SEMESTER S6

SYSTEM MODELLING AND SIMULATION

Course Code	PCIET601	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To enable students to construct a theoretical base to model discrete and continuous systems.
2. To equip students to model and simulate discrete and continuous systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to system modelling:** Concepts of a system, system environment, continuous and discrete systems, system models, comparison of analytical methods and simulation, areas of application of simulation, steps in discrete event simulation study. **Random Numbers:** Properties of random numbers, generation of pseudo-random numbers, random number generators. Tests for random numbers-frequency, gap, run, and Poker tests, test for autocorrelation, Monte Carlo method.	**11**
2	**Generation of random variates:** Inverse transformation method for exponential, uniform, Weibull, triangular, and discrete distributions, Direct transformation method for normal and lognormal distributions, Acceptance-rejection technique for Poisson and Gamma distributions. **Input modelling:** Data collection, identifying the distribution with the collected data, goodness of fit tests, selecting input models without data. Verification and validation of simulation models, Output data analysis, Variance reduction techniques. **Time Advance Mechanisms for discrete event simulation:** Next-Event time advance and fixed increment time advance methods.	**11**

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3	**System dynamic modelling:** Evolution of system dynamics as a system enquiry methodology, elements of system dynamics modelling- physical flows, information flows, level & rate variables, delays, information smoothing, table functions and table function multipliers, causal loop diagramming, flow diagrams. Steps for Modelling in system dynamics.	**11**
4	**Behaviour of linear lower order systems:** Analytical approach - first order positive and negative feedback systems, pure second order positive and negative feedback systems. **Modes of dynamic behaviour:** Exponential growth, goal seeking, oscillation, interactions of fundamental modes. Principles of simulation modelling, developing model equations, algorithms for Euler integration, hand simulation of system dynamics models. S-Shaped growth- epidemics, innovation, diffusion and growth of new products. Overview of Software packages for System modelling and simulation.	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

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Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 = 24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcomes		Bloom's Knowledge Level (KL)
CO1	Explain the basic concepts of the system and its simulation, Demonstrate the generation of random numbers and its testing.	**K2**
CO2	Perform input modeling for discrete simulation, verify and validate simulation models and perform output data analysis	**K3**
CO3	Illustrate various elements of system dynamics modelling, Construct causal loop diagrams and Flow diagrams.	**K3**
CO4	Develop the fundamental modes of dynamic behaviour and their interactions; Model and Analyze systems using the principles of system dynamics.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	1	-	-	1	1	1	2
CO2	3	3	3	2	3	2	-	-	1	1	1	2
CO3	3	3	2	2	3	3	-	-	1	1	1	2
CO4	3	3	3	3	3	3	-	-	1	1	1	2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Discrete Event System Simulation	Jerry Banks	Pearson Education	5th Edition, 2013
2	Introduction to System Dynamic Modeling	M C Bora, Pratap K J Mohapatra and P Mandal	Universities Press	1st Edition, 1994

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Simulation Modeling and Analysis	A M Law	McGraw Hill	6th Edition, 2024
2	System Simulation	Geoffrey Gordon	Prentice Hall India	2nd Edition, 1979
3	Discrete Event Simulation: Modeling, Programming and Analysis	George Fishman	Springer series in Operations Research and Financial Engg.	1st Edition, 2001
4	System Simulation with Digital Computer	Deo Narsingh	Prentice Hall India	24th Edition, 2011
5	Simulation	Sheldon M. Ross	Elsevier	6th Edition, 2023
6	Business Dynamics – Systems Thinking and Modeling for a Complex World	John D. Sterman	McGraw Hill	1st Edition, 2000

Video Links (NPTEL, SWAYAM…)	
Link ID	https://nptel.ac.in/courses/112107220
	https://onlinecourses.nptel.ac.in/noc22_me18

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