Faculty of Engineering & Technology

NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

THIRD ENGINEERING (T.E.)

CHEMICAL ENGINEERING
TERM – I & II

W.E.F. 2007-2008

NORTH MAHARASHTRA UNIVERSITY, JALGAON
STRUCTURE OF TEACHING & EVALUATION
T.E. (CHEMICAL ENGINEERING)
W.E.F.2007-2008

First Term

Sr. No.	Subject	Teaching Scheme Hours/ Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Chemical Processes-II	04	02	03	100	25	50	--
2	Process Heat Transfer	04	02	03	100	25	--	25
3	Mass Transfer-I	04	04	03	100	25	50	--
4	Process Equipment Design and Drawing -I	04	04	04	100	50	--	--
5	Chemical Engineering Thermodynamics	04	--	03	100	--	--	--
		20	12		500	125	100	25
	Grand Total	**32**			**750**			

Second Term

Sr. No.	Subject	Teaching Scheme Hours/ Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Instrumentation and Instrumental Analysis	04	02	03	100	25	--	25
2	Chemical Reaction Engineering-I	04	02	03	100	25	--	25
3	Mass Transfer-II	04	04	03	100	25	50	--
4	Process Equipment Design and Drawing -II	04	04	04	100	50	--	--
5	Mathematical Methods in Chemical Engineering	04	--	03	100	--	--	--
6	Practical Training/Mini Project/Special Study	--	--	--	--	25	--	--
		20	12		500	150	50	50
	Grand Total	**32**			**750**			

T.E. (CHEMICAL ENGINEERING)
1. CHEMICAL PROCESSES-II

Teaching Scheme:
Lectures: 4 Hrs./ Week
Practical: 2 Hrs./ Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 50 Marks
Term Work : 25 Marks

UNIT- I:

Food Industries: Types of food processing, preservation method, Food Products.
Sugar and Starch Industries: sugar and starches.
Fermentation Industries: Absolute alcohol, Beer, Wines and liquors, vinegar, citric acid lactic acid. (10 Hrs, 20 Marks)

UNIT- II:

Oil, Fat and Waxes: Vegetable oils, animal Fats and oils, Waxes.
Soaps and detergents.
Pulp and paper industries: Manufacturing of pulp, manufacturing of paper, and structural boards. (10 Hrs, 20 Marks)

UNIT- III:

Agrochemical Industries: Insecticides, pesticides, Herbicides, plant growth , Nutrients and regulators, compound fertilizers, Bio fertilizers, complex fertilizers, various grades of N.P.K. fertilizer.
Pharmaceuticals Industries: Classification of Pharmaceuticals products.
Manufacture of Antibiotics, Isolates from plant and animal, vitamins. (10 Hrs, 20 Marks)

UNIT- IV:

Explosives: Types of Explosives, Explosive characteristics, Industrial explosives, propellants, rockets, missiles, pyrotechnics, matches, toxic chemical weapons.
Plastic industries: Raw Materials, general polymerization processes, manufacturing processes, compounding and Moulding operation. (10 Hrs, 20 Marks)

UNIT- V:

Dyes: Classification and manufacturing of dyes.
Petroleum and Petrochemicals : Petroleum production and Refining , Manufacturing of Methanol , Formaldehyde , Ethylene and Acetylene , Ethylene dioxide, Isopropanol, Acetone , Isopropyl , Benzene ,Butadiene, Phenol styrene . (10 Hrs, 20 Marks)

REFERENCES

1) George T. Austin, "Shreeve's Chemical Process Industries", 5th Edition , Mc Graw Hill Book Company.
2) C.E. Dryden, Outline of Chemical Technology, Affiliated East WestPress.1973.
3) S.D.Shukla, G.N.Pandey, A text book of Chemical technology, 3rd Edition.

PRACTICAL and TERM WORK :

Practical and Term Work Shall be based on any 08 experiments mentioned below.

1) Estimation of sugar / glucose
2) Determination of saponification value of an oil
3) Determination of acid value of an oil
4) Determination of iodine value of an oil
5) Preparation of azo dye
6) Preparation of soap
7) Preparation of green pigment
8) Preparation of yellow pigment
9) Preparation of blue pigment
10) Preparation of drug aspirin

2. PROCESS HEAT TRANSFER

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 25 Marks
Term Work: 25 Marks

UNIT- I:

Heat transfer by conduction in solids;
Fourier's law of heat conduction ,steady state heat conduction through walls (single and multilayer), heat flow through cylinder ,unsteady state heat conduction ,Derivation of Fourier's heat conduction equation in three dimensions , equation for one dimensional conduction , heat conduction through a semi infinite slab , lumped capacity method of unsteady state conduction . Principles of heat flow in fluids. (10 Hrs, 20 Marks)

UNIT-II:

Typical heat exchange equipment ,counter current and parallel flows, energy balances, overall heat transfer coefficient , log mean temperature difference, individual heat transfer coefficient, calculation of overall coefficient from individual coefficients , transfer units in heat exchangers. Heat transfer to fluids without phase change.

(10 Hrs, 20 Marks)

UNIT- III:

Regimes of heat transfer in fluids, heat transfer by forced convection in laminar and turbulent flow, dimensional analysis method, use of imperials equations heat transfer by forced convection outside tubes, natural convection.

Heat transfer to fluids with phase change.

Dropwise and film type condensation, coefficient for film type condensation, practical use of Nusselt's equations, application to petroleum industries (10 Hrs, 20 Marks)

UNIT- IV:

Heat transfer to boiling liquids:

Boiling of saturated liquids maximum flux and critical temperature drop, maximum Flux and film boiling.

Radiation heat transfer:

Fundamental of radiation, black body radiation, Kirchoff's law, radiant heat exchange between non black surfaces. Combined heat transfer by conduction, convection, radiation. (10 Hrs, 20 Marks)

UNIT- V:

Heat exchange equipments:

Heat exchanger single pass 1-1 exchanger, 1-2 shell and tube heat exchanger, correction for LMTD for cross flow, design calculation (Kern Method) in heat exchanger.

Evaporation:

Liquid characteristics and types of evaporator, single effect evaporator calculation, pattern of liquor flow in multiple effect evaporators. (10 Hrs, 20 Marks)

REFERENCES

1) W.L.McCabe and J.C.Smith , Unit operations in chemical engg. McGraw Hill/Kogakusha Ltd.
2) Coulson & Richardson , Chemical engg. – Volume. I , Pergamon Press
3) Kern D.Q. Process Heat Transfer, McGraw Hill Book 1NC New York, 1950
4) D.S.Kumar, Process Heat Transfer, S.K.Kataria and Sons Publisher, New Delhi

PRACTICALS

Term Work Shall be based on any 08 experiments mentioned below.

1) Conductivity of metals and / or insulator.
2) Experiment on Pin fins.
3) Experiment on forced convection apparatus.
4) Experiment on natural convection apparatus.
5) Determination of emmisivity of test plate.
6) Stefan Boltzman apparatus .
7) Parallel / counter flow heat exchanger.
8) Study of pool boiling phenomenon and critical heat flux.
9) Study of heat transfer in evaporator .
10) Temperature profile in a rod .
11) Study of evaporators .
12) Dropwise and filmwise condensation .

3. MASS TRANSFER-I

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 50 Marks
Term Work: 25 Marks

UNIT- I:
Introduction to mass transfer operations, Steady state molecular diffusion in fluid at rest, Multicomponent mixture diffusion, Maxwell's law of diffusion
Diffusion in solids, Unsteady state diffusion (10 Hrs, 20 Marks)

UNIT- II:
Eddy (turbulent) diffusion: Relation between mass transfer coefficients.
Mass transfer coefficient in laminar and turbulent flow
Theories of mass transfer
Equipments for gas liquid operation (10 Hrs, 20 Marks)

UNIT- III:
Equilibrium for mass transfer process.: Local two phase mass transfer
Local overall mass transfer coefficient, Use of local overall coefficient.
Material balances for steady state co current, countercurrent, cross flow cascade, counter flow cascade.
Application of mass transfer processes (10 Hrs, 20 Marks)

UNIT- IV:
Introduction to Gas Absorption Operation: Equilibrium solubility of gases in liquids
Material balance for one component transferred in countercurrent flow and co current flow
Countercurrent multistage operation, one component transferred
Continuous contact equipment
Introduction to multi component system
Absorption with chemical reaction
Different absorption operation equipments (plate tower, packed tower, venturiscrubber)
Operational difficulties like coning weeping, dumping, priming ,flooding in plate and packed tower. (10 Hrs, 20 Marks)

UNIT- V:
Introduction to Humidification: Vapour liquid equilibrium, Humidification terms
Determination of humidity, Humidification and dehumidification
Water cooling operation equipment
Introduction to Drying operation: Rate of drying, Mechanism of moisture movement during drying, Drying equipments, Different methods of drying (10 Hrs, 20 Marks)

PRACTICALS

Term Work Shall be based on experiments mentioned below.

1) Diffusion In Still Air: To estimate mass transfer coefficient for given system at room temperature.
2) Liquid – Liquid Diffusion: To determine diffusion coefficient for given system as function of concentration.
3) Solid – Liquid Diffusion: To determine mass transfer coefficient for dissolution of benzoic acid without chemical reaction.
4) Wetted Wall Column: To determine mass transfer coefficient for air – water system.
5) Absorption in Packed Column: To find mass transfer coefficient of given system.
6) Cooling Tower: To determine volumetric mass transfer coefficient for air – water system.
7) Natural Drying (Batch): To obtain drying curve for batch drying operation.
8) Fluidized Bed Dryer: To determine the rate of drying and to obtain mass transfer coefficient for the given material.

REFERENCES

1) R.E.Treybal , Mass transfer operation ,McGraw Hill Publication
2) Coulson & Richardson Chemical Engineering (Vol. I and II), Pergamon Press
3) Christie J.Geankoplis ,Transport Processes & Unit Operations ,Prentice Hall inc
4) P. Chattopadhayay ,Unit operation in Chemical Engg. (Vol. I and II), Khanna Publications Delhi

4. PROCESS EQUIPMENT DESIGN & DRAWING –I

Teaching Scheme:
Lectures: 4 Hrs./ Week
Term Work: 4 Hrs./ Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 50 Marks

UNIT- I:

Design Considerations: Design codes, Maximum working pressure, Design pressure, Design Temperature, Design stress, Factors of safety, Selection of factor of safety, Design wall thickness, Corrosion ratio, Poisson ratio, Criteria of failure, Elastic stability.
Materials of construction : Mechanical properties, Materials, Corrosion, Protective coating, Corrosion prevention, Choice of materials (10 Hrs, 20 Marks)

UNIT- II:

Keys: Introduction, Types of keys, Strength of sunk key, Effect of key ways, Design of keys
Design of Heads: Introduction, Analysis and design of conical head, Flat cover head, Standard dished heads.
Gaskets & Flanges: Introduction, Types of Gaskets & Flanges. (10 Hrs, 20 Marks)

UNIT- III:

Pipe joints: Standard pipe flanges for steam, Hydraulic pipe joints for high pressure, Introduction to gaskets and flanges, Design of circular flange pipe joints.
Welded Joints
Riveted joints
Storage vessels: Introduction, Design fixed conical roof cylindrical tank, Storage of gases in Spherical vessels
Supports for vessels: Introduction, Bracket or Lug supports, Leg Supports, Skirt Supports
(10 Hrs, 20 Marks)

UNIT- IV:

Design of Cylindrical Vessels under internal Pressure: Introduction, Thin wall vessels, Design Equations.
Design of process vessels and pipes under external pressure: Introduction, Determination of safe pressure against elastic failure, Determination safe external pressure against plastic deformation, Circumferential stiffness, Pipes and tubes under external pressure.
(10 Hrs, 20 Marks)

UNIT- V:

Process Hazards and Safety Measures in Equipment Design: Introduction, Hazards in Process Industries, Hazards Analysis, Safety Measures, Safety Measures in Equipment Design, Pressure relief Devices
Design of packed absorption tower: Introduction, Design of circular & diameter of Packed Absorption Tower (10 Hrs, 20 Marks)

TERM WORK:

The term work shall consist of drawing of at least 8 half imperial size sheets from the following

1) Standard equipment symbols

2) Standard instrumentation symbols

3) Pipe fittings

4) Heads and closures

5) Keys and couplings

6) Pressure relief devices

7) Supports for vessels-Bracket Support

8) Supports for vessels-Leg Support

9) Supports for vessels-Skirt Support

10) Design and drawing of packed absorption tower

11) Riveted joints

12) Welded joints

REFERENCES:

1 B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi.

2 M.V.Joshi, V.V. Mahajan, Process Equipment Design, 3rd Edition, Macmillan India Ltd.

3 Coulson & Richardson, Chemical Engineering (Vol. VI), Pergamon Press

4 R. S. Khurmi, J.M. Gupta, A Text Book of Machine Design, S. Chand & Company Ltd, New Delhi.

5 S.D. Dawande, Process Design of Equipments (Vol. I),Central Techno Publications, Nagpur.

5. CHEMICAL ENGINEERING THERMODYNAMICS

Teaching Scheme: Examination Scheme:
Lectures: 4 Hrs./ Week Paper: 100 Marks (3 Hrs)

UNIT- I :
Fundamental Concepts : Introduction to the subject, The laws of Thermodynamics, Cyclic rule, Coefficient of Thermal Expansion, Compressibility Coefficient
First Law of Thermodynamics : Basic Laws, Law of corresponding state, Heat Capacities, Variation of energy with Temperature and Volume, Enthalpy as a function of Temperature & Pressure, Joule-Thomson Coefficient Relation between Cp and Cv, Thermodynamic relations, Generalized Equation of State, Redlich-kwong equation of state, Soave-Redlich-Kwong equation of state. (10 Hrs, 20 Marks)

UNIT- II :
The Second Law of Thermodynamics: Introduction, Mathematical Treatment of Entropy Concept, Combined form of First and Second Law of Thermodynamics, Thermodynamic Relations based on Second Law of Thermodynamics, Calculations of Entropy Changes, Third Law of Thermodynamics. (10 Hrs, 20 Marks)

UNIT- III :
Multicomponent Mixture: Partial Molar Quantities: General Aspects, Determination of Partial Molar Volume, Determination of Partial Molar Enthalpy, Fugacity and Fugacity Coefficient, Fugacity coefficient through equation of state, Fugacity coefficient through virial coefficient correlation.
Properties of Solutions: Ideal solution: General Aspects, Phase equilibrium: General Aspects, Gibbs-Duhem Equation, Gibbs-Duhem-Margules Equation, Application of Gibbs-Duhem Equation, Application of Gibbs-Duhem-Margules Equation. (10 Hrs, 20 Marks)

UNIT- IV :
Vapour-Liquid Equilibria (VLE) : Basic equations for VLE, Reduction of VLE data, VLE at low to moderate pressure, Excess Gibbs free energy Model, Margules Equation & Van Laar Equation, Thermodynamic consistency test of VLE data
Phase Equilibria for Single Component System: Gibbs-Helmholtz Equation, The Clapeyron Equation, Clausious-Clapeyron Equation, Application of Clapeyron Equation.
(10 Hrs, 20 Marks)

UNIT- V:
Chemical Reaction Equilibria: The criteria for chemical equilibrium, Equilibrium constant, Law of chemical equilibrium, Thermodynamic treatment of the law of mass action, Van't Hoff reaction isotherm, Relations between equilibrium constant, Homogeneous gaseous equilibria, Temperature dependence of the equilibrium constant (The Van't Hoff Equation), Integrated form of the Van't Hoff equation, Pressure dependence of the equilibrium constant.
Applications of Phase Equilibrium in Ideal Solutions: To construct pressure-composition and boiling point diagrams. (10 Hrs, 20 Marks)

REFERENCES:

1 Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press (INDIA) Ltd., Orient Longman Ltd., Hyderabad.

2 K.V. Narayanan, A Text book of Chemical Engineering Thermodynamic, Prentice Hall India Pvt. Ltd., New Delhi.

3 R.R.Rastogi and R.R.Mishra, An Introduction to Chemical Thermodynamics, Vikas Publishing House Pvt.Ltd, New Delhi.

4 D.Shrinivasan, Chemical Engineering Thermodynamics, New Age International Publisher New Delhi.

5 G.N. Pandey and J.C.Chaudhari, Chemical Engineering Thermodynamics, Khanna Publishers, Delhi.

6 J.M.Smith, H.C.Vanness, M.M.Abbott Introduction to Chemical Engineering Thermodynamics, 5^{th} edition, McGraw Hill International Editions.

6 B.G.Kyle, Chemical and Process Thermodynamics, Prentice Hall India Pvt. Ltd., New Delhi.

1. INSTRUMENTATION & INSTRUMENTAL ANALYSIS

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 25 Marks
Term Work: 25 Marks

UNIT- I :

Qualities of Measurement: The meaning of measurement, The elements of instruments, Static Characteristics, Dynamic characteristic.

Expansion Thermometers: Introduction, Temperature scales, Constant volume gas Thermometer, Bimetallic Thermometer, Industrial pressure spring thermometer, Response of Thermometer. (10 Hrs, 20 Marks)

UNIT- II :

Thermoelectric Temperature Measurement: Introduction, Simple thermocouple circuit, Industrial thermocouples, Thermocouple lead wires, thermal wells, response of thermocouples.

Resistance Thermometer : Introduction, Industrial resistance-thermometer bulbs, Resistance thermometer element, Resistance thermometer circuit, RTD. (10 Hrs, 20 Marks)

UNIT- III:

Radiation Temperature Measurement: Introduction, Black body conditions, Black body devices, Radiation receiving elements, Thermopile, Vacuum thermocouples, Radiation pyrometers , Lens type thermal radiation receiver , Photoelectric pyrometers, Photoelectric radiation receiver, Optical pyrometer.

Pressure and Vacuum Measurement: Introduction, Indicating pressure gage, Bellows pressure element, Useful ranges of absolute pressure measuring gages, Mclead vacuum gage.

Measurement of Pressure's in Corrosion Fluids: The steam gage siphon, Diaphragm seal in Pressure measurement, Liquid seal in pressure measurement, Response of mechanical pressure gages. (10 Hrs, 20 Marks)

UNIT- IV:

Measurement of Level: Float and tape liquid level gage, Float & shaft liquid level unit, Level measurement in pressure vessels, Gamma ray method, Ultrasonic method & resistive method.

Introduction, Theory, Instrumentation, advantages, and Application of: pH measurement, Refractrometry, Potentiometry, colourometry and Flame photometry.(10 Hrs, 20 Marks)

UNIT- V:

Introduction, Theory, Instrumentation, Advantages and Application of: Gas chromatography, Thin layer chromatography, Amerometric titration, Infrared spectrography, Atomic absorption spectrography.

Introduction to turbidimetry, Karl-Fischer titrimetry, Conductometric titrations and HPLC. (10 Hrs, 20 Marks)

PRACTICAL and TERM WORK:

Practical and Term work shall consist of minimum eight experiments given below.

1) To study the response of bimetallic thermometer.
2) Calibration of thermocouple.
3) To measure the PH of given solution.
4) To measure the conductance of given solution.
5) To determine concentration of given solution by colorimeter
6) Flame photometry
7) Thin layer chromatography
8) Paper chromatography
9) Abbey's refractometer

REFERENCE:

1. D.P.Eckman, Industrial Instrumentation, Willey Eastern Ltd., New Delhi.
2. Fatranabis D. Industrial Instrumentation, Tata – Mcgraw Hill Publications, New Delhi.
3. Gurdeep Chatwal and sham Anand, Instrumental methods of Chemical analysis, Himalaya publication House, Mumbai.
4. V.P. Kudesia and S.S. Sawhaney, Instrumental methods of chemical analysis Pragati Prakashan, P.O.Box No. 62, Begum Bridge,Meerut250001,U.P.
5. Nakra B.C. and K.K. Chaudhary, Instrumentation Measurement & Analysis, Tata – McGraw Hill, New Delhi.
6. Dr. B.K.sharma.Goel, Instrumentation methods of chemical analysis, Publishing House,11,Shivaji Road, Meerut-250001,U.P.

2. CHEMICAL REACTION ENGINEERING-I

Teaching Scheme:
Lectures: 4 Hrs./ Week
Practical: 2 Hrs./ Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Oral: 25 Marks
Term Work : 25 Marks

UNIT-I :
Introduction to chemical reaction engineering: Review of chemical reaction equilibrium, Classification of chemical reaction, rate of reaction, order and molecularity of reaction, rate constant, Temperature dependent term of rate equation, comparison of theories, Activation energy and temperature dependency, rate of reaction predicted by theories, Reaction mechanism. **(10 Hrs, 20 Marks)**

UNIT- II :
Collection & interpretation of kinetic data, Constant volume batch reactor, integral and differential method of analysis of data, Variable volume batch reactor , integral and differential method of analysis of data, The search for rate equation. **(10 Hrs, 20 Marks)**

UNIT- III :
Ideal batch reactor ,mixed flow reactor ,plug flow reactor, space time and space velocity, holding time and space time for batch , mixed and plug flow reactors, comparison in mixed and plug flow reactors, Combined flow system, Recycle reactor, Autocatalytic reaction.
(10 Hrs, 20 Marks)

UNIT- IV :
Introduction to multiple reactions: Reaction in parallel, Reaction in series, Series parallel reaction. Optimum temperature progression for single reaction, Isothermal, adiabatic, non adiabatic operation. Product distribution and temperature for multiple reactions.
(10 Hrs, 20 Marks)

UNIT- V :
Residence time distribution of fluid in vessel, Conversion directly from tracer information, Models for non-ideal flow, Dispersion models, Tank in series model, Concept of micro and macro mixing. **(10 Hrs, 20 Marks)**

PRACTICAL and TERM WORK:
Practical and Term work shall consist of minimum eight experiments from list given below.

1) To determine the reaction rate constant {k} for given reaction.(CSTR / BATCH / SEMIBATCH / PFR)
2) To determine the effect of temperature on reaction rate constant. .(CSTR / BATCH / SEMIBATCH / PFR)
3) To determine the activation energy {E} for the given reaction. .(CSTR / BATCH / SEMIBATCH / PFR)

4) To draw C [t], E [t] & F [t] curve and to calculate the mean residence time {tm} variance { σ^2} and skew ness { S^3} for plug flow reactor.
5) To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ^2} and skew ness { S^3} for packed Bed reactor.
6) To study the cascaded CSTR
7) To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ^2} and skew ness {S^3} for Annular reactor.
8) To study the kinetic in tubular flow reactor [coiled tube] for the given reaction.

REFERENCE:

1. Octave Levenspiel, Chemical reaction engineering, John Wiley and sons.
2. J.M. Smith, Chemical engineering kinetics, McGraw Hill
3. S.D. Dawande, Principles of reaction engineering, Central Techno publication, Nagpur.
4. H.Scott Fogler, Elements of chemical reaction engineering, Prentice Hall New Jersy
5. Lanny D. Schimdt , Chemical reaction engineering, Oxford University Press.

3. MASS TRANSFER-II

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 50 Marks
Term Work: 25 Marks

UNIT- I :
Introduction to distillation process, Vapor liquid equilibrium, The methods of distillation (Binary mixture), The fractionating column, Condition for varying overflow in non- ideal system(Binary), Batch distillation, Multi component mixture, Azeotropic, extractive and steam distillation, Introduction to distillation equipments. (10 Hrs, 20 Marks)

UNIT- II :
Introduction to extraction process, Liquid equilibria, Material balances for stage wise contact methods, Extraction with reflux, Fractional extraction, Stage contact and continuous contact type extractors. (10 Hrs, 20 Marks)

UNIT- III:
Introduction to crystallization, Growth and properties of crystals, Effect of impurities in crystallization, Effect of temp. on solubility, Fractional crystallization, Caking & yield of crystals, Different type of crystallizes. (10 Hrs, 20 Marks)

UNIT- IV:
Introduction to adsorption operation, Type of adsorption operation, Nature of adsorbents, Adsorption equilibria, Adsorption of vapor, gas mixture and liquids, Material balances for stage wise for operation, Continues contact process for adsorption, Unsteady state fixed bed adsorbed, Principle of ion exchange operation, Equilibria for ion exchange operation, Rate of ion exchange operation, Application of ion exchange operation. (10 Hrs, 20 Marks)

UNIT- V:
Introduction to leaching operation, Mass Transfer in leaching operation, Calculation of of stages for diff. Processes, Graphical method for calculation of no. of stages counter current washing process, Equipments for leaching operation, Introduction to membrane separation process, Different Types of membrane separation process, (Ultrafiltreation , Reverse Osmosis, Dialysis, Electro Dialysis, Pervaporation), General membrane equation, Liquid membrane (10 Hrs, 20 Marks)

TERM WORK:
Any eight experiments based on the above syllabus.

1. Simple Distillation: To verify Rayleigh's equation for simple distillation
2. Ternary Diagram: To construct ternary diagram for acetic acid –water – benzene
3. Tie Lines
4. Liquid – Liquid Extraction: To study and determine the efficiency of cross current liquid- liquid extraction.

5. Leaching
6. Crystallization
7. Adsorption: To study adsorption of acidic acid on activated charcoal
8. Determination of HTU, HETP and NTU
9. Spray Column
10. Ion Exchange
11. Bubble Cap Distillation
12. Study Of Mass Transfer Equipments

REFERENCES:

1) Coulson and Richardson, Chemical Engineering (Vol. II), Pergamon Press
2) RE. Tryebal, Mass Transfer Operation, McGraw hill.
3) Christie J. Geankoplis ,Transport Processes and Unit Operations ,Prentice Hall inc
4) P. Chattopadhyay, Unit operations in Chemical Engg. Vol. I and II, Khanna Publication, New Delhi.

4. PROCESS EQUIPMENT DESIGN & DRAWING –II

Teaching Scheme:
Lectures: 4 Hrs./ Week
Term Work : 4 Hrs./ Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Term Work: 50 Marks

UNIT- I:

Process Design of Heat Exchanger: Introduction, Types Of Heat Exchanger, Process Design of Shell and Tube Heat Exchanger.

Process Design of Evaporator: Introduction, Types of Evaporators, Methods of Feeding of Evaporators, Design of Evaporator **(10 Hrs, 20 Marks)**

UNIT- II:

Process Design of Reaction Vessels: Introduction, Materials of Construction, Agitation, Classification of Reaction Vessels, Heating Systems, Design of Reaction Vessels.

Crystallizer Design: Introduction, Types of Crystallizers, Design of crystallizers. **(10 Hrs, 20 Marks)**

UNIT- III:

Process Design of Rotary Dryer: Introduction, Types Dryers, Design of Rotary Dryer.

Design of Tall Vessels :Introduction, The Axial Stresses Due To Dead Loads, The Axial Stresses Due To Pressure, Longitudinal Bending Stresses due to Dynamic Loads, Design Of Distillation (Tall) Column (Tower). **(10 Hrs, 20 Marks)**

UNIT- IV:

Design of Sieve Tray for Distillation Column

Design of Thick Walled High Pressure Vessel **(10 Hrs, 20 Marks)**

UNIT- V:

Design of Bubble Cap Tray For Distillation Operation

Agitators : Introduction, Types Of Agitators, Baffling, Power Requirements, Design Of Turbine Agitator. **(10 Hrs, 20 Marks)**

TERM WORK:

The Term Work shall consist of process design and drawing of equipments on at least five half imperial sized sheets. Based on the above syllabus.

REFERENCES:

1) B. C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects) CBS Publisher & Distributors, New Delhi.
2) M.V.Joshi, V.V. Mahajan, Process Equipment Design, 3rd Edition, Macmillan India Ltd.
3) Coulson & Richardson, Chemical Engineering (Vol VI), Pergamon Press.
4) R.E.Treybal, Mass Transfer Operations, McGraw Hill, New Delhi.
5) S.D. Dawande, Process Design of Equipments (Vol. 1& 2) Central Techno Publications, Nagpur.
6) G.K.Roy, Solved Problems In Chemical Engg., Khanna Publications, NewDelhi.
7) J.H.Perry, Chemical Engineer's Hand Book, McGrawhill, New Delhi.

5. MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

Teaching Scheme: Examination Scheme:
Lectures: 4 Hrs./ Week Paper: 100 Marks (3 Hrs)

UNIT- I:
Root Finding Methods : Bisection Method, Regula-falsi Method, Newton-Raphson Method, Direct Integration Method, Muller's Method.
Solution Of Simultaneous Linear Equation: Gauss Elimination Method, Matrix Inversion Method, Gauss Jordan Method, Jacobi's Iteration Method, Gauss Seidal Method
(10 Hrs, 20 Marks)

UNIT- II:
Interpolation & Extrapolation: Newtons-Gregory Forward Interpolation Formula, Newtons-Gregory Backward Interpolation Formula, Stirling's Formula, Central Difference Interpolation Formula, Choice of an Interpolation Formula.
Linear Programming (L.P.) : Introduction To L.P., Formulation Of L.P. Problems (L.P.P)/L.P. Models. Solution Of L.P.P. by Analytical Method (containing two variables), Solution Of L.P.P. By Graphical Method (10 Hrs, 20 Marks)

UNIT- III :
Chemical Engineering Optimization-I : The Optimum Diameter To height ratio for Large Oil Storage Vessel for Cost Minimization, Optimization of diameter and length of heat exchanger, Optimization of dimensions of an open rectangular Tank, Optimum thickness of insulation, Optimization of outlet temperature for counter-current arrangement in heat exchanger (10 Hrs, 20 Marks)

UNIT- IV:
Solution of L.P.P. with application of simplex technique.
Chemical engineering optimization-II : Optimum (economical) pumping temperature for pumping of oil, Optimization of dimension of rotary dryer, Optimum dimensions and optimum outlet temperature of air preheater, Optimization of kinetics of consecutive reactions (10 Hrs, 20 Marks)

UNIT- V:
Chemical engineering optimization-III : Optimum residence time for maximum yield in ideal isothermal batch reactor, optimization in refinery blending operation, optimization to get max. yield with respect to reactor volume, optimization of dimensions of straight rectangular Fin, optimization of performance of batch reactor with two consecutive reactions (by considering optimum Steam flow rate), optimum temperature approach and optimum Velocity (by considering process heat transfer approach), optimum proportions of a pressure vessel, optimum size of pressure vessels. (10 Hrs, 20 Marks)

REFERENCE:

1. T.F.Edgar and B.M.Himellblau optimization of chemical processes, International Edn.1989 McGraw hill
2. B.S.Grewal, Higher engineering mathematic, Khanna Publisher,Newdelhi
3. P.K.Gupta and D.S.Hira, Operation research 1st edition reprint 1997, S.Chand& com. NewDelhi.
4. S.S.Sastry; Introduction To methods Of Numerical Analysis, Prentice Hall.
5. B.S. Grewal Numerical Methods In Engg. & Science, Khanna Publications; Delhi
6. G.K.Roy, Solved Problems In Chemical Engg., Khanna Publications, NewDelhi.

6. PRACTICAL TRAINING / MINI PROJECT / SPECIAL STUDY

Examination Scheme:
Term Work: 25 Marks

- Every student has to undergo industrial/practical training for a minimum period of two weeks during summer vacation between (S.E Second Term) fourth and (T.E. First Term) fifth term or during winter vacation between fifth and sixth term (T.E. First Term and Second Term).
- The industry in which practical training is taken should be a medium or large scale industry.
- The paper bound report on training must be submitted by every student in the beginning of (T.E. Second Term) sixth term along with a certificate from the company where the student took training.
- The report on training should be detailed one.
- Maximum number of students allowed to take training in company should be five. Every student should write the report separately.
- In case if a student is not able to undergo practical training , then such students should be asked to prepare special study report on a recent topic from reported literature

  Or

  a mini project related to the Chemical Engineering.
  1. Preparation of Chemical Compound and study of its properties.
  2. Kinetics of different types of reactions.
  3. Analysis of Natural Products, Chemical Products etc.

  Project report should be detail be detail of work, carried out by student.
- The practical training/special study/ mini project shall carry a term work of 25 marks. Every student shall be required to present a seminar in the respective class in the presence of two teachers. These teachers (fixed by the head of department in consultation with the Principal) shall award marks based on the following :

(a)	Report	10 marks
(b)	Seminar presentation	10 marks
(c)	Viva-voce at the time of Seminar presentation	05 marks

	Total	25 marks

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