Seventh Semester
Chemical Engineering

Branch: Chemical **Year**: Fourth **Semester**: Seventh

Sl. No.	Course No.	Subject	Periods			Evaluation Scheme					
Theory			L	T	P	Sessional Exam			ESE	Subject Total	Credit
						TA	CT	Total			
1	CH 781	Mass Transfer Operations-II	3	1		50	25	75	100	175	4
2	CH 782	Biochemical engineering	3	1		50	25	75	100	175	4
3	CH 783	Process Equipment Design	3	1		50	25	75	100	175	4
4	CH 784	Environmental Pollution Control Engineering	3	1		50	25	75	100	175	4
5	CH 785	Elective-I*	3	1		50	25	75	100	175	4
6	CH 786	Elective-II**	3	1		50	25	75	100	175	4
Practicals/Project											
7	CH 787	Factory Training			2					50+	2
8	CH 788	Project-I			8					100++	4
Total			18	6	10						

Total Marks: 1200 **Total Periods: 34** **Total Credits: 30**

TA: teachers assessment ***CT: Class Test*** ***ESE: End Sem Exam***

***Elective-I: CH 785** **(a) Food Processing and Preservation**
(b) Polymer science & engineering
****Elective –II: CH 786** **(a) Fluidization Engineering**
(b) Bio Separation
© Risk analysis & HAZOP

+ Factory Training:
Report: 20; Seminar cum viva: 30
++ Project-I:
Teachers assessment: 40; Report : 30; Seminar cum viva: 30

CH 781 Mass Transfer Operations-II

Theory : 100 marks L – T – P
Sessional : 75 marks 3 – 1 – 0
Time : 3 hours

1. Extractions
   Solid-liquid extraction (leaching): locus of underflow, choice and nature of solvents, single and multistage extraction, nature and composition of solids in solid-liquid extractions, graphical solutions 6 hrs

   Liquid-liquid extractions: Ternary liq-liq equilibrium (right triangular and equilateral triangular diagram), choice of solvents, selectivity, single and multistage extraction, co-current and counter-current continuous extraction with and without reflux, cross-current extraction, multi-feed extraction, graphical calculations. 6 hrs

2. Distillation:
   Binary systems: Introduction, vapor-liquid equilibria, P-X-Y and T-X-Y diagrams, concept of volatility and effect of pressure and temperature on equilibrium data, ideal solutions, Raoult's Law as applied to distillation operations, deviation from ideality, minimum and maximum boiling azeotropic mixtures, enthalpy-concentration diagram and their characteristics. 6 hrs

   Flash distillation, steam distillation, simple distillation, batch fractionation, continuous rectification, determination and number of stages, Ponchon-Savorit method and McCabe-Thiele method, multi-tray tower, concept of minimum, total and optimum reflux ration, reboilers, use of open steam, multiple feed, side product, partial condensers, cold. hot, circulating reflux. 8 hrs

   Rectification of azeotropic mixtures, concept of azeotropic distillation and extractive distillation. 1 hr

   Continuous contact equipments like packed towers, sieve, bubble cap towers etc. Determination of number of transfer units and height of transfer units. 2 hrs

3. Multi-component systems:
   Vapor-liquid equilibrium data, definition ok K etc, ideal systems, limitations, key components, reflux, Lewis and Matheson calculation, liquid-vapor ratio, method of Thiele and Geoddes, enthalpy balances of conventional columns, determination of minimum reflux ratio for conventional columns. 4 hrs

4. Use of efficiencies:
   Modified Murphree and vaporization efficiency, determination of plate efficiency, concept of ASTM, TBP and molecular distillation. 2 hrs

Books:

1. R E Treybal: Mass transfer Operations, 3rd Ed, McGraw Hill Book Co.
2. C J Geankopolis, Transport Processes in chemical Operations, 4th ef. Prentice Hall India.
3. G G Brown: Unit Operations, CBS Publishers and Distributors
4. J M Coulson and J F Richardson, Chemical Engineering, Vol-II, 3rd Ed, Pergamom Press.
5. Badger and Banchero: Introduction to chemical engineering
6. McCabe and Smith: Unit operation of Chemical Engineering

CH 782 BIOCHEMICAL ENGINEERING

L – P – T
3 – 0 – 1
Theory : 100 marks
Sessional : 75 marks
Time : 3 hrs.

Application of bioprocess in different field.
Structure of cells.
Types of cell.
Chemicals of life :

- Lipids.
- Sugar & Polysaccarides.
- Nucleotides & RNA & DNA.
- Aminoacid & Proteins
- Hybrid bio-chemicals.

Simple enzyme kinetics with one and 2 substrates

- Michaclis – Menten kinetics.
- Kinetics for reversible reactions.
- Substrate activation & inhibition.
- Multiple substrate on single enzyme.
- Influence on enzyme activity.
- Enzyme deactivation.

Application of enzyme catalyst.

- Hydrolysis of starch & cellulose by hydrolytic enzyme.
- Medical application.
- Non hydrolytic enzyme.
- Immobilized enzyme technical & kinetic – brief overview.

Basic fermentation engineering.

- Media preparation, culture , sterilization
- Fundamental of molecular Genetics.

Transport Phenomena in bio process.

- Gas liquid transfer in cellular system.
- Heat transfer.

Kinetics in cell culture.

- Reaction.
- Kinetics of balance growth.
- Death kinetics.

Product recovery operation –
Recovery of particulate, product isolation, preparation, membrane separation, electrophoresis, ……. Operations.

Books:

1. Biochemical Engineering by Bailey, Mcgraw Hills.
2. Bioprocess Engineering-Basic Concepts by M L shuler and F Kargi, Prentice Hall India

CH7 83 PROCESS EQUIPMENT DESIGN

Theory : 100 marks L – T – P
Sessional : 75 marks 3 – 1 – 0
Time : 3 hours

1. DESIGN OF PIPE FITTINGS AND JOINTS: Design and schematic of simple bolts and screws. Riveted joints. Design & Draw of shafts and couplings.

2. DESIGN OF REACTION VESSEL AND STORAGE TANK: Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.

3. DESIGN OF HIGH PRESSURE SYSTEMS: Design of high pressure vessels and reactors.

4. DESIGN OF PHASE SEPARATION EQUIPMENT: Design of physical separation equipment such as cyclones, centrifuges, thickens filtration equipment KO drum.

5. **DESIGN OF HEAT TRANSFER EQUIPMENTS:** Design and Drawing of Heat Transfer Equipments such as heat exchangers with and without phase change, evaporators, crystalizers.

5. DRAWING OF PHASE SEPARATION EQUIPMENT: Drawing of physical separation equipments such as hydro-cyclones, packed towers, plate columns, electro static precipitators.

TEXTBOOKS:

1.L. E. Brownell and E.H. Young, "Process Equipment Design - Ves Design", Wiley Eastern Edn. New York, 1968.
2. R. H. Perry, "Chemical Engineers' Handbook", 7th Edn., McGraw Hill , N York, 1998.
3.M. V. Joshi, "Process Equipment Design", 2nd Edn. .Mac Millan Press, N Delhi, 1996.

4. Process Equipment Design-mechanical aspects; B C Bhattachrjee

REFERENCES:-

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering.", Vol-VI, Pergam Press, New York, 1987.

CH784: ENVIRONMENTAL POLLUTION CONTROL ENGINEERING

L - T - P
3 - 1 - 0
Theory : 100 marks
Sessional : 75 marks
Time : 3 hours

- Man and Environment, Environmental Legislations.
- Water Pollution :

A. (i) Regulations on the discharge of industrial pollutants in water, threshold limits.
(ii) Types of waste water, sources of pollutants, classification of pollutants.
(iii) Site selection, sampling, preservation, water quality parameters and significance, monitoring, determination of BOD and COD.
(iv) Dissolved oxygen balance in water, self purification of a water system (Critical deficit of a runoff).

B. Some fundamental aspects of microbiology as applied to pollution control.

C. Control of Water Pollution :
(i) Basic approach to solve the problem.
(ii) Primary, secondary and tertiary treatment of waste water, clariflocculation, sludge disposal.
(iii) Treatment of phenolic waste water and also water containing N and P.
(iv) Control of heavy metal ions, As, Hg, Cr.

- Air Pollution :
(i) Concept of atmosphere, sources of air pollutants, classification and effects, air quality criteria and standard, methods of estimation of air pollutants, monitoring.
(ii) Meteorology and air pollution – lapse rate, plume types, stability, stack design, basic concept of dispersion.
(iii) Fundamental approach to air pollution control.
(iv) Control of particulates.
(v) Control of gaseous pollutants.

- Solid Waste Management : Types of solid wastes, sources and composition, methods of waste management – sanitary landfill, composting, incineration, pyrolysis, anaerobic digestion, concepts of recycling.
- Design of lagoons, oxidation pond, activated sludge process units, gravity settler, Rotating Biological Cyclone (RBC) separators, anaerobic digester, and stack for emission control.
- Noise Pollution : Sources of noise, levels permissible, impact of noise pollution, Noise Exposure Index (NEI), control methods of noise pollution.
- Case Studies (Sessional only) : Petroleum Refinery. Petrochemical Complex. Paper Mill. Automobile Pollution.

PRACTICALS :
- Determination of water quality parameters : pH, conductivity, Dissolved Oxygen, BOD and COD.
- Spectrophotometric and Gas Chromatographic analysis of air and water pollutants.
- Analysis of particulates and gaseous pollutants.

BOOKS :

1. G M Masters, Introduction to Environmental Engineering and Science, Prentice Hall India
2. Peavy, Rowe & Tchobanoglous, Environmental Engineering, McGraw-Hill.
3. Mahajan, S.P., Industrial Pollution Control, Tata McGraw-Hill.

CH 786 (a) FLUIDIZATION ENGINEERING (Electrive-II)

Theory : 100 marks L – T – P
Sessional : 75 marks 3 – 1 – 0
Time : 3 hours

1 INTRODUCTION AND APPLICATIONS:

Introduction to Fluidized bed systems. Fundamentals of fluidization. Industrial applications of fluidized beds - Physical operations. Synthesis reaction, cracking and reforming of hydrocarbons. Gasification, Carbonization, Gas - solid reactions ,calcining and clinkering.

2. GROSS BEHAVIOR OF FLUIDIZED BED:

Gross behavior of fluidized bed. Minimum and terminal velocities in fluidized beds .Types of fluidization. Design of distributors. Voidage in fluidized beds. TDH, variation in size distribution with height, viscosity and fluidity of fluidized beds. Power consumption.

3. ANALYSIS OF BUBBLE AND EMULSION PHASE:

Davidson's model. Frequency measurements, bubbles in ordinary bubbling bed model for bubble phase . emulsion phase: Experimental findings. Turn over rate of solids. Bubbling bed model for emulsion phase Interchange co-efficient.

4. FLOW PATTERN OF GAS AND HEAT & MASS TRANSFER IN FLUIDIZED BEDS:

Flow pattern of gas through fluidized beds. Experimental findings. The bubbling bed model for Gas inter change Interpretation of Gas mixing data. Heat and Mass Transfer between fluid and solid: Experiment findings on Heat and Mass Transfer. Heat and Mass Transfer rates from bubbling bed model.

5. HEAT TRANSFER BETWEEN FLUIDIZED BEDS AND SURFACE:

Heat transfer between fluidized beds and surfaces: Experiment finding theories of bed heat transfer comparison of theories. Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

TEXTBOOK:

1. D.Kunii and O.Levenspiel ,'Fluidisation Engineering " 2nd. Edn.,]ohn Wiley& sons, 1992.

CH 785 (b) Polymer Science and Engineering (elective-I)

Theory : 100 marks — L – T – P
Sessional : 75 marks — 3 – 1 – 0
Time : 3 hours

1. Basics:
   - History
   - Formation
   - Classification
   - Methods of Polymer formation
2. Chemistry of Polymerization:
   - Step Growth
   - Chain Growth
   - Co-ordination
   - Zerigler-Natta catalyst
3. Kinetics of Polymerization
   - Free radical
   - Cationic and anionic polymerization
   - Poly Condensation
4. Molecular weight and molecular weight distribution
5. Structure of Polymer molecules:
   - Based on chemical composition- homo and co-polymer
   - Based on geometrical structure of chain
   - Structural Model- Random Coil, fringed mecellar model, spherulites
6. Physical States and transitions:
   - Amorphous and Crystalline
   - Conformation of single chains
   - Spherulites
   - Liquid Crystals
   - Transition temperature- glass transition temperature, melting temperature
7. General properties
8. Polymer Processing/ Fabrication:
   - Injection molding (plunger and screw type)
   - Compression molding
   - Extrusion – flat, sheet and tubing
   - Pultrusion
   - Blow molding
   - Foams, thermoforming, vacuum forming
   - Spinning – wet and dry
9. Rheology:
   - Viscous flow, models of Newtonian and Non-Newtonian
   - Visco-elasticity – Maxwell Model
10. Introduction to Rubber elasticity

Books:

1. Fried; Polymer Scince and Technology, 2nd Ed, Prentice Hall India
2. Sinha; Oulines of Polymer Technology: Manufacture of Polymers, Prentice Hall India

CH 786 (b) RISK ANALYSIS & HAZOPS (Elective-II)

Theory : 100 marks L – T – P
Sessional : 75 marks 3 – 1 – 0
Time : 3 hours

1. INTRODUCTION TO CONSEQUENCE ANALYSIS - DISPERSION AND TOXIC MODELS: Risk analysis introduction - Rapid risk : Analysis - Comprehensive risk analysis -Failure types and release rate calculation - Emission and dispersion - Dispersion models for dense gas - Plume dispersion - Jet dispersion - Toxic dispersion model Evaluation of risk contours.

2. CONSEQUENCE ANALYSIS - FIRE AND EXPLOSION MODELS; Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect to plant, people & properly, UCVCE - Explosion due to - Deflatration -Detonation - TNT, TNO & DSM model - Over pressure - Effects of explosion -Risk contour - Flash fire - Jet fire - Pool fire - BLEVE - Fire ball.

3. RISK MANAGEMENT: Overall risk analysis - Generation of Meteorological data - Ignition data -Population data - Overall risk contours for different failure scenarios - Disaster management plan - Emergency Planning - on site & offsite emergency planning - Risk management &IS014000- EMS models- Case studies-Marketing terminal, gas processing complex, refinery.

4. PAST ACCIDENT ANALYSIS: Hazard identification -Safety Audits-Checklists-What if Analysis-Vulnerability models - Event tree and Fault tree Analysis - Past accident analysis Flixborough -Mexico - Bhopal - Vizak 3 miles - island chernoobyl, feyzih disasters, seveso accident analysis.

5. HAZOPS : HAZOPS- Principles - Risk ranking - Guide word - Parameter - Deviation - • Consequences - Recommendation - Coarse HAZOP study - Case studies Pumping system - Reactor System - Mass transfer system.

TEXTBOOKS:

1. K. V. Raghavan and A. A Khan, "Methodologis in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
2. V. C. Marshal, "Major Chemical Hazards", Ellis Hawood Ltd., Chichester,United Kingdom.1987.
3. Kletz, "Risk Analysis Hazops " Institute of Engineers, U.K.. 1990.

REFERENCES:

1. Frank P. Less, "Loss Prevention in Process Industries", Vol. I, II & III Butterworth, London,1980.
2. " A Guide to Hazard Operability Studies", Chemical Industry Safety and Council, 1977.

CH 788 Project-I

Sessional 100, Pass Mark :50

Under this course each student will be assigned a topic related to Chemical engineering field. The topic shall either be experimental or theoretical (feasibility report/literature survey with some mathematical calculations). The student will work under the supervision of a staff member and submit a report on the assigned project. The student will give a presentation on the project work before a panel of examiners.

CH 787 Factory Training

Sessional: 75

Factory training for a period of 6 (six) weeks is compulsory for all chemical engineering students and 20 marks are allotted for the technical report submitted after completion of the training. There will be a seminar cum viva on the report submitted by the student and 30 marks are assigned for this. The report should be submitted to the HOD, by a date announced by the HOD. Students are to obtain a certificate from the Factory authority regarding their attendance and performance during the training period which is to be submitted along with the report.