

COURSE TITLE	PROCESS MODELLING & SIMULATION
COURSE CODE	01CH0611
COURSE CREDITS	4

Objective:

- 1 The course is intended to identify the suitable modelling and simulation approach for various chemical engineering operations.

Course Outcomes: After completion of this course, student will be able to:

- 1 Identify the suitable process modelling approach for various processes.
- 2 Construct the mathematical modelling for different processes.
- 3 Plan the appropriate modelling and simulation methodology for respective system.
- 4 Test and justify the developed model for a particular process.
- 5 Design and rearrange the parameters based on the modelling approach.

Pre-requisite of course: Fluid Flow Operations, Chemical Reaction kinetics, Engineering Mathematics

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Modelling Fundamentals Uses of Mathematical models; Deterministic versus stochastic processes; Physical modelling,, Mathematical modelling; Principles of formulation; Fundamental Laws – Continuity equation, Energy equation, Equation of Motion, Transport equation,, Equations of state, Equilibrium, Chemical Kinetics,, Strategy of process engineering	6
2	Classification of Mathematical Modelling Variables and parameters; Classification based on variation of independent variables;, Classification based on the state of process; Classification based on the type of the process;, Boundary Conditions; The black box principle; Artificial Neural Network	6
3	Models in Mass-Transfer Operations Steady-state single-stage solvent extraction; Steady-state two-stage solvent extraction;, Steady-state two-stage cross-current solvent extraction; Unsteady- state single-stage solvent extraction;, Unsteady state mass balance in a stirred tank; Unsteady state mass balance in a mixing tank;, Batch Distillation with holdup; Reactor with mass transfer	8

Contents : Unit	Topics	Contact Hours
4	Models in Heat-Transfer Operations Two heated tanks; Steady-state heat conduction through a hollow cylindrical pipe; Unsteady-state steam heating of a liquid; Unsteady-state heat loss through a maturing tank; Counter-current cooling of tanks; Heat transfer through extended surfaces; Unsteady-state heat transfer in a tubular gas preheater; Heat loss through pipe flanges; Heat transfer in thermometer system	8
5	Models in Fluid-flow operations The continuity equation; Flow through a packed bed column; Laminar flow in a narrow slit; Flow of a film on the outside of a circular tube; Parallel-disc viscometer	6
6	Process Modelling Software – Professional simulation packages Introduction; Ansys; Aspen; Comsol; Case studies.	4
Total Hours		38

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	Experiment 1 Introduction to MATLAB functions: Coding and the Key Parts, writing a function file, loops and arrays	2
2	Experiment 2 To solve basic matrix calculations in MATLAB	2
3	Experiment 3 To solve ordinary differential equation in MATLAB	2
4	Experiment 4 To solve chemical engineering problems involving simultaneous differential equation in MATLAB	2
5	Experiment 5 To solve Laplace Transforms in MATLAB	2
6	Experiment 6 To solve differential equations using Laplace Transforms in MATLAB	2
7	Experiment 7 To solve differential equations using Simulink	2
8	Experiment 8 To plot curve using plot function in MATLAB.	2
9	Experiment 9 To apply Simulink for process control problems	2
10	Experiment 10 To solve batch reactor problem in Simulink	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
11	Experiment 11 To study temperature Dynamics of a Double Pipe Heat-Exchanger using MATLAB	2
Total Hours		22

Textbook :

- 1 Process Modeling, Simulation and Control for Chemical Engineers,, William L. Luyben,, McGraw Hill International Editions, 1989

References:

- 1 Process Plant Simulations,, Process Plant Simulations,, B. V. Babu,, Oxford University Press., 2004

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	25.00	25.00	10.00	10.00

Instructional Method:

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Supplementary Resources:

- 1 <http://www.prosim.net/en/index.php>
- 2 <https://www.chemstations.com/CHEMCAD/>
- 3 <https://www.aspentech.com/en/products/engineering/aspens-plus>
- 4 <https://chengineer.in/>