INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Name of the Academic Unit: E&ECE

Subject Name: Probability and Stochastic Processes
L-T-P: 3-1-0 Credits: 4

Pre-requisites: None

Syllabus and reference books:

Syllabus: Probability space, random variable, expectation, conditional probability, convergence of sequences of random variables, law of large numbers, central limit theorem, stochastic processes and LTI systems, Markov Chain, applications to signal processing/communication/networking/machine learning and other areas.
Reference Books: 1) A. Papoulis and S. Pillai, “Probability, random variables, and Stochastic Processes,” McGraw Hill Education; 4th edition, 2017. 2) S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996. 3) D. P. Bertsekas and J. N. Tsitsiklis, “Introduction to probability,” Athena Scientific, 2002. 4) Kai Lai Chung, “Elementary Probability Theory with Stochastic Processes,” Springer 2003.

Lecture-wise break-up:

Sl. No.	Topic	No. of lectures
1.	Background on set theory and analysis, events, probability space, Bayes’ theorem, law of total probability.	**6**
2.	Random variables, types of random variables (discrete and continuous), joint distribution and independence, conditional distribution, Gaussian density function, jointly Gaussian Random variables, transformation of random variables, functions of random variables and their characteristics, random vectors.	**6**

3.	Expectation, variance and covariance, conditional expectation.	**4**
4.	Moment-generating functions, characteristic functions, concentration inequalities, convergence of random variables, the law of large numbers and the central limit theorem.	**7**
5.	Introduction to stochastic processes and examples, Bernoulli processes, Brownian motion, AWGN, phase noise and jitter, shot noise, Poisson process.	**4**
6	**Signal processing applications:** Stationarity, ergodicity, Power spectral density, moving average and auto-regressive processes, response of LTI systems driven by a stochastic process.	**5**
7.	**Communication and networking applications:** Discrete-time Markov Chains: definition and examples, transition probability matrix, calculation of n-step transition probabilities, classification of states, stationary distribution, transient MC; random walk and gambler's ruin, queuing.	**6**
8.	**Machine learning and data science applications:** Hidden Markov models, Markov decision processes, MCMC and sampling, graphical models.	**6**
	Total number of hours	**44**