Stochastic Processes - Video course

COURSE OUTLINE

Probability Review and Introduction to Stochastic Processes (SPs): Probability spaces, random variables and probability distributions, expectations, transforms and generating functions, convergence, LLNs, CLT.
Definition, examples and classification of random processes according to state space and parameter space.
Stationary Processes: Weakly stationary and strongly stationary processes, moving average and auto regressive processes
Discrete-time Markov Chains (DTMCs): Transition probability matrix, Chapman-Kolmogorov equations; n-step transition and limiting probabilities, ergodicity, stationary distribution, random walk and gambler's ruin problem, applications of DTMCs.
Continuous-time Markov Chains (CTMCs): Kolmogorov differential equations for CTMCs, infinitesimal generator, Poisson and birth-death processes, stochastic Petri net, applications to queueing theory and communication networks.
Martingales: Conditional expectations, definition and examples of martingales, applications in finance.
Brownian Motion: Wiener process as a limit of random walk; process derived from Brownian motion, stochastic differential equation, stochastic integral equation, Ito formula, Some important SDEs and their solutions, applications to finance.
Renewal Processes: Renewal function and its properties, renewal theorems, cost/rewards associated with renewals, Markov renewal and regenerative processes, non Markovian queues, applications of Markov regenerative processes.
Branching Processes: Definition and examples branching processes, probability generating function, mean and variance, Galton-Watson branching process, probability of extinction.

COURSE DETAIL

Module	Topics and Contents	Lectures
1	**Probability Theory Refresher:** Axiomatic construction of probability spaces, random variables and vectors, probability distributions, functions of random variables; mathematical expectations, transforms and generating functions, modes of convergence of sequences of random	4

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Mathematics

Pre-requisites:

Probability Theory and Calculus

Additional Reading:

1. Liliana Blanco Castaneda, Viswanathan Arunachalam and S. Dharmaraja, Introduction to Probability and Stochastic Processes with Applications, Wiley, 2012.
2. Suresh Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani, Financial Mathematics: An Introduction, Narosa Publication House, 2012.
3. Kishor S. Trivedi, Probability, Statistics with Reliability, Queueing and Computer Science Applications, 2nd edition,

	variables, laws of large numbers, central limit theorem.	
2	**Introduction to Stochastic Processes (SPs):** Definition and examples of SPs, classification of random processes according to state space and parameter space, types of SPs, elementary problems.	2
3	**Stationary Processes:** Weakly stationary and strongly stationary processes, moving average and auto regressive processes.	2
4	**Discrete-time Markov Chains (DTMCs):** Definition and examples of MCs, transition probability matrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities, classification of states, ergodicity, stationary distribution, transient MC; random walk and gambler's ruin problem, applications.	7
5	**Continuous-time Markov Chains (CTMCs):** Kolmogorov- Feller differential equations, infinitesimal generator, Poisson process, birth-death process, stochastic Petri net, applications to queueing theory and communication networks.	8
6	**Martingales:** Conditional expectations, definition and examples of martingales.	2
7	**Brownian Motion:** Wiener process as a limit of random walk; process derived from Brownian motion, stochastic differential equation, stochastic integral equation, Ito formula, Some important SDEs and their solutions, applications to finance.	6
8	**Renewal Processes:** Renewal function and its properties, renewal theorems, cost/rewards associated with renewals, Markov renewal and regenerative processes, non Markovian queues, applications of Markov regenerative processes.	6
9	**Branching Processes:** Definition and examples branching processes, probability	2

Wiley, 2001.

4. S. E. Shreve, Stochastic Calculus for Finance, Vol. I & Vol. II, Springer, 2004.
5. V. G. Kulkarni, Modeling and Analysis of Stochastic Systems, Chapman & Hall, 1995.
6. G. Sankaranarayanan, Branching Processes and Its Estimation Theory, Wiley, 1989.

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	generating function, mean and variance, Galton-Watson branching process, probability of extinction.	

References:

1. J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.
2. S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996.
3. S Karlin and H M Taylor, A First Course in Stochastic Processes, 2nd edition, Academic Press, 1975.