

ME324 System Modelling, Simulation and Analysis										
L	T	P	Credit	Area		CWS	PRS	MTE	ETE	PRE
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

**Objective:** To enable the students to understand the fundamentals of probability and statistics, Continuous and discrete systems and Bond graphs. To understand techniques of simulation, System dynamics and Simulation of hydraulic systems.

Syllabus		Contact Hours
Unit-1	<b>Introduction:</b> A review of basic probability and statistics, random variables and their properties, Estimation of means, variances and correlation.	5
Unit-2	<b>Physical Modelling:</b> Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation	6
Unit-3	<b>Modeling of Physical System Dynamics:</b> A Unified Approach Physical system, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bond graphs:1-port elements – resistor R, Stiffness C, and Inertia I, Source of Effort Se and Flow SF; 2-port elements – Transformer TF and Gyrator GY, with modulation, Junction elements 1 and 0; Causality, Causality for basic 1-port and multi-ports. Derivation of System equations from Bond graphs in first order state space form.	8
Unit-4	<b>Bond Graph Modeling of Multi-energy Systems</b> Mechanical Systems, Translation and rotation (about a fixed axis) <b>System Simulation:</b> Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.	7
Unit-5	<b>System Dynamics:</b> Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random Numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.	8
Unit-6	<b>Simulation of Mechanical Systems:</b> Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.	8
	<b>Total</b>	<b>42</b>

Reference Book:	
1	<b>System Simulation-</b> Geoffrey Gordon -Prentice Hall
2	<b>System Simulation: The Art and Science</b> -Robert E. Shannon -Prentice Hall
3	<b>System Modelling and Control</b> -J. Schwarzenbach and K.F. Gill Edward Arnold
4	<b>Modelling and Analysis of Dynamic Systems</b> -Charles M Close and Dean K. Frederick Houghton Mifflin
5	<b>Simulation of Manufacturing</b> -Allan Carrie John Wiley & Sons
6	<b>Bond Graph in Modeling, Simulation and Fault Identification</b> -Amalendu Mukherjee, Ranjit Karmakar, Arun Samantary-I.K. Int. Pub. House

**Course Outcomes**

CO1	Explain modeling and simulation types, entities, objectives and benefits
CO2	Recognize the simulation types and steps for variety of complex systems
CO3	Construct simulation models from enterprise high level models.
CO4	Performance simulations to analyze real-world systems.
CO5	Evaluate the results of simulation and analysis to improve or optimize systems
CO6	Apply and experiment computer packages to implement simulation and analysis.

**CO-PO/PSO Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1