

25UMAT301	PROBABILITY, RANDOM PROCESSES AND NUMERICAL TECHNIQUES	Category	L	T	P	R	Credit	Year of Introduction
		BSC	3	0	0	0	3	2025

Preamble:

This course introduces students to the modern theory of probability and random processes, covering important models of random variables and analysis of random processes. A brief course in numerical techniques familiarises students with some basic numerical techniques which are especially useful when analytical solutions are hard to find.

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Explain the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	K3 Apply
CO2	Explain the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	K3 Apply
CO3	Demonstrate random processes using autocorrelation, power spectrum and Poisson process model as appropriate.	K3 Apply
CO4	Compute roots of equations, find the value definite integrals and perform interpolation on given numerical data using standard numerical techniques	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	-	-	-	-	-	-	1
CO2	3	2	2	2	-	-	-	-	-	-	1
CO3	3	2	2	2	-	-	-	-	-	-	1
CO4	3	2	2	2	-	-	-	-	-	-	1
Avg	3	2	2	2	-	-	-	-	-	-	1

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*			*	
CO2	*	*	*	*	*			*	
CO3	*	*	*	*	*			*	
CO4	*	*	*	*	*			*	

Wks mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*			*	

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 hrs

Continuous Internal Evaluation Pattern:

Attendance	: 5 marks
Continuous Assessment Test	: 20 marks
Continuous Assessment Assignment	: 15 marks

SYLLABUS

Module 1 (11 hrs)

Discrete random variables and their probability distributions, Expectation, mean and Variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables).

(Text-1: Relevant topics from sections-3.1-3.4, 3.6, 5.1)

Module 2 (11 hrs)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables), i. i. d random variables and Central limit theorem (without proof).

(Text-1: Relevant topics from sections-4.1-4.4, 3.6, 5.1)

Module 3 (10 hrs)

Random processes and classification, mean and autocorrelation, wide sense stationary (WSS) processes, autocorrelation and power spectral density of WSS processes and their properties, Poisson

process-distribution of inter-arrival times, combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes (results without proof).
(Text-2: Relevant topics from sections-8.1-8.5, 8.7, 10.5)

Module 4 (10hrs)

Solution of equations – Newton-Raphson method and Regula- Falsi method. Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)
(Text 3- Relevant topics from sections 19.1, 19.2, 19.3, 19.5)

Text Books:

- Devore, J. L. (2012). *Probability and statistics for engineering and the sciences* (8th ed.). Cengage Learning.
2. Ibe, O. C. (2005). *Fundamentals of applied probability and random processes*. Elsevier.
3. Kreyszig, E. (2016). *Advanced engineering mathematics* (10th ed.). John Wiley & Sons.

Reference Books:

- 1.Hossein Pishro-Nik. (2014). Introduction to Probability, Statistics and Random Processes. Kappa Research. <http://www.probabilitycourse.com>
2. V. Sundarapandian. (2009). Probability, Statistics and Queuing Theory. PHI Learning.
3. John A. Gubner. (2006). Probability and Random Processes for Electrical and Computer Engineers. Cambridge University Press.
4. B. S. Grewal. (2010). Higher Engineering Mathematics (36th ed.). Khanna Publishers.

END SEMESTER EXAMINATION–MODEL QUESTION PAPER STC (2025 SCHEME)

CourseCode	25UMAT301
Course Name	PROBABILITY, RANDOM PROCESSES AND NUMERICAL TECHNIQUES
Max.Marks:60	Duration:2.5Hours

Part A (Answer all questions. Each question carries 3 marks)				
Qn No.	Question	Marks	CO	BL
1	The probability that there will be 0, 1, 2, 3 defective light bulbs in a randomly selected batch of bulbs produced in a factory are 0.6, 0.3, 0.08, 0.02 respectively. Find the mean and variance of the number of defective bulbs in a randomly selected batch	3	1	L3
2	Determine the binomial distribution for which mean is 24 and variance is 6.	3	1	L2
3	The cumulative distribution function of a continuous random variable X is defined by:	3	2	L2

	$F(x) = \begin{cases} 0, & x \leq 2 \\ k(x-2), & 2 < x < 6 \\ 1, & x \geq 6 \end{cases}$. Find (i) the value of k. (ii) $P(X > 4)$			
4	A continuous random variable X is uniformly distributed over $[-4, 6]$. Find the mean and variance of X.	3	2	L3
5	State any three properties of autocorrelation function.	3	3	L2
6	Find the power spectral density of the WSS power process with autocorrelation function $2e^{-\frac{1}{2}\tau} \cos \frac{\tau}{2} + 4e^{-\frac{1}{2}\tau} \sin \frac{\tau}{2}$	3	3	L3
7	Find an approximate root of the equation $x^3 - 2x - 5 = 0$ using Regula Falsi method.	3	4	L2
8	Evaluate $\int_0^{\frac{\pi}{2}} \cos x \, dx$ using trapezoidal rule in 6 sub intervals.	3	4	L2

Part B

(Answer any one full question from each Module. Each carry 9 marks)

Module I

Qn No.	Question	Marks	CO	BL																				
9a	A Random variable X has the following probability distribution function	5	1	L3																				
	<table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr><tr><td>f(x)</td><td>a</td><td>3a</td><td>5a</td><td>7a</td><td>9a</td><td>11a</td><td>13a</td><td>15a</td><td>17a</td></tr></table>				x	0	1	2	3	4	5	6	7	8	f(x)	a	3a	5a	7a	9a	11a	13a	15a	17a
	x				0	1	2	3	4	5	6	7	8											
	f(x)				a	3a	5a	7a	9a	11a	13a	15a	17a											
Determine (i) the value of ‘a’ (ii) P(X < 3) (iii)P(X ≥ 3) (iv)P(0 < X < 5)																								
b	Show that Poisson distribution is the limiting case of Binomial distribution as $n \rightarrow \infty$, $p \rightarrow 0$.	4	1	L2																				

OR

10a	The joint probability mass function of two random variables X and Y is given by $P(x, y) = k(x+4y), x=1, 2, 3; y=1, 2$ where k is a constant. 1) Find the value of k. 2) Find the marginal distribution functions of X and Y. 3) Are X and Y independent?	4	1	L2
b	The monthly breakdown of a computer is a random variable having Poisson distribution with a mean equal to 1.8. Find the probability that this computer will function for a month (1) without a break down (2) with at least one break down.	5	1	L3

Module II

Qn No.	Question	Marks	CO	BL
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11a	In an examination, 30% of the students got marks below 40 and 10% got marks above 75. Assuming the marks are normally distributed, find the mean and standard deviation of the distribution.	5	2	L3
b	Let X be a random variable with probability density function $f(x) = \begin{cases} cx^2 & \text{if } 0 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases}$ 1) Find the constant c. 2). Find E(X) and V(X).	4	2	L2
OR				
12a	The joint probability distribution function of two continuous random variable X and Y is: $f(x, y) = \begin{cases} 8xy & 0 < y < x < 1 \\ 0 & \text{otherwise} \end{cases}$. Check whether X and Y are independent.	4	2	L2
b	A distribution with unknown mean μ has variance equal to 1.5. Use Central Limit Theorem to determine how large a sample should be taken from the distribution in order that the probability will be at least 0.95 that the sample mean will be within 0.5 of the population mean.	5	2	L3
Module III				
Qn No.	Question	Marks	CO	BL
13. a	A random process X(t) is defined by $X(t) = 3 \cos(4t + \theta)$, where θ is uniformly distributed in $[0, 2\pi]$. Find the mean, auto correlation and auto covariance.	5	3	L3

13. b	Find the power spectral density function of the WSS process whose autocorrelation function is given by $R_X(\tau) = \frac{a^2}{\tau} \cos(\omega\tau)$	4	3	L2
OR				
14. a	If X(t) is a WSS process with autocorrelation $R_X(\tau) = \frac{\tau^2 + 44}{\tau^2 + 4}$. Find the mean and variance.	5	3	L3
14. b	Prove that sum of two independent Poisson processes is a Poisson process.	4	3	L2
Module IV				
Qn No.	Question	Marks	CO	BL
15. a	Find the positive solution of $2\sin x = x$ starting with $x_0 = 2$ using Newton Raphson's method up to 4 decimal places	4	4	L3
15. b	Using Lagrange's interpolation method to find the polynomial f(x) which agree with the following data: f(1) = 1, f(3) = 27, f(4) = 64. Hence find f(2).	5	4	L3

OR				
16. a	Compare $\int_0^1 \frac{1}{1+x^2} dx$ by using (i) trapezoidal method (ii) Simpson's method with step size $h = 0.25$. Compare the results with exact value obtained by actual integration.	5	4	L3
16. b	Find $y(3)$ Using Newton's divided difference formula, Given $y(1) = -26$, $y(2) = 12$, $y(4) = 256$, $y(6) = 844$.	4	4	L3

