CURRICULUM OF CHEMICAL ENGINEERING

RGUKT BASAR

IV YEAR
I SEMESTER

S.No	Subject Code	Subject Name	(L-T)-P	C
1	CH3900	Summer Internship		6
2	CH4103	Transport Phenomenon	4-0	4
3	CH4102	Process Modeling and Simulation	4-0	4
4	CH4101	Process Equipment and Design	4-0	4
5	CH4403	Polymer Science and Engineering as Elective - I	4-0	3
6	CH4701	Process Equipment Design and Drawing Lab	0-3	2
7	CH4702	Process Modeling and Simulation Lab	0-3	2
8	CH4700	Major Project	0-3	4
Total Credits				**29**

L-Lectures, T-Tutorials, P-Practicals, C-Credits.

CH4103 TRANSPORT PHENOMENA

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-4**

Objectives:

- To develop detailed mathematical descriptions of momentum, heat and mass transport.
- To analyze and characterize fluid flow phenomena of various types of fluids under different conditions.
- To develop and solve the equations of change for non-isothermal systems.
- To develop and solve the equations of change for multi-component systems

Unit-1

Momentum Transport: Viscosity and Mechanism of Momentum Transport-Newton's Law of Viscosity, Shell momentum Balances and boundary conditions, Velocity Distributions in Laminar Flow- Flow of falling film, flow through a circular tube, Flow through Annulus, Flow of two adjacent immiscible fluids, Creeping flow around a sphere.

Unit-2

Equations of change for Isothermal Systems-The equation of Continuity, The equation of motion, The equation of Mechanical energy, Velocity Distributions with more than One independent variable-Time independent flow of Newtonian fluids, Introduction to stream functions Inter-phase transport in isothermal system-Definition of friction factors(FF), flow around tubes, spheres and packed columns.

Unit-3

Energy Transport: -Thermal Conductivity and Mechanism of Energy Transport-Fourier's law of heat conduction, Effect of pressure on thermal conductivity, Temperature Distributions in solids and in Laminar Flow-heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin.

Unit-4

Equations of change for Non-Isothermal Systems-The energy equation, Special Form of the energy equation, Temperature Distributions with more than One Independent Variable-unsteady heat conduction in solids, Steady Potential flow of heat in solids.

Unit-5

Mass Transport: Diffusivity and the mechanism of mass transport-Fick's law of binary Diffusion, Mass and Molar transport by convection, Concentration Distribution in solids-Diffusion through Stagnant gas film, Diffusion with a heterogeneous chemical reaction, Diffusion with a homogeneous chemical reaction, Diffusion into a falling liquid film.

Laminar Flow-Equation of change for multi component systems.

Text Books:

1. Transport Phenomena, Bird R.B., Stewart W.E. and Light Foot E.N.– John Wiley International – 2nd Edition , New York, 2002.
2. elements of Transport Phenomena, Sissom L.E, and Pitts D.R, , McGraw Hill, Newyork,1972

Reference Books

1. Fundamentals of momentum, Heat and Mass transfer, Welty J.R, Wicks C.E, Wilson R.E, and Rorer G.L 5th edition, John Wiley & sons Newyork,2007.
2. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.

CH4102 PROCESS MODELING AND SIMULATION

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-4**

Objectives:

- To develop mathematical models for chemical engineering processes
- To impart knowledge on modeling of various equipment and their simulation using different numerical techniques.
- To understand various problems associated with numerical solutions and select an appropriate solution technique.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

Unit-1

Mathematical models for chemical engineering systems: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models. Examples of mathematical models- Gravity flow tank, Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, CSTRs in series.

Unit-2

Mathematical Modeling: Gas phase pressurized CSTR, Non-isothermal Ideal Plug flow reactor, Plug flow reactor with axial dispersion, Multi component flash drum, ideal binary distillation column, batch distillation with holdup, Heat exchanger, liquid-liquid extractor.

Unit-3

Empirical model building: method of least squares, linear, polynomial and multiple regression, non-Linear regression.

Review of Numerical methods-Solution of Non-linear algebraic equations, system of non-linear linear equations, ordinary differential equations, Partial differential equations.

Unit-4

Process Simulation examples: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger, Non-isothermal Ideal Plug flow reactor, Plug flow reactor with axial dispersion

Unit-5

Process simulation using modular and equation based solving approaches: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach

Text Books:

1. Process modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.
3. Process Modeling and Simulation, Amiya K. Jana, 2012
4. Computational Methods in Process Simulation, Ramirez, W., 2nd Edn., Butterworths, New York,2000.

References:

1. Mathematical Modeling in Chemical Engineering, Franks, R. G. E., John Wiley, 1967
2. Numerical Methods and Modeling for Chemical Engineers, Davis M.E, Wiley New York,1984
3. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010

CH4101 PROCESS EQUIPMENT DESIGN

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-4**

Objectives:

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

Unit-1

Introduction to plant design. Process design development: Design project procedure, design information from the literature, flow diagrams, preliminary design, comparison of different processes, equipment design, scale-up in design, safety factors, specifications.

Unit-2

General design considerations: Health and safety hazards, fire and explosion hazards, personnel safety, loss prevention, thermal pollution control, noise pollution and control, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling.

Materials and fabrication selection: Materials of construction, selection of materials, fabrication of equipment.

Unit-3

Mechanical design of process equipment: Pressure vessels – calculation of thickness of cylindrical and spherical shells subjected to internal pressure, heads or covers. Storage vessels – storage of nonvolatile liquids, storage of volatile liquids, storage of gases. Supports for vessels – bracket or lug supports, leg supports, skirt supports, saddle supports.

Unit-4

Material transfer, handling and treatment equipment: Process specifications of Pumps and compressors, piping design.

Heat transfer equipment design: Shell and tube Heat Exchanger, condenser, single effect evaporator.

Unit-5

Mass transfer equipment design: Finite-stage contactors- bubble cap tray, sieve tray and valve tray units, maximum allowable vapor velocities, plate and column efficiency, other design factors. Continuous contactors – types of packing, liquid distribution, pressure drop, packing efficiencies. Relative merits of plate and packed towers.

Reactors: Batch reactors, tubular plug flow reactors, back mix reactors, mechanical features of jacketed reactors.

Text Books:

1. Chemical Engineering Vol. VI (An introduction to Chemical Engineering Design), Coulson J.M. and Richardson J.F Pergamon Press, 1993.

2. Process Equipment Design, M. V. Joshi, 3rd Edition, Macmillan India Limited 2003.

References:

1. Process Plant Design, Backhurst, J.R And Harker, J. H, Heieman Educational Books, London (1973).

CH4403 POLYMER SCIENCE AND ENGINEERING

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-3**

Objective:

- To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers
- To learn about polymerization reaction kinetics
- To learn about Reactor design for polymeric systems
- To understand rheological behavior of polymeric systems.
- Understand the unit operations in polymer industries

Unit-1

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

Unit-2

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.

Mechanism and kinetics of: Addition or chain polymerization

a) Free radical addition polymerization b) Ionic addition polymerizations

c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

Unit-3

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

Unit-4

Degradation of polymers, Role of the additives in the polymers: Fillers and reinforcing fillers; Plasticizers; Lubricants; Antioxidants and UV stabilizers; Blowing agents; Coupling agents ; Flame retardants; Inhibitors

Brief description of manufacture, properties and uses of: Polyethylene (HDPE&LDPE); Poly propylene; Polyvinylchloride; Polystyrene; Polytetra fluoroethylene; Polyesters; Nylon(Nylon 66) ; Phenol- Formaldehyde resins; Epoxy resins; Polyurethane; Silicones

Unit-5

Reactors for polymerization; Rheology of polymeric system.

Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion.

Text Books:

1. Polymer Science & Technology, 2nd ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.
3. Polymer science by VR Gowariker, New age international limited, India

References:

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

CH4701 PROCESS EQUIPMENT DESIGN & DRAWING LAB

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **0-0-3-2**

Objective:

- To make the student familiar with design and drawing aspects of chemical processes equipments.

List of Experiments

1. Application and use of various codes and standards in design
2. Design of non-pressure storage vessel, tall vertical vessels
3. Design of unfired pressure vessels with internal pressure, Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical and conical ends.
4. Design of Pipe lines;
5. Mechanical design of heat exchangers,
6. Mechanical design of Evaporators.
7. Mechanical design of Distillation columns.
8. Mechanical design of Absorbers, Reactors and Dryers and Crystallizers. Use of software's for design of equipments.

CH4702 PROCESS SIMULATION LAB

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **0-0-3-2**

Note: Any 8 experiments out of given set of experiments.

Objectives:

- To make the student familiar with software and simulation of chemical processes equipments.

The following experiments have to be conducted using C/C++/MATLAB/ASPEN etc

1. Three CSTR's in series – open loop & closed loop
2. Non isothermal CSTR
3. Isothermal batch reactor – open loop
4. Non-isothermal Batch reactor
5. Plug flow reactor
6. Heat Exchanger
7. Gravity Flow tank.
8. Bubble point & Dew point calculations
9. Binary Distillation column

CH4700 MAJOR PROJECT

External panel: 60 Marks **L-T-P-C**

Internal advisor: 40 Marks **0-0-3-4**

Student has to do literature review on the chosen/allotted area of project work and must submit a report.