Course Code MAT3016	Stochastic Process	Course Type	LT
		Credits	3
		Version	1.1

Prerequisite: Students should have the knowledge of basics of probabilities.

Course Objectives: The purpose of this course is to equip students with theoretical and practical knowledge of random theory and stochastic processes essential for their subsequent studies.

Course Outcomes (COs):

On successful completion of this course, the students will be able to:

CO1: Apply the Chapman-Kolmogorov equation based on classifying stochastic processes, including Markov processes and chains for problem-solving. (KL2, KL3)

CO2: Analyze limiting behavior, stationary distributions, and types of Markov chains based on cclassifying states and chains in Markov processes. (KL2, KL3)

CO3: Apply Chapman-Kolmogorov equations, transition rates, and Kolmogorov forward and backward equations in continuous-time discrete-state-space Markov chains. (KL2, KL3)

CO4: Use Brownian motion and its properties for the problems related to random walk in continuous-time continuous-state-space Markov chains. (KL2, KL3)

CO5: Employ the concepts of Gaussian processes, covariance functions, kernel functions, and martingales for problem-solving related to the context of stochastic processes. (KL2, KL3)

Correlation of COs with POs

CO \ PO	CKL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PKL		3	5	6	5	6	3	3	3	NA	M	3	M	3	3	
CO1	1	2	1	1	1	1	2	2	2	NA	M					
CO2	3	3	2	2	2	2	3	3	3	NA	M					
CO3	3	3	2	1	2	1	3	3	3	NA	M					
CO4	3	3	2	1	2	1	3	3	3	NA	M					
CO5	1	2	1	1	1	1	2	2	2	NA	M					

COs	Topics to be discussed	Lectures
CO1	**Introduction to Stochastic Processes**: Definitions and classification of general stochastic processes, Markov processes, Markov chains: definition, transition graphs, transition probability matrix, order of a Markov chain, Chapman-Kolmogorov equation.	6
CO2	**Classification of States and Chains**: Transient, persistent and ergodic states, limiting behavior of n-step transition probabilities, stationary distribution, stationary distribution of the chain, types of states, periodicity of a state, Types of Markov chain - irreducible, regular, ergodic, absorbing, mean time spent in a transient state, average number of visits to a state before absorption, probability of absorption, Markov chains with finite and countable state space, reducible chains, continuous time Markov processes, random walk, gambler ruins problem.	6

CO3	**Continuous-Time Discrete-State-Space Markov Chains** Chapman-Kolmogorov Equations: Derivation and interpretation, Application in computing transition probabilities, Transition Rates, Infinitesimal Generator, Kolmogorov Forward and Backward Equations: Derivation and interpretation, Solution methods and applications.	**6**
CO4	**Continuous-Time Continuous -State-Space Markov Chains** Brownian Motion: Definition, Construction and basic properties, Connection to random walk, Brownian motion as a limit of random walk.	**6**
CO5	**Gaussian Processes and Martingales** Gaussian Processes: Definition and properties, Covariance function and kernel functions, Martingales: Definition and properties, Martingales with respect to other process.	**6**
	Contemporary topics and Guest Lecture	**2**
	Total Lecture: **(1 Lecture = 1.5 Hrs.)**	**32**

Text Books:

1. J. Medhi, Stochastic Processes, 2nd Edition, New Age International Limited, 1994.
2. Sheldon M. Ross, Stochastic Processes, 2nd edition. John Wiley & Sons, 1995.

Reference Books:

1. N. T. Bailey, The Elements of Stochastic Processes with Applications to the Natural Sciences, John Wiley & Sons, New York, 1991.
2. V. Sundarapandian, Probability, Statistics and Queuing Theory, PHI Learning, 2009.
3. H. M.Taylor and S. Karlin, An Introduction to Stochastic Modelling, 3rd Edition, Academic Press, 1998.
4. U. Narayan Bhat, Gregory K. Miller, Elements of Applied Stochastic Processes, 3rd edition, John Wiley & Sons, New York (Indian Edition)

Recommendation by the Board of Studies on	***02/08/2021/ Revised on 15 March 2024***
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