Course Outcome(s)	Upon completion of the subject, students will be able to: Apply the concepts of probability, conditional probability and conditional, expectations. Calculate probabilities, moments and other related

	quantities based on given distributions. Understand and apply the laws of large numbers and central limit theorems, martingale limit theory, Brownian motion model.

Syllabus:
Probability measures and random variables, pi and lambda systems, expectation, moment generating function, characteristic function, laws of large numbers, limit theorems, conditional contribution and expectation, martingales, infinitely divisible laws and stable laws.

Text books:

1. Durrett R., Probability: Theory and Examples, Cambridge University Press, 4th Edition, 2010.

References:

1. Billingsley P., Probability and Measure, 3rd Edition, Wiley India, 2008.
2. Kallenberg O., Foundations of Modern Probability, 2nd Edition, Springer-Verlag,2002. 3. Walsh J., Knowing the Odds: An Introduction to Probability, AMS, 2012.

Code:MAT5019: Queueing Theory Prerequisites: Basic Probability	L	T	P	Credit
	3	2	0	4

Course Category	Elective
Course Type	Theory

Course Objective	To develop the modeling and mathematical skills to analytically determine computer systems and analytically determine computer systems and communication network performance. Students should be able to read and understand the current performance analysis and queueing theory literature upon completion of the course. Understand strengths and weaknesses of Queueing Models
Course Outcome(s)	Construct models in discrete and continuous time based on Markov Chains, describe and explain the theory of Markov Chains, describe and motivate Little's formula and its applications, describe and analyze basic Markov queuing models and situations to which they may be applied apply Markov models for selected applications.

Syllabus:

Probability and random variable, discrete and continuous, univariate and multivariate distributions, moments, law of large numbers and central limit theorem (without proof). Poisson process, birth and death process, infinite and finite queueing models M/M/1, M/M/C, M/G/1, M/M/1/N, M/E/1, E/M/1, M/G/1/N, GI/M/1, and more complex non-Markovian queueing models - GI/G/1 queues, Multiserver Queues: M/M/c, M/G/c, GI/M/c modles, Erlang's loss system, Queues with finite populations: M/M/1/N/K, M/G/1/N/K etc. models and Engset formula, Concept bulk queues: M[X]/M/1, M/M[Y]/1, M/M(a, b)/1, M[X]/G/1, GI[X]/M/1, M/G(a, b)/1, GI/M(a, b)/1 etc. queueing models. Priority queueing models, Vacation queueing models, Network of queues, finite processor sharing models, central server model of multiprogramming, performance evaluation of systems using queueing models. Concepts of bottleneck and system saturation point. Introduction to discrete time queues and its applications.

Text books:

1. Gross D. and Harris C. M., Fundamentals of Queueing Theory, Wiley, 2012.

References:

1. Kleinrock L., Queueing Systems Volume 1 : Theory, Wiley, 2013 .
2. Kleinrock L., Computer Applications, Volume 2, Queueing Systems, Wiley, 2013.

Code:MAT5020: Stochastic Models and Applications Prerequisites: Basic Probability	L	T	P	Credit
	3	2	0	4