

**ANNA UNIVERSITY TIRUCHIRAPPALLI****Tiruchirappalli – 620 024****Regulations 2008****Curriculum****B.TECH. PETROCHEMICAL TECHNOLOGY****SEMESTER III**

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>MA1201</b>	Transforms and Partial Differential Equations	3	1	0	4
2	<b>PC1201</b>	Organic Chemistry	3	0	0	3
3	<b>HS1201</b>	Environmental Science and Engineering	3	0	0	3
4	<b>PC1202</b>	Industrial Chemical Technology	3	0	0	3
5	<b>EE1205</b>	Electrical Drives and Control	3	0	0	3
6	<b>CS1201</b>	Data Structures	3	0	0	3
<b>Practical</b>						
7	<b>PC1203</b>	Organic Chemistry Laboratory	0	0	3	2
8	<b>EE1208</b>	Electrical Machines Laboratory	0	0	3	2
9	<b>CS1203</b>	Data Structures Laboratory	0	0	3	2
<b>Total</b>						<b>25</b>

**SEMESTER IV**

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>MA1251</b>	Numerical Methods	3	1	0	4
2	<b>HS1251</b>	Physical Chemistry	3	0	0	3
3	<b>HS1252</b>	Material Technology	3	0	0	3
4	<b>CH1257</b>	Process Calculations	4	0	0	4
5	<b>CH1205</b>	Fluid Flow Operations	3	0	0	3
6	<b>CH1258</b>	Mechanical Operations	3	0	0	3
<b>Practical</b>						
7	<b>PC1252</b>	Physical Chemistry Laboratory	0	0	3	2
8	<b>CH1206</b>	Fluid Flow Operations Laboratory	0	0	3	2
9	<b>CH1259</b>	Mechanical Operations Laboratory	0	0	3	2
<b>Total</b>						<b>26</b>

## SEMESTER V

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>MA1302</b>	Special Functions	3	1	0	4
2	<b>CH1308</b>	Heat Transfer	4	0	0	4
3	<b>PC1301</b>	Mass Transfer Fundamentals	4	0	0	4
4	<b>ME1312</b>	Engineering Thermodynamics	4	0	0	4
5	<b>PC1302</b>	Natural Gas Engineering	4	0	0	4
6	<b>PC1303</b>	Petroleum Exploration and Exploitation Techniques	3	1	0	4
<b>Practical</b>						
7	<b>CH1309</b>	Heat Transfer Laboratory	0	0	3	2
8	<b>PC1304</b>	Technical Analysis Laboratory	0	0	3	2
9	<b>HS1301</b>	Communication and Soft Skills Laboratory	0	0	3	1
<b>Total</b>						<b>29</b>

## SEMESTER VI

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>CH1360</b>	Process Dynamics and Control	4	0	0	4
2	<b>CH1361</b>	Mass Transfer Operations	3	1	0	4
3	<b>PC1351</b>	Principles of Chemical Kinetics	4	0	0	4
4	<b>PC1352</b>	Equipment Design and Drawing I	2	0	2	4
5	<b>PC1354</b>	Petrochemical Unit Processes	4	0	0	4
6	<b>PC1355</b>	Petroleum Crude Processing Technology	4	0	0	4
<b>Practical</b>						
7	<b>PC1356</b>	Process Dynamics and Control Laboratory	0	0	3	2
8	<b>PC1357</b>	Petroleum Physical Properties Testing Laboratory	0	0	3	2
9	<b>CH1362</b>	Mass Transfer Laboratory	0	0	3	2
<b>Total</b>						<b>30</b>

## SEMESTER VII

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>PC1401</b>	Equipment Design and Drawing II	2	0	2	4
2	<b>PC1402</b>	Chemical Reaction Engineering	3	1	0	4
3	<b>PC1403</b>	Petrochemical Derivatives	4	0	0	4
4	<b>PC1404</b>	Petroleum Secondary Processing Technology	4	0	0	4
5	<b>CH1404</b>	Water Treatment and Management	4	0	0	4
6	<b>E1****</b>	Elective I	3	0	0	3
<b>Practical</b>						
7	<b>PC1405</b>	Petrochemical Analysis Laboratory	0	0	3	2
8	<b>PC1406</b>	Petroleum Product Testing Laboratory	0	0	3	2
9	<b>PC1407</b>	Chemical Reaction Engineering Laboratory	0	0	3	2
<b>Total</b>						<b>29</b>

## SEMESTER VIII

S.No.	Subject Code	Subject	L	T	P	C
<b>Theory</b>						
1	<b>MG1301</b>	Total Quality Management	3	0	0	3
2	<b>MG1354</b>	Safety and Risk Management	3	0	0	3
<b>Practical</b>						
3	<b>PC1455</b>	Project Work	0	0	12	6
<b>Total</b>						<b>12</b>

## LIST OF ELECTIVES

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

# ANNA UNIVERSITY TIRUCHIRAPPALLI

Tiruchirappalli – 620 024

Regulations 2008

Syllabus

**B.TECH. PETROCHEMICAL TECHNOLOGY**

**SEMESTER III**

**MA1201 – TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**

**L T P C**

**3 1 0 4**

**UNIT I 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 II 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 III PARTIAL DIFFERENTIAL EQUATIONS 9**

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

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

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

**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**

## TEXTBOOKS

1. Grewal B.S, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, 2007.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill Company Ltd., 2007.

## REFERENCES

1. Bali.N.P. and Manish Goyal., "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications (P) Ltd.
2. Ramana.B.V., "Higher Engineering Mathematics" Tata McGraw Hill.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics" 8th Edition, Wiley India, 2007.

## PC1201 – ORGANIC CHEMISTRY

L T P C

3 0 0 3

### 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 monocarboxylic 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.

**Total: 45**

### TEXT BOOKS

1. Morrison R.T. and Boyd R.N., "Organic chemistry", 6th Edition, Prentice Hall of India (P) Ltd., 2003.
2. Arun Bahl and Bahl B.S., "Advanced Organic Chemistry", 16th Edition, S.Chand and Company Ltd., 2002.

### REFERENCES

1. March J., "March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure", 5th Edition, John Wiley, 2001.
2. Finar I.L., "Organic chemistry" Vol-I, 6th Edition, Pearson Education, 2002.
3. Sharma B.K., "Industrial Chemistry", 12th Edition, Goel Publishing house, 2001.

## HS1201 – ENVIRONMENTAL SCIENCE AND ENGINEERING

L T P C

3 0 0 3

### UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9

Definition, scope and importance – Need for public awareness – Forest resources – Use and over-exploitation – Deforestation – Case studies – Timber extraction – Mining – Dams and their ground water – Floods – Drought – Conflicts over water – Dams – Benefits and problems – Mineral resources – Use effects on forests and tribal people – Water resources – Use and over-utilization of surface and exploitation – Environmental effects of extracting and using mineral resources – Case studies – Food resources – World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture – Fertilizer – Pesticide problems – Water logging, salinity – Case studies – Energy resources – Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Case studies – Land resources – Land as a resource – Land degradation – Man induced landslides – Soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

### UNIT II ECOSYSTEMS AND BIODIVERSITY 9

Concepts of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (A) Forest ecosystem (B) Grassland ecosystem (C) Desert ecosystem (D) Aquatic ecosystems (Ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity – Definition genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity – Consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

### UNIT III ENVIRONMENTAL POLLUTION 9

Definition – Causes, effects and control measures of:- (A) Air pollution (B) Water pollution (C) Soil pollution (D) Marine pollution (E) Noise pollution (F) Thermal pollution (G) Nuclear hazards – Solid waste management:- Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management:- Floods, earthquake, cyclone and landslides.

### UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From unsustainable to sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people, Its problems and concerns, Case studies – Environmental ethics:- Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies – Wasteland reclamation – Consumerism and waste products – Environment production act – Air (Prevention and control of pollution) act – Water (Prevention and control of pollution) act – Wildlife protection act – Forest conservation act – Issues involved in enforcement of environmental legislation – Public awareness.

## **UNIT V HUMAN POPULATION AND THE ENVIRONMENT**

**9**

Population growth, variation among nations – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV /AIDS – Women and child welfare – Role of information technology in environment and human health – Case studies.

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

Field study of common plants, insects and birds – Field study of simple ecosystems – Pond, river, hill slopes, etc.

Field study of local polluted site – Urban/rural/industrial/agricultural

**Total: 45**

### **TEXT BOOKS**

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

### **REFERENCES**

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

## PC1202 – INDUSTRIAL CHEMICAL TECHNOLOGY

L	T	P	C
3	0	0	3

### UNIT I ALKALIES 9

Chloro-alkali industries – Manufacture of soda ash – Caustic soda – Chlorine.

### UNIT II ACIDS 9

Manufacture of sulphuric acid – Hydrochloric acid – Phosphoric acid – Nitric acid.

### UNIT III GLASSES 9

Manufacture of glasses – Special glasses – Ceramics and refractories – Paints and pigments.

### UNIT IV INDUSTRIAL GASES 9

Manufacture of carbon dioxide – Nitrogen – Hydrogen – Oxygen and acetylene.

### UNIT V FERTILIZERS 9

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: 45**

### 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”, 3rd 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.

## EE1205 – ELECTRICAL DRIVES AND CONTROL

(Common to Mechanical, Production and Petrochemical technology)

L	T	P	C
3	0	0	3

### UNIT I INTRODUCTION 9

Basic elements – Types of electric drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and load variation factors

### UNIT II MOTOR CHARACTERISTICS 9

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

### UNIT III STARTING METHODS 9

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

### UNIT IV CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES 9

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

### UNIT V CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES 9

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

**Total: 45**

#### TEXT BOOKS

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

#### REFERENCES

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

## CS1201 – DATA STRUCTURES

**L T P C**  
**3 0 0 3**

### **UNIT I FUNDAMENTALS OF ALGORITHMS 8**

Algorithm – Analysis of algorithm – Best case and worst case complexities – Analysis of algorithm using data structures – Performance analysis – Time complexity – Space complexity – Amortized time complexity – Asymptotic notation.

### **UNIT II FUNDAMENTALS OF DATA STRUCTURES 9**

Arrays – Structures – Stacks – Definition and examples – Representing stacks – Queues and lists – Queue and its representation – Applications of stack – Queue and linked lists.

### **UNIT III TREES 10**

Binary trees – Operations on binary tree representations – Node representation – Internal and external nodes – Implicit array representation – Binary tree traversal – Huffman algorithm – Representing lists as binary trees – Sorting and searching techniques – Tree searching – Hashing.

### **UNIT IV GRAPHS AND THEIR APPLICATIONS 9**

Graphs – An application of graphs – Representation – Transitive closure – Warshall’s algorithm – Shortest path algorithm – A flow problem – Dijkstra’s algorithm – Minimum spanning trees – Kruskal and Prim’s algorithm – An application of scheduling – Linked representation of graphs – Graph traversals.

### **UNIT V STORAGE MANAGEMENT 9**

General lists – Operations – Linked list representation – Using lists – Freeing list nodes – Automatic list management : Reference count method – Garbage collection – Collection and compaction.

**Total: 45**

### **TEXT BOOKS**

1. Cormen T. H., Leiserson C. E, and Rivest R.L., “Introduction to Algorithms”, Prentice Hall of India, 2007.
2. M.A.Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 2005.

### **REFERENCES**

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Computer Algorithms/C++”, Universities Press (India) Private Limited, 2nd Edition, 2007.
2. Aho, A. V., Hopcroft, J. E. and Ullman, J. D., “Data Structures and Algorithms”, 1st Edition, Pearson Education, 2003.
3. Gilberg, R. F. and Forouzan, B. A., “Data Structures”, 2nd Edition, Thomson India Edition, 2005.
4. Kruse, R.L, Leung, B. P. and Tondo, C. L., “Data Structures and Program Design in C”, Pearson Education, 2004.
5. Tanaenbaum A. S. Langram, Y. Augestein M.J, “Data Structures using C”, Pearson Education, 2004.

## PC1203 – ORGANIC CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

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 Aspirin
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**

## EE1208 – ELECTRICAL MACHINES LABORATORY

L	T	P	C
0	0	3	2

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**

## CS1203 – DATA STRUCTURES LABORATORY

L	T	P	C
0	0	3	2

### LIST OF EXPERIMENTS

1. Implement singly and doubly linked lists.
2. Represent a polynomial as a linked list and write functions for polynomial addition.
3. Implement stack and use it to convert infix to postfix expression
4. Implement a double-ended queue (dequeue) where insertion and deletion operations are possible at both the ends.
5. Implement an expression tree. Produce its pre-order, in-order, and post-order traversals.
6. Implement binary search tree.
7. Implement insertion in AVL trees.
8. Implement priority queue using binary heaps
9. Implement hashing with open addressing.
10. Implement Prim's algorithm using priority queues to find MST of an undirected graph.

**Total: 45**

## SEMESTER IV

### MA1251 – NUMERICAL METHODS

L	T	P	C
3	1	0	4

#### UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9

Linear interpolation methods (method of false position) – Newton’s method – Solution of linear system by Gaussian elimination and Gauss-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 BOOKS

1. Gerald, C.F. and Wheatley, P.O., “Applied Numerical Analysis”, 6th Edition, Pearson Education, 2005.
2. Venkatraman, M.K., ‘Numerical Methods’, National Publication Company, 1991.

#### 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. Kandasamy, P., Thilakavthy K. and Gunavathy K., “Numerical Methods”, 2nd Edition, S.Chand and Co., 2003.
3. Bali, N.P. Narayana Iyengar, N.Ch., “A Textbook of Engineering Mathematics”, Laxmi Publications (P) Ltd., New Delhi, 6th Edition, 2004.

## HS1251 – PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

### UNIT I GASEOUS STATE 9

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

### UNIT II CHEMICAL REACTION EQUILIBRIA 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.

**Total: 45**

### TEXT BOOKS

1. Atkins, P.W. and Paula, J.D., "Physical Chemistry", 8th Edition, W.H Freeman and Company, 2006.
2. Puri, B.R. and Sharma, L.R., "Principles of Physical Chemistry", S.Chand and Company Ltd., 1998.

### REFERENCES

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



# CH1257 – PROCESS CALCULATIONS

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

## **UNIT I BASIC CHEMICAL CALCULATIONS**

### **Units and Dimensions**

**5**

Basic and derived units – Use of model units in calculations – Methods of expression – Compositions of mixture and solutions.

### **Gas Calculations**

**7**

Ideal and real gas laws – Gas constant – Calculations of pressure, volume and temperature using ideal gas law – Use of partial pressure and pure component volume in gas calculations – Applications of real gas relationship in gas calculation.

## **UNIT II MATERIAL BALANCE**

**12**

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

## **UNIT III HUMIDITY AND SATURATION**

**12**

Properties of atmospheric air – Humidity of air – Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity – Use of humidity in condensation and drying – Psychrometric chart, dew point – Wet and dry bulb thermometry.

## **UNIT IV FUELS AND COMBUSTION**

**12**

Determination of composition by Orsat analysis of products of combustion of solid, liquid and gas fuels – Calculation of excess air from Orsat technique, problems on sulphur and sulphur burning compounds – Theoretical flame temperature.

## **UNIT V ENERGY BALANCE**

### **Thermo Physics**

**6**

Heat capacity of solids, liquids, gases and solutions – Use of mean heat capacity in heat calculations – Problems involving sensible heat and latent heats – Evaluation of enthalpy.

### **Thermo Chemistry**

**7**

Standard heat of reaction, heats of formation, combustion, solution, mixing etc., – Calculation of standard heat of reaction – Effect of pressure and temperature on heat of reaction – Energy balance for systems with and without chemical reaction – Unsteady state energy balances.

**Total: 60**

## **TEXT BOOKS**

1. Bhatt, B.I. and Vora, S. M., "Stoichiometry", 4th 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", 6th Edition, Prentice Hall of India (P) Ltd., 2000.
3. Chohey, N.P. and Hicks, T.G., "Handbook of Chemical Engineering Calculations", 2nd Edition, McGraw Hill Inc., 1984.

## CH1205 – FLUID FLOW OPERATIONS

L T P C

3 0 0 3

### UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE 9

Introduction – Physical properties of fluids – Types of fluids – Fluid statics and its applications – Pressure – Density – Height relationships – Pressure measurement – Units and dimensions – Dimensional analysis – Dimensionless numbers.

### UNIT II MOMENTUM 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 – Continuity Equation – Momentum balance – 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 – Heat 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 – Hot wire anemometers – Transportation of fluids – Positive displacement pumps – Rotary and Reciprocating pumps – Centrifugal pumps – Performance and characteristics – Air lift and diaphragm pumps.

**Total: 45**

### 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, 3rd 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.

## CH1258 – MECHANICAL OPERATIONS

L T P C

3 0 0 3

### 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.

**Total: 45**

### TEXT BOOKS

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", 7th Edition, McGraw Hill, 2004.
2. Badger, W.L., and Banchemo, J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

### REFERENCES

1. Raymond A. Kulweic., "Materials Handling Handbook", 3rd Edition, Wiley-Interscience Publications, 1985.
2. Richardson, J.F. and Harker J.H., "Coulson and Richardson's Chemical Engineering", Vol. II, 4th Edition, Butterworth Heineman, 2004.
3. Bhattacharaya., "Mechanical Operations", Khanna publishers, 2001.

## PC1252 – PHYSICAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

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  $\text{Fe}^{2+}$  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. pH metric measurements
  - a) To prepare buffer solutions and standardization of  $\text{P}^{\text{H}}$ meter ( $\text{P}^{\text{H}}$ 4 and 9)
  - b) Determine the molarity of HCl by pH-metrically, using 0.1 M Sodium Hydroxide.

**Total: 45**

## CH1206 – FLUID FLOW OPERATIONS LABORATORY

L	T	P	C
0	0	3	2

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	C
0	0	3	2

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. Continuous Thickener
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	C
3	1	0	4

#### 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 Laguerre 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 and 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, 1985.

#### REFERENCES

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

## CH1308 – HEAT TRANSFER

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

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

### **REFERENCES**

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

## PC1301 – MASS TRANSFER FUNDAMENTALS

L T P C

4 0 0 4

### 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 co current 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 height of 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. McCabe, W.L., Smith, J.C. and Harriot, P., “Unit Operations of 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, J.M. and Richardson, J.F., “Chemical Engineering”, Vol. I, II and III, Pergamon Press, 1977.
2. Bennett, C.O. and Myers, J.E., “Momentum, Heat and Mass Transfer”, McGraw Hill Book Company, 3rd Edition, 1983.
3. Christie J. Geankoplis, “Transport Processes and Unit Operations”, 3rd Edition, Prentice Hall of India Pvt. Ltd, 2000.

# ME1312 – ENGINEERING THERMODYNAMICS

L T P C

4 0 0 4

## 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 and 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 – Generalized 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. Smith, J.M. and Van Ness, "Introduction to Engineering Thermodynamics", 5th Edition, McGraw Hill, 1996.
2. Narayanan, K.V., "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall of India, 2002.

### **REFERENCES**

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

## PC1302 – NATURAL GAS ENGINEERING

L	T	P	C
4	0	0	4

### 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, 1968.
2. Lyons, W.C., “Standard Handbook of Petroleum and Natural Gas Engineering”, Vol. 2, Gulf Professional Publishing, Elsevier Inc., 2006.

### REFERENCES

1. Katz, D. L. and Lee, R.L., “Natural Gas Engineering”, McGraw Hill, 1990.
2. Dring, M.M., “The Natural Gas Industry – A Review of World Resources and Industrial Applications”, Butterworth, 1974.
3. Saied Mokhatab, William A. Poe, and 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 C**  
**3 1 0 4**

### **UNIT I ORIGIN AND OCCURRENCE OF PETROLEUM AND SEDIMENTARY 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 classification – Packer fluid – Casing packs – Solids removal – Completion methods – Various stimulation methods.

### **UNIT V OFF – SHORE TECHNOLOGY 9**

Seismic technology – Sniffer survey – Drilling technology – Off-shore rigs – Primary and secondary enhanced oil recovery techniques and methods – Major well complication and Remedies.

**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.I, Upstream, 6th Edition, John and Wiley Sons Ltd, 2000.

### **REFERENCES**

1. Howard B. Bradley, “Petroleum Engineering Handbook”, Society of Petroleum Engineers, 1987.
2. Norman J. Hyne., “Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production”, 2nd Edition, Pennwell Books, 2001.
3. Shay B., “Wellsite Geological Techniques for Petroleum Exploration” Allied Publishers Ltd., 1991.

## CH1309 – HEAT TRANSFER LABORATORY

L	T	P	C
0	0	3	2

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	C
0	0	3	2

1. Oil Analysis:
  - a) Acid value
  - b) Saponification value
  - c) Iodine value
2. Soap Analysis:
  - a) Moisture and Volatile matter
  - b) Fatty acid content of Soap
  - c) Total Alkali
  - d) Free alkali or free fatty acid
3. Determination of CaO in the given sample of commercial lime.
4. Analysis of water:
  - a) Total solids including suspended matter
  - b) pH
  - c) Conductivity
  - d) Alkalinity
  - e) Permanent Hardness
  - f) Temporary Hardness
5. Cement Analysis
  - a) Loss on ignition
  - b) Insoluble residue
  - c) Estimation of  $\text{SO}_3$ , Silica ( $\text{SiO}_2$ ), Lime ( $\text{CaO}$ ), Magnesia ( $\text{MgO}$ ), Iron and Aluminium Oxides ( $\text{R}_2\text{O}_3$ ).
6. Estimation of Nitrogen by Kjeldahl method
7. Estimation of metal ions (Copper, Nickel, Chromium).
8. Effluent water Analysis (COD, BOD, DO, TDS, TSS)
9. Estimation of available chlorine in the given bleaching powder

**Total: 45**

## HS1301 – COMMUNICATION AND SOFT SKILLS LABORATORY

L T P C

0 0 3 1

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,: Orient Longman, 2008
2. Malcome Goodale, “Professional Presentations”, (VCD): 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,
6. International English Language Testing System Practice Tests, CUP
7. Business English Certificate Materials, Cambridge University Press
8. Personality Development (CD – ROM), Times Multimedia,
9. Interactive Multimedia Programs on Managing Time and Stress
10. Robert M. Sherfield and et al “Developing Soft Skills” 4<sup>th</sup> edition, : Pearson Education, 2009

## SEMESTER VI

### CH1360 – PROCESS DYNAMICS AND CONTROL

L	T	P	C
4	0	0	4

#### 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 – Linearization 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. George Stephanopolous., “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 C**  
**3 1 0 4**

### **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 hysteresis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stage wise 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 Engg.", Vol-II, 3rd Edition, Pergamon Press, 1987.
2. Alan S. Foust., Leonard A. Wenzel., Curtis W. Clump., Louis Maus., and L.Bryce Andersen, "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

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### **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  $n^{\text{th}}$  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 and 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. Dawande, S.D., “Principles of Reaction Engineering”, 1st Edition, Central Techno Publications, 2001.
3. Richardson, J.F. and Peacock, D.G., “Coulson Richardson, Chemical Engineering.” Vol. III, 3rd Edition, Asian Books (P) Ltd.

**PC1352 – EQUIPMENT DESIGN AND DRAWING I**  
(To Consider as Practical Subject for Examination Purpose)

**L T P C**  
**2 0 2 4**

**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**

## PC1354 – PETROCHEMICAL UNIT PROCESSES

L	T	P	C
4	0	0	4

### 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 UNIT PROCESSES I 12

Fundamental and Technological principles involved in Alkylation – Oxidation – Nitration and Hydrolysis.

### UNIT IV UNIT PROCESSES II 12

Fundamental and Technological principles involved in Sulphonation, Sulfation and Isomerisation.

### UNIT V UNIT PROCESSES III 12

Fundamental and Technological principles involved in Halogenation and Esterification

**Total: 60**

### TEXT BOOKS

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Sukumar Maiti, “Introduction 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.

## PC1355 – PETROLEUM CRUDE PROCESSING TECHNOLOGY

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### **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. .
2. Bhaskara Rao, B.K., “Modern Petroleum Refining Processes”, 3rd edition, Oxford and IBH Publishing Company Pvt. Ltd.

### **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

## PC1356 – PROCESS DYNAMICS AND CONTROL LABORATORY

L	T	P	C
0	0	3	2

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**

## PC1357 – PETROLEUM PHYSICAL PROPERTIES TESTING LABORATORY

L	T	P	C
0	0	3	2

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**

## CH1362 – MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	2

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

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

**Total: 45**

## SEMESTER VII

### PC1401 – EQUIPMENT DESIGN AND DRAWING II

(To Consider as Practical Subject for Examination Purpose)

L	T	P	C
2	0	2	4

#### 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.

#### REFERENCES

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	C
3	1	0	4

### 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 HETEROGENEOUS 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 catalyzed reactions – Mechanism of solid catalyzed 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 catalyzed 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	C
4	0	0	4

### 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

Polymerization – 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, "Introduction 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	C
4	0	0	4

### 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 – Polymerization – 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. Gary, J. H. and Handwerk, G.E., “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	C
4	0	0	4

### UNIT I INTERNAL TREATMENT PROCESS 12

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

### UNIT II EXTERNAL TREATMENT PROCESS 12

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

### UNIT III BOILER WATER AND COOLING WATER 12

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

### UNIT IV WASTE WATER TREATMENT 12

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

### UNIT V WATER MANAGEMENT IN INDIA 12

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

**Total: 60**

### TEXT BOOKS

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

### REFERENCES

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

## PC1405 – PETROCHEMICAL ANALYSIS LABORATORY

L	T	P	C
0	0	3	2

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	C
0	0	3	2

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 testing 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	C
0	0	3	2

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

### MG1301 – TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

#### UNIT I INTRODUCTION

9

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

#### UNIT II TQM PRINCIPLES

9

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

#### UNIT III STATISTICAL PROCESS CONTROL (SPC)

9

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

#### UNIT IV TQM TOOLS

9

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

#### UNIT V QUALITY SYSTEMS

9

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

**Total: 45**

#### TEXT BOOKS

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

#### REFERENCES

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

## MG1354 – SAFETY AND RISK MANAGEMENT

L	T	P	C
3	0	0	3

### UNIT I INDUSTRIAL SAFETY 9

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

### UNIT II HAZARD IDENTIFICATION AND CONTROL 9

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

### UNIT III RISK MANAGEMENT 9

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

### UNIT IV SAFETY PROCEDURES 9

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

### UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS 9

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

**Total: 45**

### TEXT BOOKS

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

### REFERENCES

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

## PC1455 – PROJECT WORK

**L T P C**

**0 0 12 6**

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

**LIST OF ELECTIVES**  
**CH1008 – PROCESS MODELLING AND SIMULATION**

**L T P C**  
**3 0 0 3**

**UNIT I INTRODUCTION ON MODELS 9**

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 9**

Formulation and solution techniques to be discussed for vapour liquid equilibrium models – Dew point and flash calculations for multicomponent systems – Distillation 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) 9**

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 9**

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 9**

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: 45**

**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. Santhos 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 C

3 0 0 3

### UNIT I FUNDAMENTALS OF TRANSPORT PHENOMENA 9

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) 9

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 9

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 9

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 9

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

**Total: 45**

### 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. Thomson, W. J., “Introduction to Transport Phenomena”, Pearson Education Asia, 2000.
2. Griskey, R.G., “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 INSTRUMENTATION

**L T P C**  
**3 0 0 3**

### **UNIT I PHYSICAL PROPERTY MEASUREMENT 9**

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

### **UNIT II TEMPERATURE MEASUREMENT 9**

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

### **UNIT III PRESSURE MEASUREMENT 9**

Absolute pressure – Gauge pressure 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 9**

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

### **UNIT V LEVEL MEASUREMENT 9**

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

**Total: 45**

### **TEXT BOOKS**

1. Nakra, B.C. and Chaudhry, K.K., “Instrumentation, Measurement and Analysis”, 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

L	T	P	C
3	0	0	3

### UNIT I      **BASICS OF FLUIDIZATION**      **9**

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

### UNIT II      **FLUIDIZED BED TYPES**      **9**

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

### UNIT III      **DESIGN ASPECTS**      **9**

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

### UNIT IV      **HEAT AND MASS TRANSFER IN FLUIDIZED BEDS**      **9**

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

### UNIT V      **OTHER TYPES OF FLUIDIZATION**      **9**

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

**Total: 45**

### **TEXT BOOKS**

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

### **REFERENCES**

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

## PC1003 – PETROLEUM PROCESS EQUIPMENT AUXILIARIES

L	T	P	C
3	0	0	3

### UNIT I ELECTRICAL MOTORS AND STARTERS 9

Electrical motors – Induction – Synchronous – Electrical Starters.

### UNIT II ROTARY EQUIPMENT 9

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

### UNIT III INDUSTRIAL VALVE 9

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

### UNIT IV INDUSTRIAL DRYERS 9

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

### UNIT V PROCESS UTILITY EQUIPMENTS 9

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

**Total: 45**

### TEXT BOOKS

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

### REFERENCES

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

## CH1002 – INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

### UNIT I PERSONNEL MANAGEMENT 9

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

### UNIT II TQM TOOLS AND TECHNIQUES 9

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

### UNIT III QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEMS 9

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

### UNIT IV ENGINEERING ECONOMICS 9

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

### UNIT V PROCESS ECONOMICS 9

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

**Total: 45**

### TEXT BOOKS

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

### REFERENCES

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