Uka Tarsadia University

B. Tech.

Semester IV

PROBABILITY MODELS
AI4010

EFFECTIVE FROM July-2022

Syllabus version: 1.00

Subject Code	Subject Title	Teaching Scheme			
		Hours		Credits	
		Theory	Practical	Theory	Practical
AI4010	Probability Models	3	2	3	1

Subject Code	Subject Title	Theory Examination Marks		Practical Examination Marks	Total Marks
		Internal	External	CIE	
AI4010	Probability Models	40	60	50	150

Objectives of the course:

- To introduce fundamental concepts of probability theory.
- To demonstrate density and distribution functions with their applications.

Course outcomes:

Upon completion of the course, the student shall be able to,

CO1: Understand the fundamentals of probability theory.
CO2: Understand any apply the random variables.
CO3: Understand and various types of distributions with their significance.
CO4: Apply joint distributions with random vectors and understand conditional distribution.
CO5: Apply joint distributions with conditional expectations understand poisson processes.
CO6: Understand and apply limit theorem.

Sr. No.	Topics	Hours
Unit – I		
1	**Introduction to Probability Theory:** Probability, Samples space and Events, The Axioms of probability, Finite samples spaces and combinatorics, Conditional probability and independence, The law of total probability and Bayes' formula.	6
Unit – II		
2	**Random Variables:** Introduction to random variables, Discrete random variables, Continuous random variables, Expected value and Variance.	8
Unit – III		

3	**Distributions:** Special discrete distributions, The exponential distribution, The normal distribution, The Lognormal distribution, The Gamma distribution, The Cauchy distribution, Location parameters, The failure rate function.	8
Unit – IV		
4	**Joint Distributions – 1:** Introduction to joint distribution, The joint distribution function, Discrete random vectors, Jointly continuous random vectors, Conditional distributions and independence, Functions of random vectors.	8
Unit – V		
5	**Joint Distributions – 2:** Conditional expectations, Covariance and Correlation, The bivariate normal distribution, Multidimensional random vectors, Generating functions, The poisson process.	9
Unit – VI		
6	**Limit Theorems:** Introduction to limit theorem, The law of large numbers, The central limit theorem, Convergence in distribution.	6

Sr. No.	Probability Models (Practicals)	Hours
1	Consider the experiment to toss a coin three times and count the number of heads. Which of the following sample spaces can be used to describe this experiment? (a) S = {H, T } (b) S = {HHH, TTT } (c) S = {0, 1, 2, 3} (d) S = {1, 2, 3} (e) S = {HHH, HHT, HTH, THH, HTT, THT, TTH, TTT }	4
2	Let A, B, and C be three events. Express the following events in terms of A, B, and C: (a) exactly one of the events occurs. (b) None of the events occurs. (c) At least one of the events occurs. (d) All of the events occur.	4
3	The Stanley Cup final is played in best of seven games. Suppose that the good old days are brought back and that the final is played between the Boston Bruins and Montreal Canadians. Let Bk be the event that Boston wins the kth game and describe the following events in terms of the Bk: (a) Boston wins game 1, (b) Boston loses game 1 and wins games 2 and 3, (c) Boston wins the series without losing any games, (d) Boston wins the series with one loss, and (e) Boston wins the first three games and loses the series.	4
4	Choose a number at random from the integers 1,. . . ,100. What is the probability that it is divisible by (a) 2, 3, or 4, (b) i, j, or k?	4

5	You are asked to select a password for a Web site. It must consist of five lowercase letters and two digits in any order. How many possible such passwords are there if (a) repetitions are allowed, and (b) repetitions are not allowed?	4
6	"A thousand monkeys, typing on a thousand typewriters will eventually type the entire works of William Shakespeare" is a statement often heard in one form or another. Suppose that one monkey presses 10 keys at random. What is the probability that he types the word HAMLET if he is (a) allowed to repeat letters, and (b) not allowed to repeat letters?	4
7	An urn contains n white and m black balls. You draw repeatedly at random and without replacement. What is the probability that the first black ball comes in the kth draw, k = 1, 2, . . . , n + 1?	2
8	Ann and Bob shuffle a deck of cards each. Ann wins if she can find a card that has the same position in her deck as in Bob's. What is the (approximate) probability that Ann wins?	4

Text book:

1. Peter Olofsson and Mikael Andersson – "Probability, Statistics and Stochastic Processes" – Wiley Publication, Second Edition.

Reference books:

1. Michael J. Evans and Jeffrey S. Rosenthal – "Probability and Statistics", University of Toronto.
2. Sheldon M. Ross – "Introduction to Probability and Statistics", 3rd Edition, Elsevier Publications.

Course objectives and Course outcomes mapping:

- To introduce fundamental concepts of probability theory: CO1, CO2, CO3, and CO4.
- To demonstrate density and distribution functions with their applications: CO2, CO3, CO5, and CO6.

Course units and Course outcomes mapping:

Unit No.	Unit Name	Course Outcomes					
		CO1	CO2	CO3	CO4	CO5	CO6
1	Introduction to Probability Theory	✓					
2	Random Variables		✓				
3	Distributions			✓			
4	Joint Distributions – 1				✓		
5	Joint Distributions – 2					✓	
6	Limit Theorems						✓

Programme outcomes:

PO 1: Engineering knowledge: An ability to apply knowledge of mathematics, science, and engineering.

PO 2: Problem analysis: An ability to identify, formulates, and solves engineering problems.

PO 3: Design/development of solutions: An ability to design a system, component, or process to meet desired needs within realistic constraints.

PO 4: Conduct investigations of complex problems: An ability to use the techniques, skills, and modern engineering tools necessary for solving engineering problems.

PO 5: Modern tool usage: The broad education and understanding of new engineering techniques necessary to solve engineering problems.

PO 6: The engineer and society: Achieve professional success with an understanding and appreciation of ethical behavior, social responsibility, and diversity, both as individuals and in team environments.

PO 7: Environment and sustainability: Articulate a comprehensive world view that integrates diverse approaches to sustainability.

PO 8: Ethics: Identify and demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work.

PO 9: Individual and team work: An ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give/receive clear instructions.

PO 11: Project management and finance: An ability to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: A recognition of the need for, and an ability to engage in life-long learning.

Programme outcomes and Course outcomes mapping:

Programme Outcomes	Course Outcomes					
	CO1	CO2	CO3	CO4	CO5	CO6
PO1	✓					

PO2	✓					
PO3	✓					
PO4				✓	✓	✓
PO5				✓	✓	
PO6						
PO7						
PO8						
PO9						
PO10						
PO11				✓	✓	
PO12	✓	✓				