified Bessel functions.

UNIT III LEGENDRE POLYNOMIALS 9

Legendre's equation - Legendre Polynomials - Rodrigue's formula generating function - Recurrence relations - Orthogonality property.

UNIT IV HERMITE AND LAGUERRE POLYNOMIALS 9

Hermite and Leguerre equations and their solutions – Polynomials - Rodrigue's formula - Generating functions - Recurrence relations - Orthogonality property.

UNIT V BOUNDARY VALUE PROBLEMS 9

Solution of Boundary Value Problems involving Bessel functions & Legendre polynomials.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Andrews.L.A., “Special Function for Scientist and Engineers”, McGraw-Hill, 1992.
2. Narayanan, S. Manicavachagam Pillay and Ramanaiah.G, “Advanced Mathematics for Engineering Students”, Vol. II S.Viswanathan Printers Private Limited, Madras, 1985.

REFERENCES

1. Grewal, B.S., “Higher Engineering Mathematics”, Khanna Publishers, Delhi, 2005.
2. Jain R.K & Iyengar, S.R.K. Advanced Engineering Mathematics, Narosa Publishing House, New Delhi, 2002.
3. N.P. Bali, N.Ch. Narayana Iyengar, “A Textbook of Engineering Mathematics”, Laxmi Publications (P) Ltd., New Delhi, 6th Edn., 2004.

CH1310 – HEAT TRANSFER

L	T	P
4	0	0

UNIT I CONDUCTION 12

Modes of Heat Transfer - Steady and Unsteady state heat transfer - Concept of heat Conduction - Fourier's law of heat conduction - General Heat Conduction Equation in Spherical coordinates - One dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere - Analogy between flow of heat and flow of electricity - Effect of temperature on thermal conductivity - Critical Insulation Thickness - Transient heat conduction - Lumped heat parameter model.

UNIT II CONVECTION 12

Concept of heat transfer by convection - Natural and forced convection - Concept of LMTD - Local and Overall Heat Transfer Coefficient - Application of dimensional analysis for convection - Empirical Equations for forced convection under laminar, transient and turbulent conditions - Empirical Equations for natural convection - Influence of boundary layer on heat transfer - Heat transfer through packed and fluidized beds - Heat Transfer with Phase Change: Boiling, Vaporization and Condensation.

UNIT III RADIATION 12

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

UNIT IV HEAT EXCHANGERS 12

Heat Exchanger Types - Parallel and counter flow heat exchangers - Overall heat transfer coefficient - Log mean temperature difference for single pass - Correction factor for multi pass heat exchangers - Heat exchanger effectiveness - Number of transfer units - Chart for different configurations - Dirt Factor.

UNIT V EVAPORATORS 12

Evaporation - Single effect and multiple effect evaporation - Boiling Point Elevation - Effect of Liquid Head - Capacity and Economy of multiple effect evaporators - Evaporation Equipments.

Total: 60

TEXT BOOKS

1. D.S. Kumar, "Heat and Mass Transfer", S.K. Kataria & Sons, Delhi, Edition 5, 2000.
2. W. L. McCabe and J. C. Smith, "Unit Operations in Chemical Engineering", *5th* Edn. McGraw Hill Publishing Co., NewDelhi, 2001.

REFERENCES

1. D. Q. Kern, "Process Heat Transfer", Tata McGraw Hill Publishing Co., New Delhi, 1990.
2. Hollman, "Heat Transfer", 8th Edn, McGraw Hill, NewDelhi, 1997.
3. F.Kreith, "Principles of Heat Transfer", 4th Edition, Harper &Row, 1976.

PC1301 – MASS TRANSFER FUNDAMENTALS

L	T	P
4	0	0

UNIT I DIFFUSION 12

Diffusion in fluids - Molecular and eddy diffusion - Measurement and calculation of diffusivities - Ordinary diffusion in multi component gaseous mixtures - Diffusion in solids - Molecular and Knudsen diffusion in solids - Theories of Mass Transfer - Film theory, penetration theory and surface renewal theories of mass transfer.

UNIT II INTERPHASE MASS TRANSFER 12

Interphase Mass Transfer - Local and overall Mass Transfer Coefficients - Steady state cocurrent and counter current mass transfer process - Stage and stage efficiencies - Concept of NTU and HTU - Equilibrium and Operating lines - J_D Factor - Equipments for gas-liquid contact operations - Bubble columns - Tray towers and packed towers.

UNIT III ABSORPTION 12

Gas Absorption: principles of Absorption and Desorption - Selection of solvents for absorption - Tray tower absorber - Absorption factor - Calculation of number of theoretical stages - Murphree efficiency - Point efficiency - Tray efficiency and overall tray efficiency - Calculation of actual number of trays.

Packed tower absorber - Tower packing and characteristics - Calculation of NTU, HTU, HETP and number of stages in absorption towers - Absorption with chemical reactions.

UNIT IV DRYING 12

Drying - Principle and definitions - Estimation of drying rates, drying rate curve – Critical and equilibrium moisture content - Calculation of drying time under constant drying conditions - Different types of dryers.

UNIT-V HUMIDIFICATION AND CRYSTALLIZATION 12

Humidification - Definitions, Psychometric charts - Wet bulb temperature - Methods of humidification - Types of cooling towers, spray chambers and spray ponds.

Crystallization - Factors governing nucleation and crystal growth - Theory of Crystallization - Classification of crystallizer and their applications - Product size distribution.

Total: 60

TEXTBOOKS

1. W.L.McCabe, J.C.Smith and P.Harriot, “Unit Operations of Chemical Engineering”, 6th Edn., McGraw-Hill Book Co., New York, 2001.
2. R.E.Treybal, “Mass Transfer Operations”, 3rd Edn., McGraw-Hill Book Co., New York,1980.

REFERENCES

1. J.M.Coulson and J.F.Richardson,”Chemical Engineering”, Vol.I, II, III, Pergamon Press, N.Y. 1977.
2. C.O.Bennett, J.E.Myers, “Momentum, Heat & Mass Transfer”, McGraw Hill Book Company, 3rd Edn., 1983.
3. Christie J.Geankoplis, “Transport Processes and unit operations”, 3rd Edn., Prentice Hall of India Pvt. Ltd, New Delhi, 2000.

ME1309 – ENGINEERING THERMODYNAMICS

L	T	P
4	0	0

UNIT I FUNDAMENTAL CONCEPTS AND FIRST LAW OF THERMODYNAMICS 12

Scope of thermodynamics – Basic concepts – Thermodynamic System – State and equilibrium – Process and cycles – Temperature and Zeroth law of Thermodynamics – Properties of pure substances – First law of Thermodynamics – First Law Analysis of Closed systems and control volumes and its application.

UNIT II ENTROPY AND THE SECOND LAW OF THERMODYNAMICS 12

The Clausius inequality – Entropy – Causes of entropy change – Entropy change of pure substances – Thermal Energy reservoirs – Heat Engines – Perpetual Motion Machines – Reversible and irreversible processes – The Carnot cycle and principles – The Carnot Heat engine – The Second law Efficiency – Second law analysis of open and closed systems.

UNIT III REFRIGERATION, VAPOR & COMBINED POWER CYCLES 12

Refrigerators and Heat pumps – The Carnot refrigerator and heat pumps – The reversed Carnot cycle – Ideal and Actual vapor compression Refrigeration cycle – Selection of right refrigerants – Heat pumps – Absorption refrigerator system – The Carnot vapor cycle – Rankine cycle – Cogeneration – Second law analysis of vapor power cycles.

UNIT IV PVT RELATIONS AND THERMODYNAMIC RELATIONS 12

PVT relations for gases and liquids – equations of state, Cubic equations of state-Thermodynamic properties from equations of state, Compressibility factor, Generalised properties of fluids-Law of corresponding state, acentric factor, gas mixtures.
Thermodynamic relations – Maxwell's relations – Estimation of thermodynamic properties– Thermodynamic properties of homogeneous mixtures – Partial molar properties, Fugacity and fugacity coefficients – Lewis and Randall rule – Property changes of mixing, activity – Excess properties, activity coefficients.

UNIT V PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA 12

Phase equilibria – Pure component and mixtures – Van Laar, Margules equation, Group contribution method – Gibb's Duhem equation – Consistency tests – Partially miscible and immiscible systems – Azeotropes – Retrograde condensation – Thermodynamic diagrams.
Chemical equilibria – Heat effects, industrial reactions – Free energy calculations – Homogeneous and heterogeneous reactions – Equilibrium composition.

Total: 60

TEXT BOOKS

1. J.M.Smith and Van Ness, "Introduction to Engineering Thermodynamics", Ed.5, McGraw Hill, New York, 1996.
2. K.V.Narayanan, "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall of India, New Delhi, 2002.

REFERENCES

1. Hougen and Watson , "Chemical Process Principles" Vol. II, CBS Publishers, New Delhi.2002.
2. Kyle, "Chemical and Process Thermodynamics", Ed. 2. Prentice Hall of India, New Delhi.2000.
3. Y.V.C Rao, "Chemical Engineering Thermodynamics", Universities Press, 1997.

PC1302 – NATURAL GAS ENGINEERING

L	T	P
4	0	0

UNIT I PROPERTIES AND COMPOSITION OF NATURAL GAS 12

Natural gas origin - Composition of Natural gas - Sources of Natural gas - Thermodynamics properties - Compressibility factor and chart for Natural gas - Heating value and flammability limit of Natural gas.

UNIT II ESTIMATION AND PRODUCTION OF NATURAL GAS 12

Estimation of gas reserves by Volumetric Method - Production of Natural gas - Pressure Decline Method - Problems in the Production of Natural gas – Field separation.

UNIT III GAS FROM CONDENSATE OIL FIELDS 12

Processing of Condensate well fluids - Cycling of gas condensate reservoirs - Sweep Patterns - Katy cycling plant.

UNIT IV ACID GAS TREATING OF NATURAL GAS 12

Acid gas removal: Metal oxide process - Slurry process - Amine process - Carbonate washing process - Methanol based process and other process - Sulphur recovery process.

UNIT V DEHYDRATION OF NATURAL GAS AND NGL RECOVERY 12

Dehydration: Glycol Dehydration - Solid desiccant dehydration.
NGL Recovery: Refrigeration process - Lean oil absorption process - Solid bed Adsorption and Membrane separation process - NGL fractionation.

Total: 60

TEXT BOOKS

1. Katz and Lee “Hand Book of Natural Gas Engineering” McGraw Hill, New York 1968.
2. William C. Lyons, “Standard Handbook of Petroleum and Natural Gas Engineering”, Volume 2, Gulf Professional Publishing, Elsevier Inc., 2006.

REFERENCES

1. Donald L.Katz and Robert L.Lee, Natural Gas Engineering, McGraw Hill, New York 1990
2. Dring, M. M. – The Natural Gas Industry – A review of World Resources and Industrial Applications, Butterworth, London, 1974.
3. Saied Mokhatab, William A. Poe, James G. Speight, “Handbook of Natural Gas Transmission and Processing”, Gulf Professional Publishing, Elsevier Inc., 2006.

PC1303 – PETROLEUM EXPLORATION AND EXPLOITATION TECHNIQUES

L	T	P
3	1	0

UNIT I ORIGIN AND OCCURRENCE OF PETROLEUM AND SEDIMENTRARY ENVIRONMENT 9

Origin of oil – Important factors that control petroleum occurrence - Migration and Accumulation – Source and Reservoir rocks – Oil bearing rocks. Continental Environment – Transitional Environment – Marine Environment.

UNIT II EXPLORATION METHODS, WELL PROGNOSIS AND ECONOMIC ANALYSIS 9

Geological Exploration methods – Geophysical Exploration methods – Geochemical methods prognostication – Classification of Drilling Locations – Economic Analysis – Well programme – Geotechnical order.

UNIT III GEOLOGICAL STRUCTURE AND GEOLOGGING 9

Various Traps – Anticline – Fracturing – Well logging – Geological control – Gas logging – Drilling control important formation evaluation using wireline logging data.

UNIT IV DRILLING FLUIDS AND WORK COMPLETION 9

Drilling Fluids: Function, Composition, and Classicfication – Packer fluid – Casing packs – Solids removal - Completion methods – Various stimulation methods.

UNIT V OFF – SHORE TECHNOLOGY 9

Seismic Technology – Sniffer Survey – Drilling Technology – Off-share Rigs – Primary and secondary enhanced oil Recovery Techniques and methods – Major well complication and Remidies.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Bhagwan Sahay "Petroleum exploration and exploitation practices" Allied Publishers Ltd., Chennai, 1994.
2. Richard Dawe, "Modern petroleum Technology", Vol 1, Upstream,6th edition, John and wiley sons Ltd, 2000.

REFERENCES

1. Howard B, Bradley, Editor, "Petroleum Engineering Handbook", Society of Petroleum Engineers, Texas, USA, 1987.
2. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Norman J. Hyne, Norman J. Ph.d Hyne, 2nd edition, Pennwell Books, 2001.
3. Shay, B, et al, 1991 "Wellsite Geological Techniques for Petroleum Exploration" Allied Publishers Ltd., New Delhi.

CH1311 – HEAT TRANSFER LABORATORY

L	T	P
0	0	3

1. Determination of heat transfer coefficient using composite wall.
2. Determination of heat transfer coefficient using convection apparatus.
3. Determination of Stefan Boltzman constant using Stefan Boltzman apparatus.
4. Determination of condensing Heat transfer coefficient using vertical condenser.
5. Determination of condensing Heat transfer coefficient using horizontal condenser.
6. Study the effect of coil diameter on Heat transfer coefficient.
7. Determination of overall Heat transfer coefficient using shell and tube heat Exchanger.
8. Determination of overall Heat transfer coefficient using double pipe heat exchanger.
9. Determination of overall Heat transfer coefficient using plate type heat exchanger.
10. Study the effect of evaporation using Jacketed pan evaporator and Open pan evaporator.

Total: 45

PC1304 – TECHNICAL ANALYSIS LABORATORY

L	T	P
0	0	3

1. Oil Analysis: (3 experiments)
   a) Acid value
   b) Saponification value
   c) Iodine value

2. Soap Analysis: (2 experiments)
   a) Alkali Content
   b) Fatty acid content of Soap

3. Estimation of purity of glycerol: by Dichromatic method

4. Analysis of water:
   Determination chlorine demand in water: Estimation of residual chlorine in water by volumetric method

5. Cement Analysis (3 experiments)
   a) Estimation of silica content
   b) Estimation of calcium oxide content
   c) Estimation of mixed oxide content

6. Fertilizer Analysis:
   Estimation of Nitrogen in Urea by Kjeldahl method

Total: 45

HS1301 – COMMUNICATION AND SOFT SKILLS LABORATORY

L	T	P
0	0	3

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

1. Kamalesh Sadanand and Susheela Punitha, "**Spoken English: A Foundation Course**" for Speakers of Indian Languages, Part 2 Audio CD, Hyderabad: Orient Longman, 2008
2. Malcome Goodale, "**Professional Presentations**", (VCD) New Delhi: Cambridge University Press, 2005
3. Barbara Garside and Tony Garside, **Essential Telephoning in English** (Audio CD**),** Cambridge: Cambridge University Press, 2002
4. Hari Mohan Prasad and Rajnish Mohan, **How to Prepare for Group Discussion and Interview (**Audio Cassette) Tata McGraw-Hill Publishing
5. **Graded Examinations in Spoken English** and **Spoken English for Work** downloadable materials from Trinity College, London
6. **International English Language Testing System** Practice Tests, CUP
7. **Business English Certificate** Materials, Cambridge University Press
8. **Personality Development** (CD-ROM), Times Multimedia, Mumbai
9. Interactive Multimedia Programs on **Managing Time and Stress**
10. Robert M. Sherfield and et al "**Developing Soft Skills**" 4th edition, New Delhi: Pearson Education, 2009

Total: 45

SEMESTER VI

CH1360 – PROCESS DYNAMICS AND CONTROL

L	T	P
4	0	0

UNIT I FIRST ORDER SYSTEMS 12

Linear open to loop systems – Laplace transformation – Transform of standard functions – First order and linearised first order systems – Response to various disturbances – Inversion – Theorems in Laplace transformation – Applications.

UNIT II HIGHER ORDER SYSTEMS 12

First order in series – Linearisation and its application in process control – Higher order systems – Second order and transportation lag – Response to various disturbances.

UNIT III CLOSED LOOP CONTROL SYSTEMS 12

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 – Transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 12

Introduction to frequency response of closed – loop systems – Routh analysis – Control system design by frequency – Bode diagram – Stability criterion – Tuning of controller settings.

UNIT V SPECIAL CONTROLS 12

Cascade – Feed forward and ratio control – Dead time compensation – Internal model control – Control valves – Process identification.

Total: 60

TEXT BOOKS

1. Coughnowr, D.P., “Process Systems Analysis and Control”, 2nd Edition, McGraw Hill, 1991.
2. Smith, C.A., and Corripio, A.B., “Principles and Practice of Automatic Process Control”, 2nd Edition, John Wiley, 1997.

REFERENCES

1. Harriot, P., “Process Control”, Tata McGraw Hill, 1984.
2. Stephanopolous, G., “Chemical Process Control”, Prentice Hall of India Pvt. Ltd., 1990.
3. Patranabis, D., “Principles of Process Control”, 2nd Edition, Tata McGraw Hill Publishing Co. Ltd., 1981.

CH1361 – MASS TRANSFER OPERATIONS

L	T	P
3	1	0

UNIT I DISTILLATION 9

Basic concepts of distillation: Vapour – Liquid equilibrium pressure – Temperature – concentration – Phase diagram – Isothermal and isobaric equilibrium – Relative Volatility – Ideal solutions – Raoult's law – Henry's law – Deviations from ideality – Minimum and maximum boiling azeotropes.

Different Methods of distillation: flash, steam, vacuum, molecular, azeotropic and extractive distillations.

UNIT II CONTINUOUS FRACTIONATION 9

Multistage tray tower: Material and enthalpy balance of a fractionator – Mccabe – Thiele Method – Introduction of feed – Influence on operating lines – q-lines and location of feed tray – Effect of reflux ratio – Total reflux, minimum reflux, optimum reflux – Lewis – Sorel method – Ponchon – Savarit Method – Reboiler arrangements – Use of open steam – Feed conditions.

UNIT III LIQUID – LIQUID EXTRACTION 9

Description of liquid extraction – Terminologies – Application of ternary liquid equilibrium – representation in equilateral triangular co-ordinate of different type systems – Effect of temperature – Criteria for selection of solvent – Stage wise and continuous contact extractors – Types of extractors and their brief description – Stage wise contact – Cross and counter current extraction – Graphical method of determining number of stages, composition and minimum solvent requirement.

UNIT IV ADSORPTION 9

Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysterisis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stagewise adsorption – Single and multistage crosscurrent adsorption – Multistage Countercurrent adsorption – Break through curves and rates of adsorption – Calculations of composition and number of stages.

UNIT V LEACHING 9

Solid liquid extraction – Description of leaching operations and technologies – Applications of leaching – Preparation of solid – Methods of operation and classification of equipment – Solid-liquid equilibrium in leaching – Multi stage cross and counter current leaching – Calculation of composition and number of stages.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Mccabe, W.L., Smith, J.C. and Harriot, P., "Unit Operations in Chemical Engineering.", 6th Edition., McGraw Hill Book Co., 2001.
2. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co. 1980.

REFERENCES

1. Coulson, M. and Richardson, J.F., "Chemical Engineering." Vol 2, 3rd Edition, Pergamon Press, 1987.
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Maus, L. and Andersen, L.B., "Principles of Unit Operations", 2nd Edition, John Wiley and Sons (Asia) Pvt. Ltd, 1994.
3. Geankopolis, C.J., "Transport Processes in Chemical Operations", 3rd Edition, Prentice Hall of India, 1996.

PC1351 – PRINCIPLES OF CHEMICAL KINETICS

L	T	P
4	0	0

UNIT I REACTION KINETICS 12

Chemical kinetics – Classification of chemical reactions – Concentration and temperature dependent term of rate equation – Arrhenius, collision and transition state theory – Searching for a mechanism.

UNIT II INTERPRETATION OF BATCH REACTOR DATA 12

Integral and differential methods of analysis – Half-life method – Zero-order reaction – Empirical rate equation of nth order – Irreversible first and second order reactions for variable and constant volume systems.

UNIT III VARIOUS TYPES OF REACTOR DESIGN 12

Ideal Reactors – Batch reactor, plug flow reactor, mixed flow reactor – Space time, space velocity – Performance equations and their graphical representation.

UNIT IV HEAT EFFECTS 12

Temperature and pressure effects on single and multiple reactions – Adiabatic, non-adiabatic, isothermal and non-isothermal operations.

UNIT V DESIGN OF REACTOR FOR SINGLE & MULTIPLE REACTIONS 12

Single reactions – Size comparison of single reactors – Recycle reactor – Autocatalytic reactions – Multiple reactions – Irreversible reactions in series and parallel.

Total: 60

TEXT BOOKS

1. Levenspiel, O., “Chemical Reaction Engineering”, 3rd Edition, John Wiley, 1999.
2. Fogler, W., “Chemical Reaction Engineering”, 3rd Edition, Prentice Hall of India, 1999.

REFERENCES

1. Smith, J.M., “Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, 1981.
2. S.D.Dawande, “Principles of Reaction Engineering”, 1st Edition, Central Techno Publications, 2001.
3. Richardson, J.F. and Peacock, D.G., “Coulson Richardson’s Chemical Engineering.” Vol 3, 3rd Edition, Asian Books (P) Ltd, 2000.

PC1352 – EQUIPMENT DESIGN AND DRAWING I

(To Consider as Practical Subject for Examination Purpose)

L	T	P
2	0	2

UNIT I DESIGN OF PIPE FITTINGS AND JOINTS 9

Design and schematic of simple bolts and screws – Riveted joints – Design and drawing of shafts and couplings.

UNIT II DESIGN OF REACTION VESSEL AND STORAGE TANK 9

Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.

UNIT III DESIGN OF HIGH PRESSURE SYSTEMS 9

Design of high pressure vessels and reactors.

UNIT IV DESIGN OF PHASE SEPARATION EQUIPMENT 9

Design of physical separation equipments such as cyclones, centrifuges, thickeners, filtration equipment

UNIT V DRAWING OF HEAT EXCHANGERS AND COLUMNS 9

Drawing of physical process equipments such as double pipe heat exchangers – Shell and tube heat exchangers – Plate and frame heat exchangers – Distillation columns and reactors.

L: 45 P: 15 Total: 60

TEXT BOOKS

1. Dawande, S.D., “Process Design of Equipments” Central Techno Publishers.
2. Perry, R. H., “Chemical Engineers Handbook”, 7th Edition, McGraw Hill, 1998.

REFERENCES

1. Coulson, J. M. and Richardson, J. F., “Chemical Engineering”, Vol 6, Butterworth Heinmann, 2000.
2. Walas, S.M., “Chemical Process Equipment” Butterworth Heinmann, 1998.
3. Joshi, M. V., “Process Equipment Design”, 2nd Edition, Mac Millan Press, 1996.
4. Brownell, L. E. and Young, E.H., “Process Equipment Design”, John Wiley, 1968.

Note: Necessary Data Book is to be issued while conducting Practical Examination

PC1353 – PETROCHEMICAL UNIT PROCESSES

L	T	P
4	0	0

UNIT I FEED STOCK AND SOURCE OF PETROCHEMICALS 12

Overview of Petrochemical Industry – The key growth area of India, economics – Feed stock selections for petrochemicals – Steam cracking of gas and naphtha to produce olefins, diolefins and production of acetylene – Cracker product separation and BTX separation.

UNIT II SYNTHESIS GAS PRODUCTION 12

Steam reforming of natural gas – Naphtha and heavy distillate to produce hydrogen and synthesis gas – Production of methanol – OXO process.

UNIT III ALKYLATION, NITRATION, OXIDATION AND HYDROLYSIS 12

Technological principles in alkylation, oxidation, nitration and hydrolysis – Types – Agents – Process equipment – Processes – Applications – Technical Preparations.

UNIT IV SULPHONATION, SULPHATION AND ISOMERISATION 12

Technological principles in sulphonation, sulphation and isomerisation – Physical factors – Kinetics Mechanism – Working up Procedures – Industrial Equipment – Transition from batch to continuous processes.

UNIT V HALOGENATIONS AND ESTERIFICATION 12

Halogenations – Thermodynamics – Kinetics – Survey – Technical preparations – Esterification by organic and inorganic acids – Esterification practices.

Total: 60

TEXT BOOKS

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Groggins, “Unit Processes in Organic Synthesis” 5th Edition, Tata McGraw Hill, 2003.

REFERENCES

1. Maiti, S., “Indroduction to Petrochemicals”, 2nd Edition, Oxford and IBH Publishers, 2002.
2. Wells, M., “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd Edition, Affiliated East-West press, 1993.

PC1354 – PETROLEUM CRUDE PROCESSING TECHNOLOGY

L	T	P
4	0	0

UNIT I GENERAL 12

Origin – Exploration and production of petroleum – Types of crudes, crude composition, characteristics and classification – Crude oil properties – Indigenous and imported crudes – Crude availability Vs Demands.

UNIT II TESTING OF PETROLEUM PRODUCTS 12

IS 1448: Standard – Testing of petroleum crude – Products: Specifications and their significance.

UNIT III CRUDE PROCESSING 12

Pretreatment of crude for refining – Dehydration and desalting – Atmospheric distillation, Vacuum distillation of residue products – Types of trays, flow pattern in the trays – Reflux types and its significance.

UNIT IV LUBE DISTILLATE TREATMENT TECHNIQUES 12

Treatment techniques for vacuum distillates with different processes like solvent extraction, deasphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process – Production of lubricating oils.

UNIT V BITUMEN PROCESSING AND FINAL TREATMENT TECHNIQUES 12

Asphalt manufacture – Air blowing technology – Bitumen types and their properties – Acid gas removal and sulphur removal techniques.

Total: 60

TEXT BOOKS

1. Ram Prasad, “Petroleum Refining Technology”, Khanna Publishers, 2000.
2. Bhaskara Rao, B.K., “Modern Petroleum Refining Processes” 3rd Edition, Oxford and IBH Publishing Company Pvt. Ltd, 1998.
3. Kochu Baby Manjooran. S., “ Modern Petroleum Chemistry”, Leena CJ Kannutheri Publishing, 2005.

REFERENCES

1. Gary, J.H. and Handwerk, G.E., “Petroleum Refining Technology and Economics”, 4th Edition, Marcel Dekker Inc., 2001.
2. Hobson.G.D., “Modern Petroleum Refining Technology”, 4th Edition, Institution of Petroleum, 1973.
3. Nelson.W.L., “Petroleum Refinery Engineering”, McGraw Hill Publishing company Ltd., 1985.
4. Leffler, W. L., “Petroleum Refining”, 3rd Edition, Pern Well Corporation, 2000.

PC1355 – PROCESS DYNAMICS AND CONTROL LABORATORY

L	T	P
0	0	3

1. ON-OFF control of thermal process
2. Flow control loop and Flow Transmitter
3. Level Control loop and Level Transmitter
4. Pressure control loop and Pressure Transmitter
5. Control valve characteristics
6. Verifying the response of Non-Interacting and interacting level System
7. Optimum controller setting using Ziegler's Nichols Methods
8. Optimum Controller Tuning on Level Process Station
9. pH control system
10. First order and second order system
11. Computer controlled heat exchanger (Shell and tube and Double pipe)
12. Pneumatic control valve positioned trainer
13. Cascade control trainer
14. I/P and P/I converter

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

Total: 45

PC1356 – PETROLEUM PHYSICAL PROPERTIES TESTING LABORATORY

L	T	P
0	0	3

1. Determination of flash point by Pensky Marten Closed Cup Apparatus
2. Determination of flash point by Abel Open cup Apparatus
3. Determination of Kinematic Viscosity by Redwood viscometer
4. Determination of Kinematic Viscosity by Saybolt viscometer
5. Determination of Kinematic Viscosity by Engler viscometer
6. Determination of Kinematic Viscosity by U tube viscometer
7. API gravity determination
8. Moisture determination by Dean and Stark Method
9. Water estimation by Karl-Fischer conductometer Apparatus
10. ASTM Distillation
11. Vacuum Distillation
12. Determination of Calorific Value by Junker's Gas Calorific meter.
13. Reid Vapor Pressure Estimation
14. Calorific value by Bomb calorimeter
15. Melting point test

Total: 45

PC1362 – MASS TRANSFER LABORATORY

L	T	P
0	0	3

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

SEMESTER VII

PC1401 – EQUIPMENT DESIGN AND DRAWING II

(To Consider as Practical Subject for Examination Purpose)

L	T	P
2	0	2

UNIT I THERMODYNAMIC PROPERTIES EVALUAION FOR DESIGN 9

Physical properties evaluation, Thermodynamic properties of gases and binary mixtures – Methods of calculations –Vapor-liquid equilibrium data for ideal and non-ideal mixtures. Bubble points and dew points, flash distillation calculation.

UNIT II HEAT EXCHANGER DESIGN 9

Design of double pipe heat exchangers, Heat exchanger types and its selection – shell and tube heat exchangers and Condensers – Effectiveness – NTU method of heat exchanger analysis.

UNIT III EVAPORATOR DESIGN 9

Steam – Uses of steam – Outstanding qualities of steam – BPE – Duhring's rule – Principle of multiple effect evaporation – Temperature driving force – Evaporators types and its selection – Design of single and multiple effect evaporators.

UNIT IV COLUMN DESIGN 9

Design of distillation columns and Absorption columns.

UNIT V PUMPS, FANS AND COMPRESSORS 9

Pumps, fans and compressors – Types and its applications – Characteristics – Piping and pressure drop calculations – Performance analysis of pumps, fans and compressors.

L: 45 P: 15 Total: 60

TEXT BOOKS

1. Ernest E. Ludwig., "Applied Process Design for Chemical and Petrochemical Plants", Vol.I, II and III, Gulf Professional Publishing, 2002.
2. D. Q. Kern, "Process Heat Transfer", Tata McGraw Hill Publishing Co., New Delhi, 1990.

REFERENCE

1. Coulson, M. and Richardson, J.F., "Chemical Engineering", Vol.6, 3rd Edition, Pergamon Press, 1987.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.
3. Van Winkle, "Distillation Operations", McGraw Hill Publications, 1987.

Note: Necessary Data Book is to be issued while conducting Practical Examination

PC1402 – CHEMICAL REACTION ENGINEERING

L	T	P
3	1	0

UNIT I NON-IDEAL REACTORS 9

Residence time distribution function and its measurement – Characteristics of tracer – Mean residence time – Conversion in non-ideal flow reactors.

UNIT II HETROGENEOUS PROCESS AND SOLID CATALYSIS 9

Rate equation for heterogeneous reactions – Nature of catalysis – Adsorption isothermal and rates of adsorption, Desorption and surface reaction analysis of rate equation – Rate controlling steps.

UNIT III GAS-SOLID CATALYTIC REACTORS 9

Characteristics of catalysed reactions – Mechanism of solid catalysed reactions – Pore diffusion resistance combined with surface kinetics – Performance equations for reactors containing porous catalysts.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 9

Selection of the kinetic model – Progressive-conversion model, Shrinking-core model – Shrinking-core model for spherical particles of unchanging size – Shrinking-core model for cylindrical particles of unchanging size.

UNIT V GAS-LIQUID REACTIONS 9

Various ways of carrying out gas-liquid reactions catalysed by solids – General rate equation – Resistances in series in the gas-liquid reaction on catalyst surface.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Levenspiel, O., “Chemical Reaction Engineering”, 3rd Edition, Wiley Asian Edition, 1990.
2. Smith, J.M., “Chemical Engineering Kinetics”, 2nd Edition, McGraw Hill, 1984.

REFERENCES

1. Scott Fogler, H., “Elements of Chemical Reaction Engineering”, 4th Edition, Prentice Hall of India.2009
2. Gavanhe, K.A., “Chemical Reaction Engineering I”, Nirali Prakashan Publishers, 2007.
3. Dawande, D., “Principles of Reaction Engineering”, 1st Edition, Central Techno Publications, 2001.

PC1403 – PETROCHEMICAL DERIVATIVES

L	T	P
4	0	0

UNIT I FIRST GENERATION PETROCHEMICALS I 12

Alternate routes with Flow diagram for Production of Methane – Ethane – Propane – Ethylene – Propylene – Butylenes – Acetylene – Naphthalene – Chemicals from Methane – Ethane – Propane – Ethylene – Propylene – Butylenes –Acetylene.

UNIT II FIRST GENERATION PETROCHEMICALS II 12

Alternate routes with Flow diagram for production of Butadiene – Related dienes, aromatics – Benzene, toluene, xylene – Chemicals from Butadiene, related dienes, aromatics – Benzene, toluene, xylene.

UNIT III SECOND GENERATION PETROCHEMICALS 12

Alternate routes with Flow diagram for Production of Ethylene glycol – VCM – Acrylonitrile – Phenol – Caprolactum – Adipic acid – Hexamethylene diamine – DMT – TPA –Maleic anhydride – Styrene.

UNIT IV THIRD GENERATION PETROCHEMICALS I 12

Polymerisation – Modes and Techniques – Production of Polyethylene – LDPE – HDPE – Polypropylene – Poly Butadiene Rubber – SBR –Polystyrene – SAN – ABS.

UNIT V THIRD GENERATION PETROCHEMICALS II 12

Polyacrylonitrile – Polyvinyl Chloride – Polycarbonates – Nylon 6 – Nylon 66 – PolyEsters – Formaldehyde resins – Explosives – Dyes.

Total: 60

TEXT BOOKS

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Sukumar Maiti, “Indroduction to Petrochemicals”, 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd Edition, Gulf Publishing Company, 2000.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd Edition, Affiliated East-West Press, 1993.

PC1404 – PETROLEUM SECONDARY PROCESSING TECHNOLOGY

L	T	P
4	0	0

UNIT I SECONDARY PROCESSING 12

Need and significance – Types and functions of secondary processing – Visbreaking – Processes, Operating parameters and advantages – Coking – Operating parameters and advantages.

UNIT II CRACKING 12

Thermal Cracking – Processes – Operating parameters – Feed stock selection and product yields – Advantages – Free radical mechanism.

Fluid catalytic cracking – Processes – Operating parameters – Feed stock selection and product yields – Advantages – Catalyst used and regeneration – Cation mechanism.

UNIT III HYDROCRACKING AND HYDROTREATING 12

Hydrocracking – Principles – Process requirements, product yields and qualities and Residcracking – Hydrotreating – Sulphur removal – Aromatics removal – Hydrofinishing.

UNIT IV REFORMING 12

Reforming – Principles – Processes – Operating parameters – Catalyst types – Performance – Effects of operating parameters – Feed quality and Regeneration.

UNIT V OTHER PROCESSES 12

Isomerisation – Processes, Operating parameters – Advantages – Alkylation – Processes – Operating parameters – Advantages – Polymerisation – Processes – Operating parameters – Advantages.

Total: 60

TEXT BOOKS

1. Ram Prasad, “Petroleum Refining Technology”, Khanna Publishers,2007
2. Bhaskara Rao, B.K., “Modern Petroleum Refining Processes”, 4th Edition, Oxford and IBH Publishing Company Pvt. Ltd, 2002.

REFERENCES

1. James H. Gary and Glenn E. Handwerk., “Petroleum Refining Technology and Economics”, 4th Edition, Marcel Dekker Inc., 2001.
2. Nelson, W. L., “Petroleum Refinery Engineering”, McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G. D., “Modern Petroleum Refining Technology “, 5th Edition, John Wiley Publishers, 1984.

CH1404 – WATER TREATMENT AND MANAGEMENT

L	T	P
4	0	0

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 – Removal of odour, colour and taste.

UNIT II EXTERNAL TREATMENT PROCESS 12

Softening by Ion – exchange process, Demineralization – Cation exchange materials – Removal of ion, Manganese – Deaeration – Oxidation – Fluoridation – Dealkalisation – Desalination by Reverse osmosis – Electrodialysis and Freezing.

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 – Optimisation – 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. Bansil, P.C.,"Water Management in India", Concept Publishing company, 1st Edition, 2004.
2. Bridie, G.S and Bridie, J.S., "Water Supply and Sanitary Engineering", 7th Edition, Dhanpat Raj Publishing company (P) Ltd., 2003.

REFERENCES

1. Austin, G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw Hill, 1998.
2. Rangwala, S.C., "Water supply and Sanitary Engineering", 18th Edition, Charotar Publishing House, 2003.
3. Pandey, G.N., "Text Book of Chemical Technology", Vikas Publishing House Pvt. Ltd., 1992.

PC1405 – PETROCHEMICAL ANALYSIS LABORATORY

L	T	P
0	0	3

1. Sulphur content determination
2. Flue gas analysis – Orsat Apparatus
3. Aromatic content determination
4. Hydrogen sulphide content determination
5. Mercaptan as sulphur estimation apparatus
6. Determination of Lead, Acid and Salt content
7. Oil separation from lubricating grease (Oil Separation Apparatus)
8. Analysis of petrochemicals using UV spectrophotometer
9. Analysis of petrochemicals using NMR with MS
10. Analysis of petrochemicals using gas chromatography
11. Biodegradation of petrochemicals
12. Bioremediation of petrochemicals
13. Refractive index of petrochemicals
14. Determination of moisture content – KF titrator
15. Total acidity determination

Total: 45

PC1406 – PETROLEUM PRODUCT TESTING LABORATORY

L	T	P
0	0	3

1. Determination of Aniline point and Diesel Index
2. Softening point of bitumen by ring and ball method
3. Ductility and penetration number of bitumen
4. Rust preventing characteristics of lube oil
5. Drop point of greases
6. Cloud and pour point determination
7. Smoke point determination
8. Copper corrosion test of petroleum products
9. Sediment content of crude oil and fuel oils
10. Coking Tendency of oil
11. Saybolt Color of petroleum products / Loviband Tintometer
12. Water separability of petroleum products
13. Refractive index of Petroleum products
14. Hydrocarbon types in petroleum products
15. Carbon residue determination
16. Oxidation stability of gasoline and ATF
17. Bearing and grease noise characteristics

Total: 45

PC1407 – CHEMICAL REACTION ENGINEERING LABORATORY

L	T	P
0	0	3

1. Determination of reaction rate constant for a saponification reaction in batch reactor I.
2. Determination of reaction rate constant for a saponification reaction in batch reactor II.
3. Determination of reaction rate constant for a saponification reaction in plug flow reactor.
4. Determination of reaction rate constant for a saponification reaction in packed bed reactor.
5. Determination of reaction rate constant for a saponification reaction in mixed flow reactor.
6. Determination of reaction rate constant for a saponification reaction in semi-batch reactor I.
7. Determination of reaction rate constant for a saponification reaction in isothermal-batch reactor.
8. Determination of the rate frequency factor and activation energy for acetic anhydride hydrolysis using adiabatic reactor.
9. Determination of the mean residence time by RTD studies in plug flow reactor.
10. Determination of the mean residence time by RTD studies in mixed flow reactor.
11. Determination of the mean residence time by RTD studies in packed bed reactor.
12. Determination of the rate constant for a saponification reaction in equal sized CSTR's in series.

Total: 45

SEMESTER VIII

MG1352 – TOTAL QUALITY MANAGEMENT

L	T	P
3	0	0

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 – TS 16949 – ISO 14000 – Concept, requirements and benefits.

Total : 45

TEXT BOOKS

1. Dale H. Besterfiled, “Total Quality Management”, Pearson Education, Inc. 2003.
2. James R. Evans and William M. Lidsay, “The Management and Control of Quality”, 5th Edition, South-Western, 2002.

REFERENCES

1. Feigenbaum, A.V., “Total Quality Management”, McGraw Hill, 1991.
2. Oakland, J.S., “Total Quality Management”, Butterworth Heineman, 1989.
3. Narayana V. and Sreenivasan, N.S., “Quality Management – Concepts and Tasks”, New Age International, 1996.
4. Zeiri, “Total Quality Management for Engineers”, Wood Head Publishers, 1991.

MG1453 – SAFETY AND RISK MANAGEMENTS

L	T	P
4	0	0

UNIT I INDUSTRIAL SAFETY 15

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

UNIT II HAZARD ANALYSIS 15

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

UNIT III RISK MANAGEMENT 15

Overall risk analysis – Chapains model, Eand FI model– Generation of meteorological data – Ignition data – Population data – Overall risk contours for different failure scenarios – Disastar management plan – Emergency planning – Onsiteand offsite emergency planning – Risk management – Gas processing complex, refinery – First Aids.

UNIT IV SAFETY PROCEDURES 7

Safety in plant design and layout – Safety acts and regulations for industries.

UNIT V SAFETY IN HANDLING and STORAGE OF CHEMICALS 8

Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personal protection.

Total: 60

TEXT BOOKS

1. Raghavan, K.V. and Khan, A.A., “Methodologies in Hazard Identification and Risk Assessment”, Manual by CLRI, 1990.
2. Blake, R.P., “Industrial Safety”, Prentice Hall, 1953.
3. Lees, F.P., “Loss Prevention in Process Industries”, 2nd Edition, Butterworth Heinemann,1996.

REFERENCES

1. “A Guide to Hazard Operability Studies”, Chemical Industry Safety Council, 1977.
2. Geoff Wells,”Hazard Identification and risk assessment”, I.ChE, UK.

PC1455 – PROJECT WORK

L	T	P
0	0	12

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, innovation and information, and strengthen the 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 major project may be assigned to a group of two students. The project topic allotted may be of theoretical, experimental or industrial projects to be carried out under the supervision of internal guide and external guide (in case of industrial projects).

Major projects are to be executed strictly as per the project schedule prepared during VIII semester. 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.

On completion of the project work, each student has to prepare a project report and submit the same in triplicate to the department. The project work and the report will be evaluated by the internal assessment committee for a total of 100 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

ELECTIVES FOR VII SEMESTER

CH1008 – PROCESS MODELLING AND SIMULATION

L	T	P
4	0	0

UNIT I INTRODUCTION ON MODELS 12

Introduction – Models and model building – Principles of model formulation – Fundamental laws – continuity equation – Energy equation – Equations of motion – Transport equation – Equations of state – Equilibrium and kinetics – Classification of mathematical models.

Numerical solutions of model equations – Linear and non linear algebraic equations in one and more than one variables.

UNIT II LUMPED PARAMETER MODELS 12

Formulation and solution techniques to be discussed for vapour liquid equilibrium models – Dew point and flash calculations for multicomponent systems – Boiling operations – Batch and continuous distillation models, tank models, mixing tank, stirred tank with heating – CSTR with multiple reactions – Non-isothermal CSTR-multiplicity and stability – Control at the unsteady state – Non-ideal CSTR models-multi-parameter models with dead space and bypassing – Staged operation

UNIT III DISTRIBUTED PARAMETER MODELS(STEADY STATE) 12

Formulation and solution of split boundary value problems-shooting technique – Quasi-linearization techniques – Counter current heat exchanger – Tubular reactor with axial dispersion – Counter current gas absorber.

Pipe line gas flow – Tubular permeation process – Pipe line flasher.

UNIT IV UNSTEADY STATE DISTRIBUTED PARAMETER MODELS 12

Solution of partial differential equations using finite difference method – Convective problems, diffusive problems – Combined convective and diffusive problems – Unsteady state conduction and diffusion – Unsteady state heat exchangers – Dynamics of tubular reactor with dispersion – Transfer function models for distributed parameter systems.

UNIT V MODEL PARAMETERS ESTIMATION 12

Introduction, method of least squares – Curve fitting, parameter estimation of dynamic transfer function models – Least square and recursive least square methods – Parameter estimation of RTD models – Moments method.

Total: 60

TEXT BOOKS

1. Ramirez, W.F., “Computational Methods in Process Simulation”, Butterworth Publishers, 1989.
2. Roger E. Franks., “Modelling and Simulation in Chemical Engineering”, John Wiley and Sons, 1972.

REFERENCES

1. Luyben, W.L., “Process Modelling, Simulation and Control for Chemical Engineers”, 1990.
2. Santhosh Kumar Gupta, “Numerical Methods for Engineers”, Tata McGraw Hill, 1995.
3. Seinfeld and Lapidus, “Mathematical Methods in Chemical Engineering”, Prentice Hall, 1974.

CH1009 – TRANSPORT PHENOMENA

L	T	P
4	0	0

UNIT I FUNDAMENTALS OF TRANSPORT PHENOMENA 12

The nature of transport phenomena: Importance, mechanism – Driving force – Analogous nature – Conservation laws – Method of study: differential, integral and experimental methods – Phenomenological laws of transport properties – Newtonian and non newtonian fluids – Rheological models – Effect of pressure and temperature on viscosity.

UNIT II ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 12

General methods of shell balance approach to transfer problems – Momentum flux and velocity distribution for flow of Newtonian fluids in pipes, planes, slits and annulus – Heat flux and temperature distribution for heat sources such as electrical, viscous – Mass flux and concentration profile for diffusion in stagnant gas systems involving reaction.

UNIT III EQUATION OF CHANGE AND THEIR APPLICATIONS 12

Development of the equation of change for isothermal systems – Non-isothermal systems and multicomponent system – Use of equation of change for flow in a circular pipe – Rotating liquid – Temperature distribution in a rotating cylinder with viscous dissipation and flow of a newtonian fluid with constant energy flux – Concentration profile in a tubular reactor and gas diffusion through a solid – Dimensional analysis of the equation of change – Equation of motion for forced and free convection.

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 12

Time smoothed equation of change for velocity and temperature distribution – Time smoothed velocity distribution near a wall and circular jet – Time smoothed temperature profile near a wall, turbulent flow in pipes and jets – Time smoothed concentration and equation of continuity with application to turbulent mixing and reaction – Boundary layer theory, thickness, velocity separation and flow around objects, flat plate, application of penetration theory for high mass transfer rate.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 12

Importance of analogy – Development and applications of analogies between momentum, heat and mass transfer – Reynolds, Prandtl, Von Karman, Colburn analogies.

Total: 60

TEXT BOOKS

1. Bird, R.B., Stewart, W.E. and Light foot,E.N., “Transport Phenomena” John Wiley and Sons, 2002.
2. Welty, J.R., Wick, C.E., and Wilson, R.E., “Fundamentals of Momentum, Heat and Mass Transfer”, John Wiley Sons, 2002.

REFERENCES

1. William J. Thomson., “Introduction to Transport Phenomena”, Pearson Education Asia, 2000.
2. Richard G. Griskey., “Transport Phenomena and Unit Operations”, Wiley-Interscience, 2002.
3. Beek, W.J., Muttzall, K.M.K., and Van Heuven, J.W., “Transport Phenomena”, 2nd Edition, John Wiley and Sons, Ltd., 2000.

PC1001 – PROCESS INTRUMENTATION

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UNIT I PHYSICAL PROPERTY MEASUREMENT 12

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

UNIT II TEMPERATURE MEASUREMENT 12

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

UNIT III PRESSURE MEASUREMENT 12

Absolute pressure – Gauge pressure and 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 12

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 12

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

Total: 60

TEXT BOOKS

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

REFERENCES

1. Doebelin, E.O., “Measurement System Application and Design”, 4th Edition, McGraw Hill, 1998.
2. Patranabis, D., “Principles of Industrial Instrumentation”, 2nd Edition, Tata McGraw-Hill, 2007.
3. Sawhney, A.K., “A Course in Electrical, Electronics Measurement and Instrumentation”, Dhanpat Rai and Sons, 1999.

PC1002 – FLUIDIZATION ENGINEERING

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UNIT I BASICS OF FLUIDIZATION 12

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 12

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

UNIT III DESIGN ASPECTS 12

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 12

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

UNIT V OTHER TYPES OF FLUIDIZATION 12

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

Total: 60

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.

PC1003 – PETROLEUM PROCESS EQUIPMENT AUXILIARIES

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UNIT I ELECTRICAL MOTORS AND STARTERS 12

Electrical motors – Induction –Synchronous – Electrical Starters.

UNIT II ROTARY EQUIPMENT 12

Pumps –Turbines – Blowers – Compressors – Fans – Concept – Working and application.

UNIT III INDUSTRIAL VALVE 12

Needle valves – Globe, gate and ball valves – Butterfly valves – Check and needle valves – Piping system.

UNIT IV INDUSTRIAL DRYERS 12

Rotary fluid bed – Spray and freeze dryers – Electrosmotic dryers – Rotary dryer – Case studies.

UNIT V PROCESS UTILITY EQUIPMENTS 12

Vacuum devices – Filters – Cooling towers – Refrigeration systems – Flare system – Equipments for waste water treatment systems.

Total: 60

TEXT BOOKS

1. Stanley M.Walas, “Chemical Process Equipment”, Butterworth – Heinemann Oxford Publishing Ltd., 1999.
2. Charles E. Thomas, “Process Technology – Equipment and systems”, Uhai Publishing, Inc., 2002.

REFERENCES

3. Ernest E. Ludwig., “Applied Process Design for Chemical and Petrochemical Plants”, Vol.I and III, Gulf Professional Publishing, 2002.
4. Robert H. Perry and Don W. Green, “Perry’s Chemical Engineer’s Hand Book”, 7th Edition, Mc Graw Hill – International, 1997.
5. Sahu,G.K., “Hand Book of Piping Design” New Age International Publishers, 2005.

CH1002 – INDUSTRIAL MANAGEMENT

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UNIT I PERSONNEL MANAGEMENT 12

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 12

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 12

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 12

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 12

Amortisation, Capital recovery, Depreciation – Economics of selecting alternatetives – Rate of return and payout time – Budgeting – Operation Management – Strategic analysis – Problem solving technioques – Preparation of technical reports – Process Improvement.

Total: 60

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. John A. Kermath Case 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.

ELECTIVES FOR VIII SEMESTER

CH1004 – ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

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UNIT I ENERGY RESOURCES - A GLOBAL VIEW 12

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 12

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 12

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 12

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 12

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: 60

TEXT BOOKS

1. Jerrold H. Krentz, “Energy Conservation and Utilisation”, Allyn and Bacur Inc., 1976.
2. Gemand M.Gramlay, “Energy”, Macmillon Publishing Co., 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.
3. Samir Sarkar, “Fuels and Combustion”, 2nd Edition, Orient Longman Publication, 1988.

PC1004 – NOVEL SEPARATION PROCESS

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UNIT I MEMBRANE SEPARATIONS 12

Types and choice of membranes **–** Plate and frame membranes, tubular membranes, spiral wound membranes, hollow fibre membrane and their relative merits, membrane reactors, membrane permeators involving Dialysis **–** Reverse osmosis **–** Ultrafiltration **–** Donnan dialysis.

UNIT II SEPARATIONS BY ADSORPTION TECHNIQUES 12

Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysterisis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stagewise adsorption – Single and multistage crosscurrent adsorption – Break through curves and rates of adsorption.

UNIT III CHROMATOGRAPHY TECHNIQUES 12

Affinity chromatography, immuno chromatography and Ion exchange chromatography –Introduction – Principles – Types of equipment – Commercial processes – Applications.

UNIT IV IONIC SEPARATIONS 12

Electrophoresis – Introduction – Electrokinetics – The electrical double layer – Zeta potential and electrophoresis – Laboratory methods – Analytical and Preparative methods – Applications Electrodialysis – Principles and applications.

UNIT V ZONE MELTING 12

Zone melting – Introduction – Equilibrium Diagram – Apparatus and Applications – Large scale and continuous operations – Limitations.

Total: 60

TEXT BOOKS

1. Schoen, H.M., “New Chemical Engineering Separation Techniques”, Interscience Publishers, 1972.
2. Treybal, R.E., “Mass Transfer Operations”, 3 rd Edition., McGraw Hill Book Co., 1980.

REFERENCES

1. Christie J. Geankoplis, “Transport Processes and Unit Operations”, 3rd Edition, Prentice Hall of India Pvt. Ltd, 2000.
2. Sivasankar.B, “Bioseparations Principles and Techniques”, Prentice Hall India Pvt. Ltd, 2006.
3. Seader, J.D. and Ernest J.Henley., ”Separation Process Principles”, 2nd Edition, John Wiley and Sons,Inc, , 2006.

CH1001 – FERTILIZER TECHNOLOGY

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UNIT I NITROGENOUS FERTILISERS 15

Feed stock for production of ammonia – Natural gas – Associated gas – Coke-oven gas – Naphtha – Fuel oil – Petroleum heavy stock – Coal, electricity etc – Processes for gasification and methods of production of ammonia and nitric acid – Nitrogenous fertilizer – Ammonium sulphate , nitrate, urea and calcium ammonium nitrate – Ammonium chloride and their methods of production – Characteristics and specifications – Storage and handling.

UNIT II PHOSPHATIC FERTILISERS 14

Raw materials; phosphate rock, sulphur, pyrites etc- Processes for the production of sulphuric and phosphoric acids – Phosphates fertilizers – Ground rock phosphate – Bone meal-Single super phosphate and triple super phosphate – Thermal phosphates and their methods of production – Characteristics and specifications.

UNIT III POTASSIC FERTILISERS 7

Methods of production of potassium chloride – Potassium schoenite – Their characteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 12

Methods of production of ammonium phosphate, Sulphate, diammonium phosphate – Nitro phosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MISCELLANEOUS FERTILISERS 12

Mixed fertilizers and granulated mixtures – Biofertilisers – Nutrients – Secondary nutrients and micro nutrients – Fluid fertilizers – Controlled release fertilizers – Controlled release fertilizers.

Total: 60

TEXT BOOKS

1. "Handbook of Fertiliser Technology", Association of India, 1977.
2. Menon, M.G., "Fertiliser Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

REFERENCES

1. Sauchelli, V., "The Chemistry and Technology of Fertilisers", ACS Monograph No. 148, Reinhold Publishing Cor., 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", 1967.
3. Slack, A.V., "Chemistry and Technology of Fertilisers", Interscience, 1966.

PC1005 – MULTICOMPONENT DISTILLATION

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UNIT I THERMODYNAMIC PRINCIPLES 12

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys.

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

UNIT II THERMODYNAMIC PROPERTY EVALUATION 12

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

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM 12

Definition of minimum reflux ratio – calculation of R_m for multi component distillation – Underwood method – Colburn method.

UNIT IV VARIOUS METHODS OF MCD COLUMN DESIGN 12

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

UNIT V VARIOUS TYPES OF MCD COLUMNS 12

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

Total: 60

TEXT BOOKS

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

REFERENCES

1. King, C.J., “ Separation Process Principles”, Mc Graw Publications, 1986.
2. Treybal, R.E., “ Mass Ttransfer Operations”, 5th Edition, Mc Graw Hill publications. 1996.
3. Mc Cabe and Smith, J.C., Harriot., “Unit Operation of Chemical Engineering”, 6th Edition, McGraw Hill, 2001.

PC1006 – COMBUSTION AND FURNACE DESIGN

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UNIT I COMBUSTION STOICHIOMETRY 12

Stoichiometry relations – Theoretical air required for complete combustion – Calculation of minimum amount of air required for a fuel of known composition – Calculation of dry flue gases if fuel composition is known – Calculation of the composition of fuel and excess air supplied, from exhaust gas analysis – Dew point of products – Flue gas analysis (O_2, CO_2, CO, NO_X, SO_X).

UNIT II COMBUSTION THERMODYNAMICS AND KINETICS 12

Combustion reaction – Reaction kinetics – Rate of reaction – Mass and energy balance of chemical reactions – First and second law analysis of combustion system – Adiabatic flame temperature-Calculation of equilibrium composition and temperature.

UNIT III TUBESTILL HEATERS 12

Types of stills – Radiant and convection heat recovery sections – Radiant absorption rate – Lobo-Evans method – distribution of radiant heat – Rate of heat absorption in the convection section – Pipe still losses – Pipe still design – Pressure drop in Pipe stills – Gas and oil fired burner design, Refractory lining – Air pre-heater and economizer design – Furnace efficiency and safety.

UNIT IV HEAT TREATMENT FURNACE 12

Muffle Furnace – Bogey hearth furnace – Rotary hearth furnaces – Open hearth furnaces – Retards – Kilns – Horizontal and Vertical tube furnaces.

UNIT V BURNER DESIGN 12

Ignition – Concept of ignition - Functional requirements of burners – Ignitors – Auto ignitors – Ignition temperature – Various types of ignitors.

Flame propagation – Deflagration – Flammability limits – Flame blow out and flash back – Flame quenching.

Various methods of flame stabilization – Incorporation in burner design – Swirl number and its significance – Basic features and types of solid, liquid and gaseous fuel burner – Design considerations of different types of coal – Oil and gas burners – Atomization for oil burners – Recuperative burners – Regenerative burners – Domestic burners – Properties of solid, liquid and gaseous fuels with reference to suitability for a given burner type – selection of an appropriate type of burner and design of the burner for a specified duty.

Total: 60

TEXT BOOKS

1. Samir Sarkar, “Fuels and Combustion”, 2nd Edition, Orient Longman Publication, 1988.
2. John Griswold, “Fuel Combustion and Furnaces”, McGraw Hill, 1996.

REFERENCES

1. Bhatt, B.I. and Vora, S.M., “ Stoichiometry”, 3rd Edition., TMH, 1976.
2. Gupta, O.P., “ Elements of Fuels, Furnaces and Refractories”, Khanna Publishers,2007.
3. Rai,G.N., “Non Conventional Energy Sources,” Khanna Publishers, 1999.

PC1007 – POLYMER TECHNOLOGY

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UNIT I CHARACTERISTICS, ANALYSIS OF POLYMERS 12

The science of large molecules – Theory of polymer solutions – Measurement of molecular weight and size – Analysis and testing of polymers.

UNIT II POLYMER MATERIAL STRUCTURE AND PROPERTIES 12

Deformation, flow and melt characteristics – Morphology and order in crystalline polymers – Rheology and the mechanical properties of polymers – Polymer structure and physical properties.

UNIT III POLYMER SYNTHESIS AND REACTION ENGINEERING 12

Condensation polymerization – Addition polymerization – Ionic and coordination polymerization – Copolymerisation – Polymerization conditions and polymer reactions.

UNIT IV INDUSTRIAL POLYMERS: MANUFACTURING PROCESS AND APPLICATIONS 12

Hydrocarbon plastics and elastomers – Other carbon chain polymers – Heterochain thermoplastics, thermosetting resins.

UNIT V PROCESSING OF POLYMERS: PLASTICS, FIBRES AND ELASTOMERS 12

Polymers developed for synthetic plastics, fibres and elastomer applications – Plastics technology – Fiber technology – Elastomer technology.

Total: 60

TEXT BOOKS

1. Billmeyer Jr, F.W., " Text Book of Polymer Science", 3rd Edition., Wiley Inter Science, 1984.
2. Gowarikar, V.R., Viswanathan, N.V. and Heaved Sridhar., "Polymer science", 1st Edition, New Age International Ltd, 2003.

REFERENCES

1. Rodriguez, F., "Principals of Polymer Systems", 4th Edition, Taylor and Francis, 1996.
2. Herman F.Mark., "Encyclopedia of Polymer Science and Technology", 3rd Edition John Wiley Inter Science, 2007
3. Robert O. Ebewele, "Polymer Science and Technology**",** CRC Press, 2000.