Eighth Semester
Chemical Engineering

Branch: Chemical **Year**: Fourth **Semester**: Eighth

Sl. No.	Course No.	Subject	Periods			Evaluation Scheme					
Theory			L	T	P	Sessional Exam			ESE	Subject Total	Credit
						TA	CT	Total			
1	CH 881	Transport Phenomena	3	1		50	25	75	100	175	4
2	CH 882	Chemical Proc Design & Drawing	3	1		50	25	75	100	175	4
3	CH 883	Math Modeling and Simulation	3	1		50	25	75	100	175	4
4	CH 884	Elective-III*	3	1		50	25	75	100	175	4
5	CH 885	Elective-IV**	3	1		50	25	75	100	175	4
Practicals/Project											
7	CH 886	Project-II			12					150+	8
8	CH 887	Viva Voce								75	2
Total			15	5	12						

Total Marks: 1100 **Total Periods: 32** **Total Credits: 30**

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

***Elective-III: CH 884 (a) Petroleum Production technology**
(b) Advanced Separation Techniques
© Computational Fluid Dynamics

****Elective-IV: CH 885 (a) Energy Auditing**
(b) Environmental Impact assessment
© Safety in Chemical Industries

+ Project-II:
Teachers assessment: 60; Report : 40; mid-sem presentation: 25; end-sem presentation:25

CH 881: TRANSPORT PHENOMENA

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

Introduction:

- Transport phenomena and Unit Operation
- Equilibrium and rate processes.
- Role of intermolecular forces.

Molecular Transport Mechanisms:

- Heat, mass and momentum transport by molecular mechanism.
- The Analogy – Case of Heat Transfer, Case of Mass Transfer, Case of Momentum Transfer, the analogous forms.
- Heat Transfer.
- Mass Transfer – Equimolar Counter Diffusion, Partial Pressure.
- Momentum transfer.

General Property Balance:

- The balance or conservation concept- input-output balance, generation, accumulation, the balance equation in differential form.
- The one directional balance equation including molecular and convective transport.
- The three dimensional balance equation.
- The continuity equation.
- The general property balance equation for an incompressible fluid.

Molecular Transport and the General Property Balance:

- Steady transport in one dimension involving input-output with no generation (constant area and variable area transport).
- Steady transport with generation (Heat and mass transport with constant generation, momentum transfer with generation at steady state – laminar flow in a tube, Hagen-Poisseuille Equation, laminar flow between parallel plates).

Transport with net convective flux :

- Convective flux caused by forced convection.
- Relation between shear stress and shear rate.
- Navier-Stoke's Equation.
- Fick's Law.

Books :

1. Brodkey, R.S. & Hershey, H.C., Transport Phenomena – An Unified Approach, McGraw-Hill.
2. Bird, Stewert & Lightfoot, Transport Phenomena, John Wiley.

CH 882: CHEMICAL PROCESS DESIGN AND DRAWING

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

1. DESIGN OF MASS TRANSFER EQUIPMENTS: Design and Drawing of mass transfer equipments such as distillation columns, absorption columns, extraction columns, evaporator, dryers and cooling towers.

2. TARGETTING: Heat exchanger networks, targeting, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting. Problem representation, temperature enthalpy diagram, simple match matrix Heat content diagram.

3. Economic Design Criteria: The evolution of design criteria, accounting for risk, the effects of limited capital, a summary of industrial design criteria, estimating the economic life of a process.

4. Engineering in the presence of uncertainty: Anticipating the future, sizing new chemical plants in a dynamic economy, parametric sensitivity.

5. Failure Tolerance: Reliability under extreme conditions, safety through proper layout, the theory of reliability.

6. ENERGY RESOURCE ANALYSIS FOR VARIOUS PROCESSES: Batch processes, flexible processes, distillation processes, evaporation processes, reaction processes, process using mass separating agents.

TEXTBOOKS:

1. R .H. Perry, "Chemical Engineers' Hand Book", 6" Edn., McGraw Hill Company, 1984

2. D F Rudd and Charles C Watson, " Strategy Of Process engineering", Wiley International Edition

2. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 6, Pergamon Press, 1993.

3. Uday V. Shenoy Gulb "Heat Exchanger Network Synthesis", by Publishing Co. USA, 1995.

4. Linnhoff, D. W. Townsens, D. Boland and G.F. Hewitt, "User Guide on Process Integration for the efficient use of Energy", Institution of Chemice Engineers, U.K., 1994.

5. R. Smith, "Chemical Process Design", McGraw Hill Book Co., New York 1997

REFERENCES:

1. L.E. Brownell and E.H. Young, "Process Equipment Design Vessel Design' Wiley Eastern Edn. New York, 1968.

2. M. V. Joshi, "Process Equipment Design and Drawing", Mac Millan Press, New Delhi, 1996.

CH 883 Mathematical Modeling and Simulation

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

1. Introduction: Process synthesis, Process analysis, Optimization, Process plant Simulation.

2. Modeling Aspects: deterministic vs. stochastic Processes, Physical Modeling, mathematical Modeling, Chemical Systems modeling, cybernetics, Controlled System, Principles of similarity.

3. Classification of Mathematical Modeling: Independent and dependent Variables and Parameters, Classification based on variation of Independent Variables, Classification based on the State of the Process, Classification based on the type of the Process, Boundary conditions, The Black Box principle, Artificial Neural Networks.

4. Chemical system modeling: Models in mass transfer Operations, Models in heat Transfer Operations, Models in Fluid-Flow operations, and Models in Reaction Engineering.

5. Treatment of Experimental Results: error Propagation and data regression.

6. Optimization: Optimization techniques.

7. Simulation: Modular Approaches and Equation Solving Approach, Decomposition of Networks, convergence Promotion and Physical and thermodynamic Properties, specific Purpose simulation and Dynamic simulation, Simulation Packages

Text Book:

1. B V Babu, Process Plant Simulation, Oxford University Press
2. Hussain A, Chemical Process simulation, Wiley Eastern

Reference Books:

1. Rudd D F and Watson C C, Strategy of Process engineering, Wiley International
2. Stephanopoulos G, Chemical Process Control, Prentice Hall India
3. Singh S K , " Computer aided Process Control, Prentice Hall India

CH 884 (b) Advanced Separation techniques (elective-III)

L – T – P
3 – 1 – 0

Time : 3 Hrs
Theory : 100 marks
Sessional : 75 marks

1. Introduction, Separation Factor.
2. Inherent separation factor, infinite separation factor, reverse osmosis,
3. Rate governed separation factor, membrane characterization, motion of molecules through membranes, classification and characterization of membrane processes
4. Reverse Osmosis: Chemical Potential and Osmotic pressure, solvent and solute transport through membrane, solution diffusion model, physical and separation characteristics of RO membranes, mechanism of salt rejection by membranes, concentration polarization, membrane separator unit design, applications
5. Ultra filtration: types of transport, Separation factor, membranes used, fouling and concentration polarization, evaluation of mass transfer coefficients, determination of real rejection, osmotic pressure model, separation schemes using UF, Dia-filtration, Process design, Application.
6. Dialysis: Solute transport in dialysers, analysis of dialyser operations. Mode of dialysis, enhancement of separation by secondary chemical reaction, hemodialysis(blood purification), dialysis equipment, applications
7. Electro dialysis: Types of electro dialysis, ion transport fundamentals, concept of limiting current density, concentration polarization in ED cells, resistances and voltages in ED cells, power requirements, ED membranes and cells, problems of ED operation, plant design and process cost.
8. Liquid membrane Separation process: nature and types of available liquid membranes, separation factor, liquid membranes on solid membranes, applications.
9. Gas separations using polymeric membranes: membrane gas separation, industrial applications.

Book:

1. Synthetic membranes, Bugay, Lonsdale, De Pinho
2. membrane Separation Processes, P Meares
3. Progress in Separation and Purification (3 Volumes) E s Perry and C J Van Ness
4. Membrane technology and industrial techniques, P R Keller
5. Industrial Processes with membranes, Lacey and Loeb.
6. Reverse Osmosis: S Sourirajan
7. Ultra filtration hand book, M Cheryan
8. Desalination by reverse Osmosis, Morten

CH 885 (a) ALTERNATIVE ENERGY RESOURCES (ELECTIVE – IV)

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

Energy Crisis – Present position in India and World. Remedial measures.

Energy Resources – Survey, classification and scope of utilization, Alternative uses of conventional sources of energy, Gasification of coal, Synthetic liquid fuels.

Hydroelectricity – its production and future prospects in India.

Nuclear Energy – Nuclear reaction, materials and reactors, Reprocessing of spent nuclear fuels.

Solar Energy and its effective utilization for room and water heating and other industrial processes, Solar Heat Pump, Silicon cells, storage of solar energy.

Energy from Biomass – Animal and vegetable wastes, Utilization of Municipal Solid Waste as a renewable source of energy.

Geothermal, Wind and Tidal Energy – Energy from geothermal, tidal and ocean thermal sources, Energy from high velocity winds and high pressure gases.

Developments in energy routes, Fuel cells, MHD systems.

Energy carriers.

Conservation of energy.

BOOKS :

1. Renewable Energy Resources and their Environmental Impact,
S A abbasi and Naseema abbasi, Prentice Hall India
2. Chem. Tech.-I, Chemical Engineering Education development Centre, IIT, Madras.
3. Kashkari, C., Energy Resource, Demand and Conservation in India, Tata McGraw-Hill.
4. Tyner, Energy Resources and Economic Development in India, Allied Publishers.
5. Culp, Jr., Principles of Energy Conservation, McGraw-Hill.
6. Sarkar, S., Fuels and Combustion, Orient Longman.
7. Fuel Combustion Energy Technology, S N Saha, Dhanpat Rai Publishing Company

CH 885 (c) SAFETY IN CHEMICAL INDUSTRIES (Elective-IV)

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

1. INTRODUCTION: Industrial safely principles. Site selection and plant layout. Legal Aspects. Design for ventilation. Emergency response systems for hazardous goods basic rules and requirements which governs the chemical industries.

2. HAZARDS: Chemical hazards classification. Hazards due to fire, explosion and radiation. Reduction of process hazards by plant condition monitoring. Materials Safety Data sheets and National Fire protection agency's classifications.

3. DISEASES: Dangerous occupational diseases, poisoning, dust effect. The biomedical and engineering response to health hazards.

4. CONTROL OF HAZARDS: Engineering control of plants instrumentation. Color codes for pipe lines. Safety aspects of reactive chemicals.

5. OPERATION AND PROCESS HAZARDS: Safety in operations and processes. Runaway reactions, unstable products.

TEXTBOOKS:

1. H. H. Fawcett and W. S. Wood, "Safety and Accident Prevention in Chemical Operation", 2nd Edn., Interscience, 1982.

2. "Loss Prevention and Safety Promotion in Chemical Process Industries", Vol.III Published by Institution of Chemical Engineers U.K., 1983.

REFERENCES:

1. T.Yoshida,"Safety of Reactive Chemicals",Vol.l,Elsevier,1987.

2. H. Willium, "Industrial Safely Handbook", 2"d Edn.,McGraw Hill, 1968.

3. R. V. Betrabet and T .P. S. Rajan, "Safety in Chemical Industry in Chemical Tech. I", Chemical Engg. Education Dev. Centre, IIT, Madras.

CH 885 (b) Environmental Impact Assessment (Elective-IV)

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

Time : 3 hours

1. Environmental Impact Assessment: An Overview

Introduction to EIA; Basic methodology: Screening, scoping Baseline data, Stake holder's involvement, Prediction of effects, Mitigation, EIA in decision making , Documentation, Project Implementation

2. Environmental Laws:

Introduction, Constitutional Provisions, Union list, sate list, concurrent list, Environmental Protection Acts, Functions of central and state boards, penalties, water act.

3. Screening and Scoping: Aims and objectives, Checklists and matrix, choosing tools.

4. Environmental Indices and Indicators for Describing the Affected Environment: Background Information, Environmental-Media Index- Air Quality ,Environmental-Media Index- Water Quality, Environmental-Media Index- Noise, Environmental-Media Index- Ecological Sensitivity and Diversity, Environmental-Media Index- Archaeological Resources, Environmental-Media Index- Visual Quality, Environmental-Media Index- Quality of life, Development of indices

5. Prediction and Assessment of Impacts on the Air, Surface water, Soil, Ground Water, Noise Environment, Biological Environment, Cultural Environment and socio-economic environment: Key regulations, Addressing Environment impacts: identification of the types, qualities/quantities of pollutants and effects, Base line data, Relevant quality standards and regulations, Impact Prediction, Assessment of impact significance, identification and incorporation of mitigation measures

6. Public Participation in EIA
7. Rapid Environmental Impact assessment:
8. Environmental Risk assessment,
9. Preparation of written document
10. Environmental Monitoring
11. Some case studies and project work

Text Book:

1. Environmental Impact Assessment, Larry W Canter, McGraw-Hill
2. Renewable Energy Resources and Their Environmental Impact, S A Abbasi and Naseema Abbasi, Prentice Hall India

CH 884 (a) PETROLEUM PRODUCTION TECHNOLOGY

(Elective –III)

Theory: 100 marks	L – T – P
Sectional: 75 marks	3 – 1 – 0

Time: 3 hours

Introduction.

Geologic consideration in Production Operations: Habitat for oil & gas, Traps of oil & gas, Structural geology, folds, faults, Sedimentary petrology, Sand stone Reservoir, Carbonate Reservoir, Migration.

Reservoir consideration: Hydrocarbon properties of oil & gas, Characteristics of reservoir rocks, porosity, permeability, wettability etc, Fluid flow in the reservoir, Reservoir drive Mechanism, reservoir Homogeneity.

Drilling technology: Methods of Drilling, Rotary Drilling rig, Rotary rig circulation system, Basic operation in drilling, the drill stem, Introduction of offshore, types of offshore rigs, casing, tubing & line pipes, Cementing, Introduction, Packers.

Analysis of Derrick structure – Major design factors: Self weight of the structure, operation of line load, Wind loads.

Problem well analysis: Low reservoir pressure, Low reservoir permeability, plugging, high viscosity oil, Removal of wax deposits etc.

Formation damage: Significance, Damage mechanism, Determination of permeability reduction.

Well production testing: Periodic production test, Productivity or Deliverability test, Transient pressure test.

Fundamental of stimulation/Activation techniques: Acidization, Fracturing, Sand control, Gravel packing, Nitrogen application etc.

Work over rigs and work over jobs: Main composition of WOR, Routine maintenance, Major overhauls.

Oil separation, storage and gathering system

Corrosion Control.

Reference: Production operation Vol I and Vol II –by Thomas O. Allen P. Roberts.

CH 886 PROJECT – II

Sessional: 150 ; Pass mark: 75

In this course each student is required to submit a Project Report on the designing of a Chemical Plant. The Report will consist of important chapters such as the following :

- Introduction
- Literature Survey
- Selection of the Process and Process Details with justification of selection.
- Thermodynamic and kinetic Considerations
- Material Balances with Flow Sheet
- Physico-Chemical data and Properties
- Energy Balane with Flow Sheets
- Process Design of Equipments and Optimum Conditions of Operation (Design of a minimum of two process equipments must be undertaken)
- Fabrication drawing of one of the major equipments
- Instrumentation & Process Control, Plant Layout, Safety, Precaution, etc.
- Cost Estimation
- Site Selection and Conclusion.

CH 887: VIVA VOCE
75 Marks, Pass Mark: 38

A final semester viva voce examination will be held at the end of 8^{th} semester. The viva voce will be to assess the student on his/her overall knowledge of the subjects related to Chemical Engineering in addition to the project works he/she had undertaken in 7^{th} and 8^{th} semester.