



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3733010

Semester – III

Subject Name: Computer Aided Design

Type of course: Program Elective 5

Prerequisite: The students should be having basic knowledge of computer and its use. The students must be aware of units and conversion, material and energy balance, thermodynamics for properties of components and mixtures, chemical engineering unit operation and processes.

Rationale: The objective of this course is to understand importance and applications of CAD in the field of chemical engineering. The student will become familiar to the basic structure and components of CAD software and importance of underlying thermodynamic and physical principles. They will get detailed insight into the approaches used in the simulation of flow sheets. They will be in position to relate flow charts, computer languages and numerical methods used for writing algorithms.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction : Introduction to CAD, Scope and applications in chemical Engineering, Mathematical methods used in flow sheeting and simulation, Introduction to solution methods for linear and non-linear algebraic equations, solving one equation one unknown, solution methods for linear and nonlinear equations, general approach for solving sets of differential equations, solving sets of sparse non-linear equations.	6	10
2	Properties Estimation : Physical properties of compounds, Thermodynamic properties of gases and binary mixtures, Viscosity, Vapour pressure, Latent heat, Bubble point and dew point calculation, phase equilibria, Vapour-liquid equilibria, Liquid phase activity coefficients, K-values, Liquid phase activity coefficients, K-values, Liquid-Liquid equilibria, Gas solutions.	8	15
3	Equipment Design : Computer aided Design of Equipment: Design of Shell and Tube Heat exchangers; Design of Evaporators; Design of Distillation columns; Design of Reactors, Design of adsorption columns; Distillation columns (specific attention to multi components systems. Heat exchangers.	12	25



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4	Computer Aided Flow Sheet Synthesis : Computerized physical property calculations, degrees of freedom in process design, degrees of freedom for a unit, degrees of freedom in a flow sheet, steady state flow sheeting and process design, approach to flow sheeting systems, introduction to sequential modular approach, simultaneous modular approach and equation solving approach, sequential modular approach to flow sheeting, examples. Tear streams, convergence of tear streams, partitioning and tearing of a flow sheet, partitioning and precedence ordering, tearing a group of units. Flow sheeting by equation solving methods based on tearing.	14	20
5	Dynamic Simulation : Dynamic simulation of stirred tanks system with heating Multi component system, Reactors, Absorption and distillation columns, Application of orthogonal collocation and weighted residuals techniques in heat and mass transfer systems, Introduction to special software for steady and dynamic simulation of Chemical engineering systems. Introduction to various commercial design software and optimization tools used in field of chemical engineering.	20	30

Reference Books:

1. Douglas James M., "Conceptual design of Chemical Processes", McGraw -Hill Book Company, New York, 1988.
2. Remirez, W.F. - " Computational methods for Process Simulations ", Butterworths, New York, 1989.
3. Sinnott R.K. "Chemical Engineering", Volume 6, Pergamon Press, New York, 1989.
4. Westerberg A.W., et al, "Process Flow Sheeting", Cambridge University Press.
5. Biegler Lorenz T, et al, "Systematic method of Chemical Process Design", Prentice Hall.
6. Crowe C.M., et al, "Chemical Plant Simulation-An Introduction to Computer Aided Steady State Analysis", Prentice Hall.
7. Anil Kumar, "Chemical Process Synthesis and Engineering Design", TMH, 1981.
8. Richard Turton et al., " Analysis, Synthesis, and Design of Chemical Processes", Pearson.

Course Outcomes: At the end of the course, the student will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the computations for design simulation and optimization	15
CO-2	Estimate properties for chemical compounds and mixtures	20
CO-3	Design operations and processes equipment using computer aided design tools	25



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CO-4	Model dynamic processes and validate simulation results	20
CO-5	Analyse simulation results and process plant data to identify optimal process conditions.	20

List of Experiments:

1. Thermodynamic property estimations using property estimation tools.
2. Analysis of VLE data for Non-ideal mixtures using property estimation tools.
3. Simulation studies of simple unit operations using process plant simulator.
4. Simulation of evaporators, heat exchangers, and distillation
5. Design verification for reactive distillation columns.
6. Apply sensitivity, design specification and case study tools
7. Dynamic simulation of Distillation Columns.
8. Simulation of Heat/Mass Transfer coefficient in 3 phase fluidized bed column
9. Modelling and Simulation of cyclone separator
10. Modelling and optimization of Spray Dryer
11. Design optimization for non-ideal reactors
12. Design and Simulation of adsorption for practical applications

Note: Software tools like DWSIM, HTRI, ASPEN PLUS, CHEMCAD may be used for laboratory experiments.

Major Equipment: Computer Lab

List of Open Source Software/learning website: DWSIM - an open source process plant simulator