



# GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3734107

Semester – III

Subject Name: Modelling and Simulation Techniques

**Type of course:** Professional Elective Course

**Prerequisite:** Detection and Estimation Theory

**Rationale:** Now a day computerized simulation is a most powerful tool to present, the dynamic behavior of real life systems. The models are used to experiment and predict the information. Simulations are helpful to find solutions of that kind of problems where analytical solutions are not available. The main purpose of this subject is to gain the knowledge about system and its behavior so that a person can transform the physical behavior of a system into a mathematical model that can in turn transform into efficient algorithm for simulation purpose.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	0	70	30	0	0	100	

Sr. No.	Content	Total Hrs	% Weightage
1	<b>UNIT 1</b> Introduction to dynamic systems, Transfer functions, poles and zeroes, State space, Deterministic Systems, Difference and Differential Equations, Solution of Linear Difference and Differential Equations, Numerical Simulation Methods for ODEs, System Identification, Stability and Sensitivity Analysis.	09	15%
2	<b>UNIT 2</b> Statistical methods, Description of data, Data-fitting methods, Regression analysis, Least Squares Method, Analysis of Variance, Goodness of fit.	08	25%
3	<b>UNIT 3</b> Probability and Random Processes, Discrete and Continuous Distribution, Central Limit theorem, Measure of Randomness, Monte Carlo Methods	08	20%
4	<b>UNIT 4</b> Stochastic Processes and Markov Chains, Time Series Models.	06	10%
5	<b>UNIT 5</b> Modeling and simulation concepts, Discrete-event simulation, Event scheduling/Time advance algorithms, Verification and validation of simulation models.	08	15%
6	<b>UNIT 6</b>	07	15%



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Continuous simulation: Modeling with differential equations, Example models, Bond Graph Modeling, Population Dynamics Modeling, System dynamics.		
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## Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	20	10	10	10

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

## Reference Books:

- R. L. Woods and K. L. Lawrence, "Modeling and Simulation of Dynamic Systems", Prentice-Hall, 1997.
- Z. Navalih, "VHDL Analysis and Modelling of Digital Systems", McGraw-Hill, 1993.
- J. Banks, JS. Carson and B. Nelson, "Discrete-Event System Simulation", 2nd Edition, Prentice-Hall of India, 1996.

## Course Outcome:

Sr. No.	CO statement	Marks % weightage
1	Understand mathematics behind modelling and simulation of systems. (deterministic and random)	20%
2	Understand the modelling using stochastic processes.	30%
3	Identify and model discrete systems (deterministic and random)	30%
4	Understand modelling and simulation techniques to characterize systems/processes.	20%

## List of Experiments:

1. Write Matlab code to plot the poles and zeros of the continuous-time system represented by the transfer function.
2. Write Matlab code to plot the pole-zero map of a discrete time identified state-space (IDSS) model.
3. Write Matlab code to solve higher order differential equation with initial conditions.
4. Write Matlab code for study and analysis of Fit probability distribution techniques.
5. Write Matlab code for regression modelling.
6. Write Matlab code to study discrete distribution techniques.
7. Write Matlab code to study continuous distribution techniques.
8. Write Matlab code for the analysis of any system using Monte Carlo simulation technique. .
9. Write Matlab code to create Markov chain using different techniques.
10. Simulation of electrical systems using Bond Graph Modelling.

## Major Equipment:



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Computational lab or facility with the following software or their equivalent:

1. Matlab
2. NI LabVIEW

**List of Open Source Software/learning website:**

1. NPTEL Video lectures