

Text Book :

1. *Smith, J.M., Van Ness, H.C., " Introduction to Chemical Engineering Thermodynamics ", Kogakushai 1976.*

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 edn. ", Wiley, 1989.*
4. *Kyle, B.G., " Chemical and Process Thermodynamics 2nd edn. ", Prentice Hall of India Pvt.Ltd., 1990.*

1 . UNITS AND DIMENSIONS 3

Basic and derived units, use of model units in calculations, Methods of expression, compositions of mixture and solutions.

2 . GAS CALCULATIONS 8

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

3 . MATERIAL BALANCE 11

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

4 . HUMIDITY AND SATURATION 4

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

5 . FUELS AND COMBUSTION 5

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds.

6 . THERMO PHYSICS 6

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.

7 . THERMOCHEMISTRY 8

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

Total No of periods: 45

Text Books:

1. *Bhatt, B.L., VORA, S.M., " Stoichiometry ", Tata McGraw-Hill, 1976.*
2. *Hougen, O.A., Watson, K.M and Ragatz, R.A., " Chemical Process Principles Part-I ", John Wiley and Asia Publishing, 1970.*

References:

1. *Himmelblau, D.M., " Basic Principles and Calculations in Chemical Engineering ", Fourth Edition, Prentice Hall Inc., 1982.*
2. *Whitwell, J.C., Tone, R.K. " Conservation of Mass and Energy ", McGraw-Hill, 1973.*
3. *Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engineering Education Developement Centre, I.I.T., Madras, 1981.*

1 . INTRODUCTION	5
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.	
2 . PRESSURE DISTRIBUTION IN A FLUID	5
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.	
3 . INTEGRAL RELATIONS FOR A CONTROL VOLUME	7
Basic laws of fluid mechanics, concept of system and control volume concept - The Reynold's transport theorem - continuity equation - the linear momentum equation - the angular momentum theorem - steady flow energy equation - friction less flow - Bernoulli equation - relation between the Bernoulli and steady flow energy equation.	
4 . DIFFERENTIAL RELATIONS FOR A FLUID PARTICLE	7
The acceleration field of a fluid - the differential equation of conservation of mass - the differential equation of linear momentum - the Euler's and Navier -Stoke's equations - differential equation of energy - boundary conditions for the basic equations - the stream function, vorticity and irrotationality.	
5 . DIMENSIONAL ANALYSIS AND SIMILITUDE	4
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.	
6 . VISCOUS FLOW IN DUCTS AND BOUNDARY LAYER FLOW	5
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 fluidised beds.	
7 . FLOW MEASUREMENT AND TUBRO MACHINERY	4
Constant and variable headmeters - classification of pumps - performance curves - matching pumps to system charateristics, compressors and its efficiency.	
8 . COMPRESSIBLE FLOW	4
Adiabatic and isentropic flow with the area changes, shock waves, operation of convergence and divergence nozzles, compressible duct flow with friction.	
9 . COMPUTATIONAL FLUID MECHANICS	4
Introduction, numerical operations for differentiation and integration, fluid flow problems represented by partial differential equation.	

Total No of periods: 45

Text Books:

1. Noel de Nevers, " *Fluid Mechanics for Chemical Engineers* ", Second Edition, McGraw-Hill Inc, 1991.
2. Liggett, J.A., " *Fluid Mechanics* ", International Edition, McGraw-Hill, Inc., 1994.

References:

1. Shames, I.H., " *Mechanics of Fluids* ", Third Edition, McGraw-Hill Inc., 1992.
2. White, F.M., " *Fluid Mechanics* ", Third Edition, McGraw-Hill Inc., 1994.
3. Daugherty, R.L., Franzini, J.B and Finnemore, E.J., " *Fluid Mechanics with Engineering Applications* ", SI metric Edn., McGraw-Hill Book Company, 1989.
4. Streeter, V.L., Wylie, E.B., " *Fluid Mechanics* ", First SI metric Edition, McGraw-Hill Book Company, 1989.
5. Welty, J.R., Wicks, C.E and Wilson, R.E., " *Fundamentals of Momentum, Heat and Mass Transfer* ", Third Edition, John Wiley & Sons, 1984.

1 . PULP AND PAPER INDUSTRIES 5

Cellulose derivatives, pulp, paper and boards.

2 . SUGAR AND STARCH INDUSTRIES 3

Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

3 . OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 7

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, fatty acids and alcohols, waxes, soaps, synthetic detergents.

4 . PETROLEUM AND PETROCHEMICAL INDUSTRIES 10

Petroleum refining, physical and chemical conversion products, lubricating oils, petrochemical precursors, methane, olefines, acetylenes and aromatics and products obtained from them by various unit processes.

5 . POLYMERS 12

Monomer Materials, Thermo plastic and Thermosetting materials (such as polyethylene, polypropylene, polyvinyl chloride, polytetra fluoro ethane) and PF resins; Epoxy and polyesters - Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic Rubbers.

6 . SYNTHETIC FIBRE AND FILM INDUSTRIES 5

Viscose rayon, cuprammonium and cellulose acetate, nylons, polyesters, acrylics.

7 . FOOD PRESERVATION 3

Food Addition - Food Processing - Food preservation

Total No of periods: 45

Text Books:

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

References:

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

1 . PARTICLE CHARACTERISTICS AND SIZE ANALYSIS 7

General characteristics of solids, their behaviour under different external forces, agglomeration, techniques for size analysis.

2 . SIZE REDUCTION 7

Laws of size reduction, classification of equipment, methods of size reduction, disintegration, preparation of colloids.

3 . 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.

4 . FILTRATION 8

Theory of filtration, Batch and continuous filters, centrifuges, membrane and ultra filtration.

5 . MIXING AND AGITATION 7

Equipment for blending and kneading, dispersion, power for agitation, correlations.

6 . STORAGE AND CONVEYING OF SOLIDS 7

Conveyors, elevators, pneumatic conveying, Different methods for storage of solids.

Total No of periods: 45

Text Book :

1. McCabe, W.L., Smith J.C., " Unit Operations in Chemical Engineering ", McGraw-Hill, Fourth Edition, 1984.

References:

1. Coulson, J.M., Richardson, J.F., " Chemical Engineering ", Volume 2, Third Edition, Pergamon Press, 1977.

1 . IMPROPER INTEGRALS AND SERIES SOLUTIONS 9

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

2 . BESSEL FUNCTIONS 9

Bessel's equation, bessel functions, recurrence relations, orthogonality property, generating function, equations reducible to Bessel's equation, modified Bessel functions. Applications to boundary value problems.

3 . LEGENDRE POLYNOMIALS 9

Legendre's equation, Legendre Polynomials, Rodrigue's formula generating function, recurrence relations, orthogonality property, Applications to boundary value problems.

4 . HERMITE AND LAGUERRE POLYNOMIALS 9

Hermite and Leguerre equations and their solutions-Polynomials, Rodrigue's formula, generating functions, recurrence relations, orthogonality property.

5 . DIFFERENCE EQUATIONS AND Z-TRANSFORM 9

Linear difference equation with constant coefficients, elementary properties of z transform applications of z transform, application of z transform to difference equations.

6 . TUTORIAL 15

Total No of periods: 60

Text Book :

1. Andrews.L.A., " Special Function for Scientist and Engineers ", McGraw-Hill, 1992.

References:

- 1. Narayanan, S.Manicavachagam Pillay and Ramanaiah.G, " Advanced Mathematics for Engineering Students ", Vol II and III S.Viswanathan Printers Private Limited, Madras, 1985.*
- 2. Grewal, B.S., " Higher Engineering Mathematics ", Khanna Publishers, Delhi, 1989.*
- 3. Andrews, L.C., and Shivamoggi, B.K., " Integral Transforms for Engineers and applied Mathematicians ", MacMillan, New York, 1988.*

. LIST OF EXPERIMENTS ***60**

1. Oil Analysis: (3 experiments)
 - a) Acid value
 - b) Saponification value
 - c) Iodine value
2. Soap Analysis: (2 experiments)
 - a) Alkali Content
 - b) Fatty acid content of Soap
3. Estimation of purity of glycerol: by Dichromatic method
4. Analysis of water:
Determination chlorine demand in water : Estimation of residual chlorine in water by Volumetric method
5. Cement Analysis (3 experiments)
 - a) Estimation of silica content
 - b) Estimation of calcium oxide content
 - c) Estimation of mixed oxide content
6. Fertilizer Analysis:
Estimation of Nitrozen in Urea by Kjeldals method

* Minimum TEN experiments shall be offered.

Total No of periods: 60

CH337 Chemical Engineering Lab I

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. FLUID MECHANICS AND MECHANICAL OPERATION LAB

60

List of Experiments *

1. Calibration of constant and variable Head meters
2. Calibration of Weirs
3. Flow through straight pipe
4. Pressure drop studies in packed column
5. Fluidisation
6. Characteristic curves of centrifugal pump
7. Ball mill
8. Leaf filter
9. Filter press
10. Effectiveness of screens
11. Sedimentation
12. Cyclone separator

* Minimum 10 experiments shall be offered.

Total No of periods: 60

1 . PROPERTIES OF SOLUTIONS 8

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures.

2 . PHASE EQUILIBRIA 10

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-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.

3 . CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 10

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

4 . CHEMICAL REACTION EQUILIBRIA 10

Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

5 . REFRIGERATION 7

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles.

Total No of periods: 45

Text Books :

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

References:

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

1 . REACTION KINETICS 12

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.

2 . IDEAL REACTORS 6

Design for homogeneous systems, batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions, combination reactor system, size comparison of reactors.

3 . CHOICE OF REACTORS 9

Factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield problems, consecutive, parallel and mixed reactions, recycle.

4 . HEAT EFFECTS IN REACTORS 9

Isothermal and nonisothermal 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.

5 . REACTOR STABILITY 4

Criteria for stability of reactors, limit cycles and oscillating reaction, parameter sensitivity.

6 . REACTION EQUILIBRIA 5

Equilibrium in chemically reactive systems, evaluation of reaction equilibrium constant, effect of temperature on equilibrium, application to system involving gaseous components, computation of equilibrium composition.

Total No of periods: 45

Text Books:

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

1 . DIFFUSION 8

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.

2 . MASS TRANSFER COEFFICIENTS 10

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.

3 . HUMIDIFICATION AND AIR CONDITIONING 9

Basic concepts, psychrometric chart construction, Humidification and dehumidification operations, design calculations, cooling tower principle and operation, types of equipment, design calculation.

4 . DRYING 9

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.

5 . CRYSTALLISATION 9

Nuclei formation and crystal growth, theory of crystallisation, growth coefficients and the factors affecting these in crystallisation, batch and continuous industrial crystallisers, principle of design of equipment.

Total No of periods: 45

Text Books :

1. Coulson, J.M., Richardson, J.F., " *Chemical Engineering* ", Pergamon Press, 1977.
2. Foust, A.S. Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., " *Principles of Unit Operations* ", Second Edition, Wiley, 1980.

References:

1. Treybal, R.E., " *Mass Transfer Operations* ", McGraw-Hill Kogakusha, 1980.
2. Sherwood, T.K., Pigford, R.L., and Wilke, C.R., " *Mass Transfer* ", McGraw-Hill, 1976.
3. McCabe, W.L., Smith, J.C., and Harriot, P., " *Unit Operations in Chemical Engineering* ", McGraw-Hill Edn, 1993.
4. Roman Zarzytci, Andrzej Chacuk, " *Absorption: Fundamentals and Application* ", Pergamon Press, 1993.
5. Skelland, A.H.P., " *Diffusional Mass Transfer* ", Krieger, Malabar FL (1985).
6. Strigle (jr), R.F., " *Packed Tower Design and Applications* ", Second Edition, Gulf Publishing Company, USA., 1994.
7. Strumila, C.Kudra, T., " *Drying Principles: Applications and Design* ", Gordon and Breach Science Publishers, U.K., 1986.

1 . BASIC PRINCIPLES 2

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Mean temperature difference.

2 . CONDUCTION 8

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 - Thermal conductivity measurement; effect of temperature on thermal conductivity; conduction through liquids.

3 . FILM COEFFICIENTS AND THEIR APPLICATION 8

Individual and overall heat transfer coefficients and the relationship between them - Conduction with heat source - Two dimensional steady state conduction - Analytical and graphical methods - Transient heat conduction.

4 . 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 vapours, heat transfer to boiling liquids - Influence of boundary layer on heat transfer - Heat transfer to molten metals - Heat transfer in packed and fluidised beds.

5 . HEAT EXCHANGERS 5

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 furnaces - Design of condensers, - Design of tubular reactors.

6 . RADIATION 5

Concept of thermal radiations - Black body concept - Stefan Boltzman's law -concept of grey body - radiation between surfaces.

7 . EVAPORATION 5

Types of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation.

Total No of periods: 45

Text Books:

1. Binay K.Dutta "*Heat Transfer Principles and Applications*", Prentice Hall of India, 2001.
2. Kenn, D.Q., "*Process Heat Transfer*", McGraw-Hill - Revised edition - 1999.

References:

1. McAdams, W.H., "*Heat Transmission*", McGraw-Hill, 1964.
2. Kreith, F., "*Principles of Heat Transfer*", Third Edition, Harper and Row, 1976.
3. Necati ozisik, M., "*Basic Heat Transfer*", McGraw-Hill, Kogakusha, 1977.
4. Giedt, W.H., "*Principles of Engineering Heat Transfer*", D.Van Nostrand Company Inc., 1957.
5. Mccabe, W.L., Smith, J.C., "*Unit Operations in Chemical Engineering*", McGraw-Hill, Kogakusha, 1976.
6. Coolson, J.M., Richardson, J.F., "*Chemical Engineering*", Vol.I., Pergamon and ECBS, 1970.

1 . UNIT-1 9

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for chemical reactors and dynamics.

2 . UNIT-2 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

3 . UNIT-3 9

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings.

4 . UNIT-4 9

Controller mechanism, introduction to advanced control systems, cascade control, feed forward control, control of distillation towers and heat exchangers, introduction to microprocessors and computer control of chemical processes.

5 . UNIT-5 9

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, pH, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties and spectroscopy.

Total No of periods: 45

Text Books :

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

References:

1. *Emenule, S.Savas, " Computer Control of Industrial Processes ", McGraw-Hill, London, 1965.*
2. *Eckman, D.P., " Industrial Instrumentation ", Wiley, 1978.*

. DRAWING AND DESIGN DETAILS OF

60

1. PRESSURE VESSELS

Constructional details and supporting structure.

2. HEAT EXCHANGERS

Single and multipass heat exchangers, Double pipe, floating head exchangers, constructional details and assembly.

3. EVAPORATORS

Constructional details and assembly drawings.

4. DISTILLATION TOWER

Constructional details and assembly drawings of packed and plate towers.

5. FILTERS AND CENTRIFUGES

Constructional details and assembly drawings of filters and Centrifuges.

Total No of periods: 60

CH344 Chemical Engineering Lab II

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. HEAT AND MASS TRANSFER LAB

60

List of Experiments *

1. Simple distillation
2. Steam distillation
3. Packed column distillation
4. Bubble cap distillation
5. Diffusivity measurements
6. Liquid-liquid extraction
7. Wetted wall column
8. Pan dryer
9. Jacketted Pan/Kettle
10. Heat exchanger
11. Evaporator
12. Heat loss in pipes

* Minimum 10 experiments shall be offered.

Total No of periods: 60

1 . COMPONENTS OF ENVIRONMENT 9

Components - Water, air and land - Inter-relationship between components - Subcomponents; Ecosystem - Structure and functional components of ecosystem - Development and evolution of ecosystem - Energy flow and material cycling in ecosystem - Natural and man made impacts on water, air and land; Environment and development - Concept of sustainable development.

2 . SCIENCE OF ENVIRONMENT 9

Chemistry, Physics and biology of water, air and land; Stress on the Chemistry, Physics and Biology of water, air and land owing to the impacts; Environmental quality objective and goals - Policies on development projects and their impacts, with emphasis on the branch of engineering of the student.

3 . CURRENT ENVIRONMENTAL ISSUES 9

Current Environmental issues at Country level - management of municipal sewage, municipal solid waste, Hazardous waste and Bio-medical waste - Air pollution due to industries and vehicles; Global issues - Biodiversity, Climatic change, Ozone layer depletion.

4 . ENGINEERING INTERVENTIONS TO REDUCE THE ENVIRONMENTAL STRESSES 9

Minimisation of Stress - Principles of Physics, chemistry and biology in engineering interventions such as waste treatment - Flow sheets of engineering interventions relevant to the Engineering discipline of the student - Waste minimisation techniques - Clean technology options - Standards of performance of the interventions.

5 . 9

(A) TOOLS FOR ENVIRONMENTAL MANAGEMENT 6

Environmental impact assessment; Precautionary Principle and Polluter Pays Principle; Constitutional provisions, Legal and economic instruments in Environmental Management; Role of Non-government organisations - Community participation environmental management works; International conventions and protocols; Pollution Control Boards and Pollution Control Acts.

(B) FIELD STUDY 3

In-depth study of environmental issues at least one environmentally sensitive site relevant to the discipline of the student and preparation of a report thereupon.

Total No of periods: 45

Text Books:

1. *G.M.Masters, " Introduction to Environmental Engineering & Science ", Prentice Hall, New Delhi, 1997*
2. *J.G. Henry and G. W. Heike, " Environmental Science & Engineering ", Prentice Hall International Inc., New Jersey, 1996.*

References:

1. *S. K. Dhameja, Environmental Engineering and Management, S. K. Kataria and Sons, New Delhi, 1999.*
2. *State of India's Environment - A Citizen's Report, Centre for Science and Environment and Others, 1999.*
3. *Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Cases, Materials and Statutes, Oxford University Press, 2001.*

1 . PART A: 21**1. PRINCIPLES OF MANAGEMENT AND ORGANISATION 7**

Planning, organisation, staffing, coordination, directing, controlling, communicating, organisation as a process and a structure; types of organisations.

2. PRODUCTION AND MANAGEMENT 10

Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning, routing; scheduling; despatching; costs and costs control, inventory and inventory control.

3. QUALITY AND QUALITY CONTROL 4

Elements of quality control, role of control charts in production and quality control.

2 . PART B: 24**1. ENGINEERING ECONOMICS FOR PROCESS ENGINEERS 1****2. INTEREST, INVESTMENT COSTS AND COST ESTIMATION 8**

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability.

3. PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 10

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

4. ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 3

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

5. ECONOMIC BALANCE 2

Different unit operations with single and multiple variables.

Total No of periods: 45

References:

1. *Davis, G.S, " Chemical Engineering Economics and Decision Analysis ", CENDC, I.I.T., Madras, 1981.*
2. *Holland, F.A., Watson, F.A and Wilkinson, J.K., " Introduction to process Economics ", John Wiley, 1974.*
3. *Sumanth, D.T., " Production Engineering and Management ", McGraw-Hill, 1984.*
4. *Shukla, M.C., " Business Organisation and Management ", Sultan Chand and Sons, 1975.*

1 . NON-IDEAL REACTORS 9

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.

2 . HETEROGENEOUS PROCESS AND SOLID CATALYSIS 9

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.

3 . GAS-SOLID CATALYTIC REACTORS 9

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

4 . GAS-SOLID NON-CATALYTIC REACTORS 9

Models for explaining the kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidised and static reactors.

5 . GAS-LIQUID REACTIONS 9

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 No of periods: 45

Text Books :

- 1. Levenspiel, O; " Chemical Reaction Engineering ", 2nd Edition, John Wiley, 1972.*
- 2. Smith J.M., " Chemical Engineering Kinetics ", 3rd edition, McGraw-Hill, New York, 1981.*

1 . ABSORPTION 10

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stagewise 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.

2 . DISTILLATION 13

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.

3 . LIQUID-LIQUID EXTRACTION 9

Equilibrium in ternary systems; equilibrium stagewise 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.

4 . SOLID-LIQUID EXTRACTION (LEACHING) 4

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages.

5 . ADSORPTION AND ION EXCHANGE 5

Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operation; design calculation of ion-exchange resins; principle of ion-exchange; industrial equipment.

6 . MISCELLANEOUS SEPARATION PROCESSES 4

Membrane separation process; solid and liquid membranes; concept of osmosis; reverse osmosis; electrodialysis; their applications; foam separation process; Thermal and sweep diffusion process.

Total No of periods: 45

Text Books :

1. R.E.Treybal, " *Mass Transfer Operations* ", McGraw-Hill, Kogakusha, 1980.
2. W.L McCabe and J.G.Smith, " *Unit Operations in Chemical Engineering* ", McGraw-Hill Kogakusha, 1976.

References:

1. T.K.Sherwood R.L Pigford and C.R. Wilke, " *Mass Transfer* ", McGraw-Hill 1976.
2. C.Judson King " *Separation Processes* ", Tata McGraw-Hill 1974.
3. A.H.P.Skelland, " *Diffusional Mass Transfer* ", Krieger, Malapur, FL (1985).
4. Roman Zarfyki and Andrzej Chacuk, " *Absorption Fundamentals and Applications* ", Pergamon Press, 1993.
5. P.Wankat " *Equilibrium Stage Separations* ", Prentice Hall, 1993. R.F.Strigle (jr), *Packed Tower Design and Application*, 2nd Edn Gulf Publishing company U.S.A. 1994.

1 . PHILOSOPHY AND FUNDAMENTALS OF TRANSPORT PHENOMENA 3

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.

2 . TRANSPORT BY MOLECULAR MOTION 5

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.

3 . ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 12

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.

4 . EQUATIONS OF CHANGE AND THEIR APPLICATIONS 14

Conservation laws and equations of change; Developement of equations of continuity motion and energy in single multicomponents systems in rectangular coordinates and the forms in curvilinear coordinates; 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.

5 . TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 7

Turbulents 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 thickness; analysis of flow overflat surface.

6 . ANALOGIES BETWEEN TRANSPORT PROCESSES 4

Importance of analogy; developement and applications of analogies between momentum and mass transfer; Reynolds, prandtl, Von Karman and Colburn analogies.

Total No of periods: 45

Text Book :

1. *R.B.Bird, W.E.Stewart and E.W.Lighfoot, " Transport Phenomena ", John Wiley, 1978.*

References:

1. *Robert. S.Brodkey, Harry C.Hershey, " Transport Phenomena ", McGraw-Hill International Edn 1988.*
2. *L.S.Sissom, and D.R.Pitts, " Elements of Transport Phenomena ", McGraw-Hill. New York, 1972.*
3. *R.W.Fahien, " Elementary, Transport Phenomena ", McGraw-Hill, New York, 1983.*
4. *J.R.Wilty, R.W.Wilson, and C.W.Wicks, " Fundamentals of Momentum Heat and Mass Transfer ", 2nd Edn., John Wiley, New York, 1973.*

1 . ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy - professions and professionalism - professional ideals and virtues - theories about right action - self-interest-customs and religion - uses of ethical theories

2 . ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics-a balanced outlook on law-the challenger case study

3 . ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and risk - assessment of safety and risk - risk benefit analysis-reducing risk-the three mile island and Chernobyl case studies.

4 . RESPONSIBILITIES AND RIGHTS 9

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - intellectual property rights (IPR)-discrimination.

5 . GLOBAL ISSUES 9

Multinational corporations - environmental ethics-computer ethics-weapons development-engineers as managers-consulting engineers-engineers as expert witnesses and advisors-moral leadership-sample code of conduct.

Total No of periods: 45

Text Book:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York 1996.

References :

- 1. Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.*
- 2. Laura Schlesinger, "How Could You Do That: The Abdication of Character, Courage, and Conscience", Harper Collins, New York, 1996.*
- 3. Stephen Carter, "Integrity", Basic Books, New York, 1996.*
- 4. Tom Rusk, "The Power of Ethical Persuasion: From Conflict to Partnership at Work and in Private Life", Viking, New York, 1993.*

Design of the following equipments as per ASME, ISI, TEMA codes and drawing according to scale.
Drawing and design of

1. STORAGE VESSELS FOR NON-VOLATILE AND VOLATILE FLUIDS

2. PRESSURE VESSELS AND AUTOCLAVES

Drawing and design of Monobloc and multilayer vessels

3. HEAT EXCHANGERS

Drawing and design of Double pipe, single pass and multipass exchangers, floating head, U-tube heat exchangers and condensers.

4. EVAPORATORS

Drawing and design Standard vertical tube evaporator, single and multiple effect evaporators, forced circulation evaporator.

5. ABSORPTION TOWER

Plate and packed towers

6. EXTRACTION TOWER

Plate and packed towers.

7. DISTILLATION TOWER

Plate and packed towers.

8. DRYERS

Rotary and spray dryers.

9. FILTERS

Filter presses and filtering type centrifuge.

Total No of periods: 60

Text Books:

1. Kern, D.Q; " *Process Heat Transfer* ", McGraw-Hill, Revised Edition, 1985.
2. Brownhell, I.E., Young , E.H., " *Chemical Plant Design* ", Revised Edition, 1985.

. CHEMICAL REACTION ENGINEERING AND PROCESS CONTROL LAB 60

List of Experiments *

1. Kinetic studies in a batch reactor
2. Kinetics a plug flow reactor
3. Kinetics in a PFR followed by a CSTR
4. RTD in a PFR
5. RTD in a packed bed
6. RTD in CSTR's in series
7. Study of step response
8. Time constant in measuring instrument
9. Study in level control
10. Study in temperature control
11. Study in flow control
12. Study in interacting and non-interacting system
13. Study in valve characteristics

*Minimum 10 experiments shall be offered.

Total No of periods: 60

CH437 Seminar and Comprehension

0 0 4 100

The Objective of the comprehension test is to assess the overall level of proficiency and the scholastic attainment of the student in the various subjects studied during the degree course.

Total No of periods:

1. 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.

2. 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, PDCA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

3. 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.

4. 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.

5. QUALITY SYSTEMS**9**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

TEXT BOOK:

1. Dale H.Besterfield, et al., Total Quality Management, Pearson Education Asia, 1999. (Indian reprint 2002).

REFERENCES:

1. James R.Evans & William M.Lindsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. “Total Quality Management, McGraw-Hill, 1991.
3. Oakland.J.S. “Total Quality Management Butterworth – Heinemann Ltd., Oxford. 1989.
4. Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International 1996.
5. Zeiri. “Total Quality Management for Engineers Wood Head Publishers, 1991.

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry. The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course.

Total No of periods: