

ANNA UNIVERSITY TIRUCHIRAPPALLI**Tiruchirappalli – 620 024****Regulations 2007****Curriculum****B.TECH. CHEMICAL ENGINEERING****SEMESTER III**

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|--------------------------------|---|---|---|------------|
| Theory | | | | | | |
| 1 | MA1201 | Mathematics III | 3 | 1 | 0 | 100 |
| 2 | HS1202 | Organic Chemistry | 3 | 1 | 0 | 100 |
| 3 | CE1214 | Mechanics of Solids | 3 | 1 | 0 | 100 |
| 4 | HS1206 | Material Technology | 4 | 0 | 0 | 100 |
| 5 | EE1208 | Electrical Machines and Drives | 3 | 1 | 0 | 100 |
| 6 | CS1201 | Data Structures | 3 | 1 | 0 | 100 |
| Practical | | | | | | |
| 7 | HS1203 | Organic Chemistry Laboratory | 0 | 0 | 3 | 100 |
| 8 | EE1209 | Electrical Machines Laboratory | 0 | 0 | 3 | 100 |
| 9 | CS1204 | Data Structures Laboratory | 0 | 0 | 3 | 100 |

SEMESTER IV

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|---------------------------------------|---|---|---|------------|
| Theory | | | | | | |
| 1 | MA1251 | Numerical Methods | 3 | 1 | 0 | 100 |
| 2 | CH1251 | Physical Chemistry | 3 | 1 | 0 | 100 |
| 3 | HS1201 | Environmental Science and Engineering | 4 | 0 | 0 | 100 |
| 4 | CH1202 | Process Calculations | 3 | 1 | 0 | 100 |
| 5 | CH1201 | Industrial Chemical Technology | 4 | 0 | 0 | 100 |
| 6 | CH1252 | Process Instrumentation | 4 | 0 | 0 | 100 |
| Practical | | | | | | |
| 7 | CH1253 | Physical Chemistry Laboratory | 0 | 0 | 3 | 100 |
| 8 | HS1251 | Environmental Engineering Laboratory | 0 | 0 | 3 | 100 |
| 9 | CH1254 | Technical Analysis Laboratory I | 0 | 0 | 3 | 100 |

SEMESTER V

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|--|---|---|---|------------|
| Theory | | | | | | |
| 1 | MA1303 | Statistics and Linear Programming | 3 | 1 | 0 | 100 |
| 2 | CH1301 | Fluid Mechanics | 3 | 1 | 0 | 100 |
| 3 | CH1302 | Mechanical Operations | 3 | 1 | 0 | 100 |
| 4 | CH1303 | Chemical Thermodynamics Principles | 3 | 1 | 0 | 100 |
| 5 | CH1304 | Organic Chemical Technology | 4 | 0 | 0 | 100 |
| 6 | CH1305 | Instrumental Methods of Analysis | 3 | 1 | 0 | 100 |
| Practical | | | | | | |
| 7 | CH1306 | Fluid Mechanics Laboratory | 0 | 0 | 3 | 100 |
| 8 | CH1307 | Mechanical Operations Laboratory | 0 | 0 | 3 | 100 |
| 9 | HS1301 | Communication and Soft Skills Laboratory | 0 | 0 | 3 | 100 |

SEMESTER VI

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|---|---|---|---|------------|
| Theory | | | | | | |
| 1 | CH1351 | Applied Chemical Thermodynamics | 4 | 0 | 0 | 100 |
| 2 | CH1352 | Heat Transfer Operations | 4 | 0 | 0 | 100 |
| 3 | CH1353 | Mass Transfer Fundamentals | 4 | 0 | 0 | 100 |
| 4 | CH1354 | Principles of Chemical Kinetics | 3 | 1 | 0 | 100 |
| 5 | CH1355 | Process Dynamics and Control | 4 | 0 | 0 | 100 |
| 6 | GE1351 | Professional Ethics and Human Values | 4 | 0 | 0 | 100 |
| Practical | | | | | | |
| 7 | CH1356 | Heat Transfer Laboratory | 0 | 0 | 3 | 100 |
| 8 | CH1357 | Chemical Process Equipment Design and Drawing I | 0 | 0 | 3 | 100 |
| 9 | CH1358 | Process Control and Simulation Laboratory | 0 | 0 | 3 | 100 |

SEMESTER VII

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|--|---|---|---|------------|
| Theory | | | | | | |
| 1 | CH1401 | Transport Phenomena | 3 | 1 | 0 | 100 |
| 2 | CH1402 | Mass Transfer Operations | 4 | 0 | 0 | 100 |
| 3 | CH1403 | Chemical Reaction Engineering | 4 | 0 | 0 | 100 |
| 4 | CH1404 | Water Treatment and Management | 4 | 0 | 0 | 100 |
| 5 | CH1405 | Process Utilities | 4 | 0 | 0 | 100 |
| 6 | E1**** | Elective I | 4 | 0 | 0 | 100 |
| Practical | | | | | | |
| 7 | PC1362 | Mass Transfer Laboratory | 0 | 0 | 3 | 100 |
| 8 | CH1406 | Chemical Reaction Engineering Laboratory | 0 | 0 | 3 | 100 |
| 9 | CH1407 | Chemical Process Equipment Design and Drawing II | 0 | 0 | 3 | 100 |

SEMESTER VIII

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|------------------|---------------|----------------------------|---|---|----|------------|
| Theory | | | | | | |
| 1 | MG1352 | Total Quality Management | 3 | 0 | 0 | 100 |
| 2 | MG1453 | Safety and Risk Management | 4 | 0 | 0 | 100 |
| 3 | E2**** | Elective II | 4 | 0 | 0 | 100 |
| Practical | | | | | | |
| 4 | CH1455 | Project Work | 0 | 0 | 12 | 100 |

ELECTIVE I

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|---------------|---------------|--|---|---|---|------------|
| Theory | | | | | | |
| 1 | CH1001 | Fertilizer Technology | 4 | 0 | 0 | 100 |
| 2 | PC1008 | Petrochemical Technology | 4 | 0 | 0 | 100 |
| 3 | CH1002 | Industrial management | 4 | 0 | 0 | 100 |
| 4 | CH1003 | Process Integrating and Pinch Technology | 4 | 0 | 0 | 100 |

ELECTIVE II

| S.No. | Subject Code | Subject | L | T | P | Max. Marks |
|---------------|---------------|--|---|---|---|------------|
| Theory | | | | | | |
| 1 | CH1004 | Energy Management in Chemical Industries | 4 | 0 | 0 | 100 |
| 2 | CH1005 | Process Modeling and Simulations | 4 | 0 | 0 | 100 |
| 3 | CH1006 | Natural Gas Engineering | 4 | 0 | 0 | 100 |
| 4 | CH1007 | Modern Separation Processes | 4 | 0 | 0 | 100 |

ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024

Regulations 2007

Syllabus

B.TECH. CHEMICAL ENGINEERING

SEMESTER III

MA1201 – MATHEMATICS III

| L | T | P |
|----------|----------|----------|
| 3 | 1 | 0 |

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9

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

UNIT II FOURIER SERIES 9

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

UNIT III BOUNDARY VALUE PROBLEMS 9

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

UNIT IV FOURIER TRANSFORM 9

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

UNIT V Z-TRANSFORM AND DIFFERENCE EQUATIONS 9

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

L: 45 T: 15 Total: 60

TEXT BOOK

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

REFERENCES

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

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.

L: 45 T: 15 Total: 60

TEXT BOOKS

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

REFERENCES

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

CE1214 – MECHANICS OF SOLIDS

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3 1 0

UNIT I STRESS, STRAIN AND DEFORMATIONS OF SOLIDS 9

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

UNIT II TRANSVERSE LOADING ON BEAMS 9

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

UNIT III SLOPE, DEFLECTIONS OF BEAMS 9

Fourth order differential equations – Relationship – Intensity of loading, Shear, B.M, Slope and deflection – Double integration method – Macaulay's method – Area – Moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

UNIT IV STRESSES IN BEAMS 9

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

UNIT V TORSION AND COLUMNS 9

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

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Prakash Rao D.S., "Strength of Materials: A Practical Approach", Vol-I, Universities Press, 2004.
2. Junarkar S.B., "Mechanics of Structures ", Vol-I, Twenty First Edition, Charotar Publishing House, 1995.

REFERENCES

1. Nash W.A., "Theory and Problems of Strength of Materials ", Third Edition, McGraw Hill, 1994.
2. Popov., "Engineering Mechanics of solids", Second Edition, Prentice Hall of India (P) Ltd.,1998.
3. Khurmi R.S., "Applied Mechanics and Strength of Materials" Thirteenth Edition, S.Chand & Company Ltd., 2005.

UNIT I NATURE OF MATERIALS 12

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

UNIT II FERROUS AND NON-FERROUS METALS 12

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

UNIT III POLYMERIC AND CERAMIC MATERIALS 12

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

UNIT IV INORGANIC MATERIALS 12

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

UNIT V CORROSION AND COATING 12

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

L: 60 Total: 60

TEXT BOOKS

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

REFERENCES

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

UNIT I D.C. CIRCUITS 9

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

UNIT II STEADY STATE ANALYSIS OF SINUSOIDAL EXCITATION 9

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

UNIT III D.C. MACHINES AND TRANSFORMER 9

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

UNIT IV A.C. MACHINES 9

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

UNIT V ELECTRIC DRIVES 9

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

L: 45 T: 15 Total: 60**TEXT BOOKS**

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

REFERENCES

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

CS1201 – DATA STRUCTURES

L T P
3 1 0

UNIT I PROBLEM SOLVING 9

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

UNIT II LISTS, STACKS AND QUEUES 9

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

UNIT III TREES 9

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

UNIT IV SORTING 9

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

UNIT V GRAPHS 9

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

L: 45 T: 15 Total: 60

TEXT BOOKS

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

REFERENCES

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

HS1203 – ORGANIC CHEMISTRY LABORATORY

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0 0 3

1. Hydrolysis of Sucrose
2. Estimation of Sugars
3. Preparation of L – D – Glucose penta - acetate
4. Determination of the number of Amino acids
5. Isolation of Casein from Milk
6. Diazotisation
 - a. Preparation of Phenyl azo – β – naphthal
 - b. Preparation of Methyl red
7. Isolation of Oleic acid from Olive oil.
8. Preparation of 5,10,15,20 Tetrakis Phenyl Porphyrin.
9. Estimation of Phenol
10. Industrial waste water analysis
11. Determination of saponification value of an oil
12. Separation of pigment present in Spinach leaves by Paper Chromatography
13. Polymer Analysis
14. Ore / Alloy Analysis
15. Qualitative analysis of simple Organic compounds.

Total: 45

EE1209 – ELECTRICAL MACHINES LABORATORY

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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

Implement the following exercises using C

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

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

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

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

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

 - III. Implement the application for ‘Evaluating Postfix Expressions’ using array and linked list implementations of Stack ADT (by implementing file (d) and using file (b) - and then by using files (d) and (c))
7. Queue ADT
 8. Search Tree ADT – Binary Search Tree
 9. Heap Sort
 10. Quick Sort

Total: 45

SEMESTER IV

MA1251 – NUMERICAL METHODS

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UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9

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

UNIT II INTERPOLATION AND APPROXIMATION 9

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

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9

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

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

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

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

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

L: 45 T: 15 Total: 60

TEXT BOOK

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

REFERENCES

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

CH1251 – PHYSICAL CHEMISTRY

L T P
3 1 0

UNIT I ELECTROCHEMISTRY 9

Electrical Conductance – Specific conductance – Equivalent conductance – Variation with dilution – Kohlrausch's law – Transport Number – Galvanic cells – EMF and its measurement – Reference electrode – Standard Hydrogen Electrode – Nernst equation – Electrochemical series – Applications of EMF measurements.

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 – 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 PHASE RULE 9

Derivation – Application of phase rule to water system – Thermal Analysis – Cooling curves – Two Component system – Eutectic and compound formation.

UNIT V ADSORPTION AND CATALYSIS 9

Physical and Chemical adsorption – Types of adsorption isotherm – BET method – Gibbs equation – Homogeneous catalysis – Heterogeneous catalysis – Acid–base catalysis – Enzyme catalysis – Applications of catalysts in industries.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Atkins P., "Physical Chemistry", Sixth Edition, W.H. Freeman and Company, 1997.
2. Puri B.H. and Sharma L.R., "Principles of Physical Chemistry ", S. Nagin Chand & Company, 1994.

REFERENCES

1. Kund and Jain., "Physical Chemistry ", S.Chand & Co Ltd., 1996.
2. Shashi Chawla, "A Took Book of Engineering Chemistry", Third Edition, Dhanpat Rai & Sons, 2007.
3. Bahl B.S., Tuli G.D. and Arun Bahl., "Essentials of Physical Chemistry", S.Chand & Co Ltd., 1998.

UNIT I IMPORTANCE OF ENVIRONMENTAL STUDIES 12

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

UNIT II ECOSYSTEMS AND BIODIVERSITY 12

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

UNIT III ENVIRONMENTAL POLLUTION 12

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

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 12

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

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 12

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

L: 60 Total: 60**TEXT BOOKS**

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

REFERENCES

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

CH1202 – PROCESS CALCULATIONS

L T P
3 1 0

UNIT I STOICHIOMETRY 9

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

UNIT II IDEAL GASES AND VAPOR PRESSURE 9

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

UNIT III HUMIDITY AND SOLUBILITY 9

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

UNIT IV MATERIAL BALANCE 9

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

UNIT V ENERGY BALANCE 9

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

L: 45 T: 15 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1201 – INDUSTRIAL CHEMICAL TECHNOLOGY

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UNIT I ALKALIES 12

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

UNIT II ACIDS 12

Manufacture of Sulphuric acid – Hydrochloric acid – Phosphoric acid.

UNIT III GLASSES 12

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

UNIT IV INDUSTRIAL GASES 12

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

UNIT V FERTILIZERS 12

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

L: 60 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1252 – PROCESS INSTRUMENTATION

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UNIT I PHYSICAL PROPERTY MEASUREMENT 12

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

UNIT II TEMPERATURE MEASUREMENT 12

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

UNIT III PRESSURE MEASUREMENT 12

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

UNIT IV FLOW MEASUREMENT 12

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

UNIT V LEVEL MEASUREMENT 12

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

L: 60 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1253 – PHYSICAL CHEMISTRY LABORATORY

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1. Molecular weight determination of Polymer by using
 - a) Rast's Method
 - b) Viscometer
2. Partition Coefficient Studies
For Benzene – Water system
3. Phase rule Studies
Simple Eutectic system
4. Conductivity Studies
 - a) Precipitation Titration
 - b) Mixtures of acid – Strong Base Titration
5. EMF Studies
Estimation of Fe^{2+} by Potentiometric Titration
6. Kinetic Studies
 - a) Kinetic studies of Persulphate – Iodide reaction
 - b) Kinetic studies of Iodination of Acetone.
 - c) Determination of Rate constant of Acid catalyst hydrolysis of an Ester.
7. Polarimetry Studies - Kinetic study of Inversion of Cane Sugar.
8. Adsorption Studies - Freundlich Adsorption Isotherm
9. Determination of Transition Temperature.
10. Determination of Critical solution temperature for the Phenol Water system.

Total: 45

HS1251 – ENVIRONMENTAL ENGINEERING LABORATORY

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

Total: 45

CH1254 – TECHNICAL ANALYSIS LABORATORY I

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1. Silica Content in Cement
2. Analysis of Oils and Fats
3. Analysis of Copper
4. Analysis of Bleaching Powder
5. Estimation of CaO in Lime
6. Analysis of Fertilizer
7. Analysis of Fatty Acid Content and Alkali Content in soaps
8. Pigment Analysis
9. Water Analysis
10. Flame Photometer
11. Colorimetry

Total: 45

SEMESTER V

MA1303 – STATISTICS AND LINEAR PROGRAMMING

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UNIT I **PROBABILITY AND RANDOM VARIABLE** **9**

Axioms of probability - Conditional probability - Total probability - Bayes theorem – Random variable – Probability mass function - Probability density function - Properties- Moments - Moment generating functions and their properties.

UNIT II **STANDARD DISTRIBUTIONS** **9**

Binomial- Poisson- Geometric- Negative Binomial- Uniform- Exponential- Gamma- Weibull and Normal distributions and their properties - Functions of a random variable.

UNIT III **TESTING OF HYPOTHESIS** **9**

Sampling distributions – Testing of hypothesis for mean, variance, proportions and differences using Normal, t, Chi-square and F distributions - Tests for Independence of attributes and Goodness of fit.

UNIT IV **LINEAR PROGRAMMING** **9**

Formulation of linear programming problem – Graphical solution – Simplex algorithm - Artificial variable – Big M method - Two phase method.

UNIT V **FURTHER TOPICS IN LINEAR PROGRAMMING** **9**

Duality – Primal, Dual computations - Dual simplex algorithm - Transportation and Assignment models.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Johnson, R. A., “Miller & Freund’s Probability and Statistics for Engineers”, Sixth Edition, Pearson Education, Delhi, 2000. (Chapters 3, 4, 5, 7, 8 & 9).
2. Taha, H. A., “Operations Research - An Introduction”, Seventh Edition, Pearson Education Edition Asia, New Delhi, 2002.

REFERENCES

1. Walpole, R. E., Myers, R. H., Myers, S. L. and Ye. K, “Probability and Statistics for Engineers and Scientists”, Seventh Edition, Pearson Education, Delhi, 2002.
2. Gupta, S.C, and Kapur, J.N., “Fundamentals of Mathematical Statistics”, S. Chand and Co. Ninth Edition, New Delhi, 1996
3. Manmohan, P.K. and Gupta, S.C. “Operations Research”, Sultan Chand & Co. Ninth Edition, Delhi, 2001.

UNIT I INTRODUCTION 9

The concept of fluid- The fluid as a continuum - Laws of dimensional homogeneity - Properties of velocity field - Thermodynamic properties of a fluid - Viscosity and other secondary properties - Basic flow analysis techniques - Flow patterns.

UNIT II PRESSURE DISTRIBUTION IN A FLUID 9

Pressure and pressure gradient - Equilibrium of fluid element - Hydrostatic pressure distributions - Applications to manometry - Hydrostatic forces on planed and curved submerged surfaces - Laws of buoyancy and stability considerations for bodies in floatation.

UNIT III DIMENSIONAL ANALYSIS AND SIMILITUDE 9

The principle of dimensional homogeneity - The Pi-theorem - Non-dimensional action of the basic equations - Similitude - Relationship between dimensional analysis and similitude - Use of dimensional analysis for scale up studies.

UNIT IV VISCOUS FLOW IN DUCTS AND BOUNDARY LAYER FLOW 9

Reynold's number regimes- Internal versus external viscous flow- Flow in circular pipe - Head loss- Minor losses in pipe systems and multiple-pipe systems - Boundary layer concepts-Functions and pressure drag - Flow through fixed and fluidized beds.

UNIT V FLOW MEASUREMENT AND TUBRO MACHINERY 9

Constant and variable head meters - Working and applications of pumps and compressors – Working and applications of Needle / Check / Globe / Gate / Bell / Butterfly Valves.

L: 45 T: 15 Total: 60**TEXT BOOKS**

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

REFERENCES

1. Coulson J.M., and Richardson J.F., "Coulson and Richardson's Chemical Engineering", Vol-I, Third Edition, Butterworth – Heinemann Publishers, 2004.White, F.M., "Fluid Mechanics", 4th Edition, McGraw-Hill Inc., 1999.
2. Daugherty, R.L., Franzini, J.B and Finnemore, E.J., "Fluid Mechanics with Engineering Applications", SI metric Edn., McGraw-Hill Book Company, 1989.
3. Darby, R. Chemical Engineering Fluid Mechanics, Marcel Dekker, 1998.

CH1302 – MECHANICAL OPERATIONS

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UNIT I PARTICLE CHARACTERISTICS AND SIZE ANALYSIS 9

General characteristics of solids-Their behaviour under different external forces- Agglomeration- Techniques for size analysis- Storage and Conveying of solids.

UNIT II SIZE REDUCTION 9

Laws of size reduction- Classification of equipment- Methods of size reduction- Disintegration- Preparation of colloids.

UNIT III MECHANICAL SEPARATIONS 9

Screening and Screening equipment- Effectiveness of screens- Gravity settling- Sedimentation- Thickening- Centrifugal separation- Impingement methods- Industrial dust removing equipment with special reference to electrostatic and magnetic separators-Heavy media separations- Floatation.

UNIT IV FILTRATION 9

Theory of filtration- Batch and continuous filters- Centrifuges-Membrane and ultra filtration.

UNIT V MIXING AND AGITATION 9

Equipment for blending and kneading-Dispersion-Power for agitation-Correlations.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Third Edition, Pergamon Press, 1977.

REFERENCES

1. Badger W.L., and Banchemo J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997
2. Richardson J.F. and Harker J.H., "Coulson and Richardson's Chemical Engineering", Vol-II Fourth Edition, Butterworth Heineman, 2004.
3. Bhattacharaya., "Mechanical Operations", Khanna publishers, 2001

CH1303 – CHEMICAL THERMODYNAMICS PRINCIPLES

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UNIT I BASIC CONCEPTS 9

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

UNIT II FIRST LAW OF THERMODYNAMICS 9

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

UNIT III SECOND LAW OF THERMODYNAMICS 9

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

UNIT IV THERMODYNAMIC FORMULATIONS 9

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

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

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

L: 45 T: 15 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1304 – ORGANIC CHEMICAL TECHNOLOGY

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UNIT I SUGAR AND STARCH INDUSTRIES 12

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

UNIT II OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 12

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

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 12

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

UNIT IV RUBBER AND POLYMERS 12

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

UNIT V SYNTHETIC FIBRE AND FILM INDUSTRIES 12

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

L: 60 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1305 – INSTRUMENTAL METHODS OF ANALYSIS

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UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 9

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

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

UNIT II MOLECULAR SPECTROSCOPY 9

Various electronic transitions in organic and inorganic compounds effected by UV- Visible and infra red radiations-Variou energy level diagrams of saturated- Unsaturated and carbonyl compounds- Excitation by UV and Visible radiations- Woodward-Fischer rules for the calculation of absorption maxima (dienes and carbonyl compounds)-Effects of auxochromes and effects of conjugation on the absorption maxima- Instrumentation for UV, VISIBLE and IR spectroscopies (source, Optical parts and Detectors)- Multicomponent analysis- Photometric titration (Experimental set-up and various types of titrations)- Applications of UV, VISIBLE AND IR spectroscopies.

UNIT III ATOMIC SPECTROSCOPY 9

Atomic Absorption Spectrophotometry: Principle- Instrumentation and Application- Various interferences observed in AAS (Chemical radiation and excitation)- Polarimetry and refractometry- Principle, Instrumentation and Applications

UNIT IV ELECTROMETRIC METHODS OF ANALYSIS 9

Introduction of electrometric methods- Difference between redox and acid- Base reactions- Types of cells- Schematic representation of cell- Single electrode potential- Laboratory reference electrodes (Standard hydrogen- saturated calomel, Ag – AgCl and inert electrodes)- Ion-selective electrodes.

Potentiometry: Nernst equation- Experimental set-up and measurement of pH; Conductometry- Measurement of conductance- Experimental set-up and various titrations (strong and weak acid/base)

UNIT V CHROMATOGRAPHIC METHODS 9

Classification of chromatographic methods- Column- Thin layer paper- Gas- High performance liquid Chromatographical methods (principle, mode of separation and technique)- Separation of organic compounds by column and thin layer- Mixture of Cu, Co and Ni by Paper- Separation of amino acids by paper-Estimation of organic compounds by GC and, HPLC.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Willard, H.H., Merritt.I.I., Dean J.A., and Settle, F.A., Instrumental methods of analysis, Sixth edition, CBS publishers, 1986.
2. Parikh V.M. Absorption spectroscopy of organic molecules Addison –Wesley Publishing Company, 1994.

REFERENCES

1. Skoog D.A. and West D.M.M., Fundamentals of Analytical Chemistry, Saunders –college Publishing, 1982.
2. Banwell, G.C., Fundamentals of molecular spectroscopy TMH, 1992.

CH1306 – FLUID MECHANICS LABORATORY

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1. Calibration of constant and variable Head meters
2. Calibration of Weirs & Notches
3. Drag reduction studies
4. Flow through straight pipe
5. Flow through Vertical concentric pipe
6. Pressure drop studies in packed column
7. Fluidization
8. Bernoulli's Theorem Apparatus
9. Flow through helical coil and spiral
10. Characteristic curves of centrifugal pump
11. Reynolds's Apparatus
12. Flow of air thro' orifice using Air compressor

Total: 45

CH1307 – MECHANICAL OPERATIONS LABORATORY

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1. Jaw crusher
2. Crushing rolls
3. Ball mill
4. Size analysis by sieving
5. Angle of repose
6. Filter press
7. Leaf filter
8. Cyclone separator
9. Sedimentation
10. Elutriator
11. Rotary Drum filter
12. Effectiveness of screens

Total: 45

HS1301 – COMMUNICATION AND SOFT SKILLS LABORATORY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Lab session # 14: Critical and creative thinking exercises.

Lab session # 15: Improving body language and cross-cultural communication with pictures.
Learning material: Body Language (S. Chand and Co.)
For a detailed plan, refer to the topics given below;

UNIT I LISTENING AND SPEAKING PRACTICE IN COMMUNICATIVE FUNCTIONS

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

UNIT II SPEAKING APPLICATIONS

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

UNIT III UNDERSTANDING AND PREPARING FOR INTERNATIONAL ENGLISH LANGUAGE EXAMINATIONS

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

UNIT IV SOFT SKILLS (1)

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

UNIT V SOFT SKILLS (2)

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

RESOURCES

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

Total: 45

SEMESTER VI

CH1351 – APPLIED CHEMICAL THERMODYNAMICS

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UNIT I PROPERTIES OF SOLUTIONS 8

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

UNIT II PHASE EQUILIBRIA 14

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

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 14

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

UNIT IV CHEMICAL REACTION EQUILIBRIA 14

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

UNIT V REFRIGERATION AND POWER PLANT OPERATIONS 10

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

Total: 60

TEXT BOOKS

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

REFERENCES

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

UNIT I BASIC CONCEPTS AND CONDUCTIVE HEAT TRANSFER 12

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

UNIT II CONVECTION 12

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

UNIT III RADIATION 12

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

UNIT IV HEAT EXCHANGERS 12

Parallel and counter flow heat exchangers – Log mean temperature difference – Single pass and multipass heat exchangers – Plate heat exchangers – Use of correction factor charts – Heat exchangers effectiveness – Number of transfer unit – Chart for different configurations – Fouling factors and Wilson's plot – Design of various types of heat exchangers – Design of condensers.

UNIT V EVAPORATION 12

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

Total: 60**TEXT BOOKS**

1. McCabe, W.L., Smith, J.C. and Harriot, P., "Unit Operations in Chemical Engineering", 5th Edition, McGraw-Hill, 2001.
2. Dutta, B. K. "Heat Transfer Principles and Applications", Prentice Hall of India, 2001.

REFERENCES

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

UNIT I DIFFUSION 12

Molecular and eddy diffusion in gases and liquids – Steady state diffusion under stagnant and laminar flow conditions – Diffusivity measurement and prediction – Multicomponent diffusion – Diffusion in solids and its applications.

UNIT II MASS TRANSFER COEFFICIENTS 12

Concept of mass transfer coefficients – Mass transfer under laminar and turbulent flow past solids – Boundary layers – Mass transfer at fluids surfaces correlation of mass transfer coefficients – JD, HTU, and NTU concepts-Theories of mass transfer and their applications – Interphase mass transfer and over all mass transfer coefficients in binary and multicomponent systems – Application to gas-liquid and liquid-liquid systems.

UNIT III HUMIDIFICATION AND AIR CONDITIONING 12

Basic concepts – Psychrometric chart construction – Humidification and dehumidification operations – Design calculations – Cooling tower principle and operation – Types of equipment –Design calculation.

UNIT IV DRYING 12

Theory and mechanism of drying – Drying characteristics of materials – Batch and continuous drying – Calculation for continuous drying – Drying equipment – Design and performance of various drying equipments.

UNIT V CRYSTALLISATION 12

Nuclei formation and crystal growth –Theory of crystallization – Growth coefficients and the factors affecting these in crystallization – Batch and continuous industrial crystallizers – Principle of design of equipment.

Total: 60**TEXT BOOKS**

1. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 5th Edition, McGraw-Hill, 1993.
2. Treybal, R.E., “Mass Transfer Operations”, 3rd Edition, McGraw-Hill, 1980.

REFERENCES

1. Coulson, J.M., Richardson, J.F., “Chemical Engineering”, Vol. I, 3rd Edition, Pergamon Press, 1977.
2. Foust, A.S.Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of Unit Operations”, 2nd Edition, Wiley, 1980.
3. Christie J.Geankoplis, “Transport Processes and unit operations”, 3rd Edition., Prentice Hall of India Pvt. Ltd, 2000.

CH1354 – PRINCIPLES OF CHEMICAL KINETICS

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UNIT I REACTION KINETICS 9

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

UNIT II IDEAL REACTORS 9

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

UNIT III CHOICE OF REACTORS 9

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

UNIT IV HEAT EFFECTS IN REACTORS & REACTOR STABILITY 9

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

UNIT V REACTION EQUILIBRIA 9

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

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Levenspiel, O., “Chemical Reaction Engineering”, 2nd Edition, John Wiley, 1972.
2. Smith, J.M., “Chemical Engineering Kinetics”, 3rd Edition, McGraw–Hill, 1981.

REFERENCES

1. Fogler, W., “Chemical Reaction Engineering”, 3rd Edition., Prentice Hall of India, 1999.
2. Dawande, S.D., “Principles of Reaction Engineering”, 1st Edition. Central Techno Publications, 2001.
3. Richardson, J.F. Peacock, D.G. and Richardson, C., “Chemical Engineering.” Vol 3, 3rd Edition. Asian Books (P)Ltd

CH1355 – PROCESS DYNAMICS AND CONTROL

| L | T | P |
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UNIT I INTRODUCTION 12

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

UNIT II FIRST ORDER & HIGHER ORDER SYSTEMS 12

First order systems and their transient response for standard input functions – First order systems in series – Linearization and its application in process control – Second order systems and their dynamics – Transfer function for chemical reactors and dynamics.

UNIT III CLOSED LOOP CONTROL SYSTEMS 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 –Transportation lag – Transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 12

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

UNIT V SPECIAL CONTROLS 12

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

Total: 60

TEXT BOOKS

1. Coughnowr and Koppel, “Process Systems Analysis and Control”, McGraw Hill, 1986.
2. Stephanopolous, G., “Chemical Process Control”, Prentice Hall of India Pvt. Ltd., 1990.

REFERENCES

1. Thomas, E.Marlin, “Process Control”, 2nd Edition, McGraw Hill, 2000.
2. Ceaglske, N. H., “Automatic Process Control for Chemical Engineers”, John Wiley and Sons, 1956.
3. Patranabis.D, “Principles of Process Control”, 2nd Edition, Tata McGraw–Hill Publishing Co. Ltd., 1981.
4. Harriott, P., “Process Control”, Tata McGraw Hill Publishing Co., Reprint 2004.

GE1351 – PROFESSIONAL ETHICS AND HUMAN VALUES

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UNIT I HUMAN VALUES 12

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

UNIT II ENGINEERING ETHICS 12

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

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 12

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

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 12

Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk – The three Mile Island and Chernobyl case studies– Collegiality and loyalty – Respect for authority – Collective bargaining – Confidentiality – Conflicts of interest – Occupational crime – Professional rights – Employee rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 12

Multinational corporations – Environmental ethics – Computer ethics – Weapons development – Engineers as managers – Consulting engineers – Engineers as expert witnesses and advisors – Moral leadership – Sample code of Ethics (Specific to a particular Engineering Discipline).

Total:60

TEXT BOOKS

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

REFERENCES

1. Harris, C. E., Protchard, M.S. and Rabins, M.J., "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Leatning, 2000.
2. Boatright, J. R., "Ethics and the Conduct of Business", Pearson Education, 2003.
3. Seebauer, E.G. and Barry, R. L., "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, , 2001.

CH1356 – HEAT TRANSFER LABORATORY

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

Total: 45

CH1357 – CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING I

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UNIT I DESIGN OF PIPE FITTINGS & JOINTS 9

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

UNIT II DESIGN OF REACTION VESSEL & STORAGE TANK 9

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

UNIT III DESIGN OF HIGH PRESSURE SYSTEM 9

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

UNIT IV DESIGN OF PHASE SEPARATION EQUIPMENT 9

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

UNIT V DESIGN OF CRYSTALLIZERS & HEATED VESSELS 9

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

Total:45

TEXT BOOKS

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

REFERENCES

1. Dawande, S.D., “Process Design of Equipments”, Central Techno Publications, 2000.
2. Indian Standard Specifications IS–803, 1962; IS–4072, 1967; IS–2825, 1969. Indian Standards Institution, New Delhi.
3. Perry, R.H., “Chemical Engineers’ Handbook”, McGraw–Hill.
4. Coulson , J.M. and Richardson, J. ,“Chemical Engineering”, Vol. 6, Asian Books Printers Ltd.

CH1358 – PROCESS CONTROL AND SIMULATION LABORATORY

| L | T | P |
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| 0 | 0 | 3 |

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

Total: 45

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

SEMESTER VII

CH1401 – TRANSPORT PHENOMENA

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UNIT I PHILOSOPHY AND FUNDAMENTALS OF TRANSPORT PHENOMENA 9

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

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

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

UNIT III EQUATIONS OF CHANGE AND THEIR APPLICATIONS 9

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

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

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

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9

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

L: 45 T:15 Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1402 – MASS TRANSFER OPERATIONS

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UNIT I **ABSORPTION** **12**

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

UNIT II **DISTILLATION** **12**

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

UNIT III **LIQUID-LIQUID EXTRACTION** **12**

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

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

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

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

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

Total: 60

TEXT BOOKS

1. Treybal, R.E., "Mass Transfer Operations", McGraw-Hill, 1980.
2. Coulson M. Richardson J.F., "Chemical Engineering", Vol.2, 3rd Edition, Pergamon Press, 1987.

REFERENCES

1. McCabe, W.L., Smith, J.C. and Harriot, P., "Unit Operations of Chemical Engineering", 6th Edition, McGraw-Hill International Edition, 2001.
2. Judson King, C., "Separation Processes", Tata McGraw-Hill 1974.
3. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

CH1403 – CHEMICAL REACTION ENGINEERING

| L | T | P |
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UNIT I NON-IDEAL REACTORS 12

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

UNIT II HETEROGENEOUS PROCESS AND SOLID CATALYSIS 12

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

UNIT III GAS-SOLID CATALYTIC REACTORS 12

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

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 12

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

UNIT V GAS-LIQUID REACTIONS 12

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

Total: 60

TEXT BOOKS

1. Fogler, H.S., "Elements of Chemical Reaction Engineering", 3rd Edition, Prentice Hall of India Pvt. Ltd., 1999.
2. Levenspiel, O., "Chemical Reaction Engineering", 2nd Edition, John Wiley, 1972.

REFERENCES

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

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

REFERENCES

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

CH1405 – PROCESS UTILITIES

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UNIT I WATER 12

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

UNIT II COMPRESSED AIR and VACUUM 12

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

UNIT III REFRIGERATION 12

Refrigeration systems and their characteristics – Production of cryogenic temperatures.

UNIT IV AIR CONDITIONING and VENTILATION 12

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

UNIT V STEAM 12

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

Total: 60

TEXT BOOKS

1. Bhasin, S.D., “Project Engineering of Process Plants”, Chemical Engineering Education Development Centre, I.I.T., Madras, 1979.
2. Davidson, P.J. and West, T.F., “Services for the Chemical Industry”, Pergamon Press, 1968.

REFERENCES

1. Kumar, R.S. and Gupta, J.K., “A Text Book of Refrigeration and Air Conditioning”, S.Chand and Co., 1987.
2. Cremer, H.W. and Davis, “Chemical Engineering Practice”, Vol.10., Butterworths, 1960.
3. “Process Utilities”, Chemical Engineering Development Centre, I.I.T., Madras, 1968.

PC1362 – MASS TRANSFER LABORATORY

| L | T | P |
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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

CH1406 – CHEMICAL REACTION ENGINEERING LABORATORY

| L | T | P |
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1. Determination of reaction rate constant for saponification reaction in a batch reactor for equimolar reactants
2. Determination of reaction rate constant for saponification reaction in a batch reactor for Non - equimolar reactants
3. Determination of reaction rate constant for saponification reaction in a plug flow reactor
4. Determination of reaction rate constant for saponification reaction in a packed bed reactor
5. Determination of reaction rate constant for saponification reaction in CSTR
6. Determination of reaction rate constant for saponification reaction in a PFR followed by a CSTR
7. Determination of reaction rate constant for saponification reaction in CSTRs in series
8. Residence Time Distribution in a PFR
9. Residence Time Distribution in a packed bed Reactor
10. Residence Time Distribution studies in CSTR

Total: 45

CH1407 – CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING II

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

UNIT I DESIGN OF COOLING TOWER, EVAPORATORS, DRIERS 9

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

UNIT II DESIGN OF HEATEXCHANGER 9

Heat exchangers, condensers and reboilers.

UNIT III DESIGN OF DISTILLATION COLUMN 9

Distillation columns – Sieve tray and bubble cap tray columns and packed column.

UNIT IV DESIGN OF ABSORPTION and ADSORPTION 9

Equipments for absorption and adsorption of gases.

UNIT V DESIGN OF EXTRACTION 9

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

Total :45

TEXT BOOKS

1. Joshi, M.V. and Mahajan, V.V., "Process Equipment Design", MacMillan India Ltd,2009.
2. Dawande, S.D., "Process Design of Equipments", Central Techno Publications, 2000.

REFERENCES

1. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
2. Perry, R.H., "Chemical Engineers' Handbook", McGraw-Hill,1999.
3. Coulson, J.M. and Richardson, J., "Chemical Engineering", Vol. 6, Asian Books Printers Ltd,2001.

SEMESTER VIII

MG1352 – TOTAL QUALITY MANAGEMENT

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UNIT I INTRODUCTION 9

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

UNIT II TQM PRINCIPLES 9

Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation, empowerment, teams, recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy – PDSA cycle – 5S – Kaizen – Supplier partnership – Partnering – Sourcing – Supplier selection – Supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure.

UNIT III STATISTICAL PROCESS CONTROL (SPC) 9

The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.

UNIT IV TQM TOOLS 9

Benchmarking – Reasons to benchmark – Benchmarking process – Quality Function Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 and other quality systems – ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 – Concept, requirements and benefits.

Total : 45

TEXT BOOKS

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

REFERENCES

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

MG1453 – SAFETY AND RISK MANAGERMENTS

| L | T | P |
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UNIT I INDUSTRIAL SAFETY 15

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

UNIT II HAZARD ANALYSIS 15

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

UNIT III RISK MANAGEMENT 15

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

UNIT IV SAFETY PROCEDURES 7

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

UNIT V SAFETY IN HANDLING and STORAGE OF CHEMICALS 8

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

Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1455 – PROJECT WORK

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

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

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

- Data collection
- Critical literature review
- Laboratory experience and tests
- Mathematical modeling
- Software application
- Industrial visits
- Design and/or assembly
- Process analysis

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

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

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

Total: 45

LIST OF ELECTIVES I

SEMESTER VII

CH1001 – FERTILIZER TECHNOLOGY

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UNIT I NITROGENOUS FERTILISERS 15

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

UNIT II PHOSPHATIC FERTILISERS 14

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

UNIT III POTASSIC FERTILISERS 7

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

UNIT IV COMPLEX AND NPK FERTILISERS 12

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

UNIT V MISCELLANEOUS FERTILISERS 12

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

Total: 60

TEXT BOOKS

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

REFERENCES

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

PC1008 – PETROCHEMICAL TECHNOLOGY

L T P
4 0 0

UNIT I PETROCHEMICAL PRECURSORS 15

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

UNIT II CHEMICALS FROM C₁ 6

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

UNIT III CHEMICALS FROM C₂ 12

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

UNIT IV CHEMICALS FROM C₃ and C₄ 12

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

UNIT V CHEMICALS FROM AROMATICS 15

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

Total: 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. Hahn, A.V.G., “The Petrochemical Industry”, McGraw Hill, 1970.
2. Waddams, A.L., “Chemicals from Petroleum”, Chemical Publishing Co., 1969.
3. Popchiev, A.V., Naigyevev M.F. and Shakhakhtinskii, T.N., “Synthetic Materials from Petroleum”, Pergamon Press, 1963.

CH1002 – INDUSTRIAL MANAGEMENT

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UNIT I PERSONNEL MANAGEMENT 12

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

UNIT II TQM TOOLS AND TECHNIQUES 12

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

UNIT III QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEMS 12

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

UNIT IV ENGINEERING ECONOMICS 12

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

UNIT V PROCESS ECONOMICS 12

Amortisation, capital recovery, depreciation – Economics of selecting alternatives – Rate of return and payout time – Budgeting – Operation management – Strategic analysis – Problem solving techniques – Preparation of technical reports – Process improvement.

Total: 60

TEXT BOOKS

1. Peters and Timmer Haus, “Plant Design and Economics for Chemical Engineering”, 4th Edition, McGraw Hill Book Co., 1991.
2. Arun Monappa, Mirza S. Saiyadain, “ Personnel Management”, 2nd Edition., Tata McGraw – Hill Publishing Company Ltd,2005.

REFERENCES

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

CH1003 – PROCESS INTEGRATION AND PINCH TECHNOLOGY

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UNIT I PINCH TECHNOLOGY 14

Basic concepts of pinch technology – Stream networks – Locating the pinch- Significance of pinch – Selection of pinch temperature differences – Tabular method – Stream splitting – Process retrofit – case studies.

UNIT II TARGETING 10

Heat exchanger networks – Energy Targeting – Area targeting – Unit targeting – Shell targeting – Cost targeting – Continuous targeting.

UNIT III PINCH METHODOLOGY 12

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

UNIT IV PINCH DESIGN AND OPTIMIZATION 12

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

UNIT V ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES AND MASS EXCHANGE NETWORK 12

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

Total: 60

TEXT BOOKS

1. Udhay Shenoy, V., “Heat Exchanger Network Synthesis”, Gulf publishing Co, 1995.
2. Linnhoff, D.W., “ User Guide on Process Integration for the Efficient Use of Energy”, Institution of Chemical Engineers, 1994.

REFERENCES

1. James M.Douglas “Conceptual Design of Chemical Process”, Mc Graw Hill, 1998.
2. Anilkumar, “Chemical Process Synthesis and Engineering Design”, Tata McGraw Hill, 1977.
3. Robin Smith, “Chemical Process Design”, McGraw Hill International Edition, 1995.

LIST OF ELECTIVES II

SEMESTER VIII

CH1004 – ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

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UNIT I ENERGY RESOURCES - A GLOBAL VIEW 12

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

UNIT II ENERGY AND ENVIRONMENT 12

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

UNIT III MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES 12

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

UNIT IV ENERGY ALTERNATIVES 12

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

UNIT V ECONOMIC BALANCE IN ENERGY CONSUMPTION 12

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

Total: 60

TEXT BOOKS

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

REFERENCES

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

CH1005 – PROCESS MODELLING AND SIMULATIONS

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UNIT I BASIC MODELLING 12

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

UNIT II MATRIX MODELS 12

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

UNIT III LUMPED PARAMETER MODEL 12

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

UNIT IV DISTRIBUTED PARAMETER MODEL 10

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

UNIT V OPTIMISATION AND SIMULATIONS 14

Introduction – Application – Analytical and numerical techniques for multivariable problems – Techniques for constrained optimization – Simulation; introduction – Discrete event and continuous simulation – Dynamic simulation of reactors, distillation columns, absorbers, evaporators and crystallizers – Simulation in process control.

Total: 60

TEXT BOOKS

1. Ramirez, W., “Computational Methods in Process Simulation”, Butterworths Publishers, 1989.
2. Edgar, T.F. and Himmelblau, D.M., “Optimisation of Chemical Processes”, McGraw-Hill Book Co., 1989,

REFERENCES

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

CH1006 – NATURAL GAS ENGINEERING

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

REFERENCES

1. Donald L. Katz and Robert L. Lee, “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.

CH1007 – MODERN SEPARATION PROCESSES

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UNIT I GENERAL 12

Review of conventional processes – Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances – Process concept – Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter – Surface based solid – liquid separations involving a second liquid – Sirofloc filter.

UNIT II MEMBRANE SEPARATIONS 12

Types and choice of membranes – Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits – Commercial, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis – Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis – Economics of membrane operations – Ceramic membranes.

UNIT III SEPARATIONS BY ADSORPTION TECHNIQUES 12

Mechanism – Types and choice of adsorbents – Normal adsorption techniques – Affinity chromatography and immuno Chromatography – Types of equipment and commercial process – Recent advances and process economics.

UNIT IV IONIC SEPARATIONS 12

Controlling factors – Applications – Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electro dialysis – Commercial processes.

UNIT V OTHER TECHNIQUES 12

Separations involving lyophilisation, pervaporation and permeation techniques for soils, liquids and gases, Industrial viability and examples, zone melting, addluctive crystallization – Other separation processes – Supercritical fluid extraction – Oil spill Management – Industrial effluent treatment by modern techniques.

Total: 60

TEXT BOOKS

1. Lacey, R.E. and Loeb, S., “Industrial Processing with Membranes”, Wiley Inter Science, 1972.
2. King, C.J., Separation Processes, Tata McGraw–Hill Publishing Co. Ltd., 1982.

REFERENCES

1. Schoew, H.M., “New Chemical Engineering Separation Techniques”, Interscience Publishers, 1972.
2. Ronald W. Roussel., “Handbook of Separation Process Technology”, John Wiley, 1987.
3. Kestory, R.E., “Synthetic Polymeric Membranes”., Wiley Interscience, 1985.
4. Osadar, Varid Nakagawal., “Membrane Science and Technology”, Marcel Dekkar, 1992.