

Course Code	Course Name	PROBABILITY AND QUEUEING THEORY		Course Category	U	Basic Sciences							
18MAE204T						L	T	P	C				
Pre-requisite Courses	18MA102T	Co-requisite Courses	Nil	Progressive Courses	Nil	3	1	0	4				
Course Offering Department	Mathematics	Data Book / Codes/Standards											

Course Learning Rationale (CLR):				The purpose of learning this course is to:		
CLR-1 :	Apply and evaluating probability using random variables	1	2	3	Learning	
CLR-2 :	Gain the knowledge and acquire the application of distribution to find the probability using Theoretical distributions					
CLR-3 :	To Assess the appropriate model and apply and solving any realistic problem situation to determine the probability					
CLR-4 :	To interpret the decision using Markov queueing applications					
CLR-5 :	To construct chain of decisions from the past situations using Monovians					
CLR-6 :	Interpret random variables and Queueing theory in engineering problems.					
Course Learning Outcomes (CLO):		At the end of this course, learners will be able to:				
CLO-1 :	Solving problems on Discrete and Continuous Random variables	3	85	80	Level of Thinking (Bloom)	
CLO-2 :	Identifying Distribution and solving the problems in Discrete and Continuous Distribution	3	85	80	Expected Proficiency (%)	
CLO-3 :	Decision Models using sampling techniques in Large and Small samples	3	85	80	Expected Attainment (%)	
CLO-4 :	Solving Queueing problems using Kendall's notation	3	85	80		
CLO-5 :	To Evaluate the probability in uncertain situations using Markov chain rule	3	85	80		
CLO-6 :	Solving and analyzing the problems in random variables and Queueing theory.	3	85	80		
		1	2	3		Program Learning Outcomes (PLO)
	Engineering Knowledge	M	H	L		
	Problem Analysis	M	H	L		
	Design & Development	M	H	L		
	Analysis, Design, Research	M	H	L		
	Modern Tool Usage	M	H	L		
	Society & Culture	M	H	L		
	Environment & Sustainability	M	H	L		
	Ethics	M	H	L		
	Individual & Team Work	M	H	L		
	Communication	M	H	L		
	Project Mgt. & Finance	M	H	L		
	Life Long Learning	M	H	L		
	PSO - 1	M	H	L		
	PSO - 2	M	H	L		
	PSO - 3	M	H	L		

Duration (hour)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
S-1	Probability Basic concepts and Axioms	Discrete Probability distribution	Sampling distribution, Null Hypothesis, Alternate Hypothesis	Introduction to F-test	Markov Process and Introduction of a Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain	Markov Chain
S-1	Conditional probability, Multiplication theorem	Introduction to Binomial distribution	One tailed test, two tailed test	Problems on F-test	Past and Future - Step and State	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability	One step Transition Probability
S-2	Discrete and continuous Random variables	MGF, Mean, Variance of Binomial distribution	Level of significance	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit	Chi square test - Goodness of fit
S-3	Probability mass function, cdf	Applications of Binomial distribution	Large samples test	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit
S-4	Continuous Random variables	Fit a Binomial distribution	Student - t test	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit
S-5	pdf and cdf applications	Introduction to Poisson Distribution	Two Sample proportions	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit	Problems on Chi square test - Goodness of fit
S-6	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13	Problem solving using tutorial sheet 13
S-7	Expectation and Variance	MGF, Mean, Variance of Poisson distribution	Large sample test- Single Mean	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-8	Problems on Expectation and Variance	Applications of Poisson Distribution	Difference of Means	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-9	MGF, Mean, Variance of Poisson distribution	Fit a Poisson Distribution	Problems on difference of Means	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-10	Moment Generating Function	Fit a Poisson Distribution	Problems on difference of Means	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-11	Problems on MGF	Introduction, MGF Mean, Variance of Geometric distribution	Applications of Difference of Means	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-12	Functions of Random variables	Applications of Geometric Distribution problems on Memory less property	Introduction to small samples	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation
S-13	Problems on Functions of Random variable	Introduction, MGF Mean Variance of Uniform Distribution	Introduction to small Samples	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation	Introduction to Queueing Theory and Applications, Kendall, notation

S-8	SLO-1 SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	SLO-1 SLO-2	Theory of Chebyshev inequality	Applications of Uniform Distribution problems	Problems on single mean - small samples	Single Server Model with Finite System Capacity. Characteristics of the Model (M/M/1), (K/FIFO)	Problems on Classification-State-stationary using Markov Chain
S-10	SLO-1 SLO-2	Introduction to theoretical distribution	Introduction, MSE, Mean Variance of Exponential distribution	Problems on single mean - small samples	Effective arrival rate	Problems on Stationary and steady state
S-11	SLO-1 SLO-2	Formula and application of Chebyshev inequality	Applications of Normal distribution problems	Problems on difference of mean-small samples	Problems on Model (M/M/1), (K/FIFO)	Problems on Ergodicity using Markov Chain
S-12	SLO-1 SLO-2	Applications of Chebyshev inequality	Introduction to Normal distribution	Problems on difference of mean-small samples	Problems on Model (M/M/1), (K/FIFO)	Problems on Ergodicity using Markov Chain
	SLO-1 SLO-2	Applications of Chebyshev inequality	Applications of Normal distribution problems	Problems on paired - t test	Problems on Model (M/M/1), (K/FIFO)	Problems on Ergodic and Non Ergodic Using Markov chains
	SLO-1 SLO-2	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-1 SLO-2	Applications of random variables in engineering	Applications of distribution to find the probability using Theoretical distributions	Applications of solving any realistic problem situation to determine the probability	Applications of Queueing decision models	Applications of constructing chain of decisions from the past situations using Markovians

Learning Resources	1. Veerarajan T. Probability, Statistics and Random Processes, Tata Mc Graw Hill, 1st Edition 2004 2. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, 9th ed., Sultan Chand & Sons, 1999 3. Gross, D and Hami, C.M. Fundamentals of Queueing theory, John Wiley and Sons, 1983	4. Trivedi K.S. Probability and Statistics with reliability, Queueing and Computer Science Applications, Prentice Hall of India, New Delhi, 1984 5. Allen A.O., Probability Statistics and Queueing theory, Academic Press
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Learning Assessment		Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA-1 (10%)		CLA-2 (15%)		CLA-3 (15%)		CLA-4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	30%	-	30%	-	30%	-
Total		100%		100%		100%		100%		100%	

CLA-4 can be from any combination of these assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.

Course Designers					
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts		
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