



**MATHEMATICS**

**Instructor Name :**

**PROF.S. DHARAMRAJA ( IIT Delhi - Mathematics )**

**PROF.N. SELVARAJU ( IIT Gowahati - Mathematics )**

**COURSE DURATION :** Jan-Apr 2018 **CORE / ELECTIVE :** Elective **UG / PG:** UG

**PRE-REQUISITES :** A basic course on Probability

**INTENDED AUDIENCE :** Under-graduate, Post-graduate and PhD students of mathematics, electrical engineering, computer engineering

**INDUSTRIES APPLICABLE TO :** Goldman Sachs, FinMechanics, Deutsche Bank and other finance companies.

**COURSE OUTLINE :** This course explanations and expositions of stochastic processes concepts which they need for their experiments and research. It also covers theoretical concepts pertaining to handling various stochastic modeling. This course provides classification and properties of stochastic processes, discrete and continuous time Markov chains, simple Markovian queueing models, applications of CTMC, martingales, Brownian motion, renewal processes, branching processes, stationary and autoregressive processes.

**ABOUT INSTRUCTOR :** S. Dharmaraja earned his M.Sc. degree in Applied Mathematics from Anna University, Madras, India, in 1994 and Ph.D. degree in Mathematics from the Indian Institute of Technology Madras, in 1999. From 1999 to 2002, he was a post-doctoral fellow at the Department of Electrical and Computer Engineering, Duke University, USA. From 2002 to 2003, he was a research associate at the TRILabs, Winnipeg, Canada. He has been with the Department of Mathematics, IIT Delhi, since 2003, where he is currently a Professor, Department of Mathematics and joint faculty of Bharti School of Telecommunication Technology and Management.

N. Selvaraju earned his Ph.D. degree in Mathematics from the Indian Institute of Technology Madras in 2001. From 2001 to 2003, he was a post-doctoral fellow at the Department of Mechanical Engineering (Division of Industrial Engineering), University of Minnesota, USA. He has been with the Department of Mathematics, IIT Guwahati, since 2003, where he is currently a Professor. His research interests are applied probability and stochastic modelling, in particular in the areas of queueing theory, mathematical finance and inventory management in supply chains and has published over 15 papers in international journals and international conferences in these areas.

**COURSE PLAN**

**Week 1:**Probability theory refresher 1. Introduction to stochastic process 2. Introduction to stochastic process (contd.)

**Week 2:**Probability theory refresher (contd.) 1. Problems in random variables and distributions 2. Problems in Sequence of random variables

**Week 3:**Definition and simple stochastic process 1. Definition, classification and Examples 2. Simple stochastic processes

**Week 4:**discrete-time Markov chains 1. Introduction, Definition and Transition Probability Matrix 2. Chapman-Kolmogorov Equations 3. Classification of States and Limiting Distributions

**Week 5:**Discrete-time Markov chains (contd.) 1. Limiting and Stationary Distributions 2. Limiting Distributions, Ergodicity and stationary distributions 3. Time Reversible Markov Chain, Application of Irreducible Markov chains in Queueing Models 4. Reducible Markov Chains

**Week 6:**Continuous-time Markov chains 1. Definition, Kolmogrov Differential Equation and Infinitesimal Generator Matrix 2. Limiting and Stationary Distributions, Birth Death Processes 3. Poisson processes

**Week 7:**Continuous-time Markov Chains (contd.) 1. M/M/1 Queueing model

**Week 8:**Applications of CTMC 1. Queueing networks 2. Communication systems 3. Stochastic Petri Nets

**Week 9:**Martingales 1. Conditional Expectation and filtration 2. Definition and simple examples

**Week 10:** Brownian Motion 1. Definition and Properties 2. Processes Derived from Brownian Motion 3. Stochastic Differential Equation

**Week 11:** Renewal Processes 1. Renewal Function and Equation 2. Generalized Renewal Processes and Renewal Limit Theorems 3. Markov Renewal and Markov Regenerative Processes 4. Non Markovian Queues 5. Application of Markov Regenerative Processes

**Week 12:** Branching Processes, Stationary and Autoregressive Processes