Semester: 3				
Programme: Data Science				
Course: Probability Theory and Applications				
Paper code: C2DS250321T			**Credits: 4**	
Hours/week: 4				
Category: Core/MDC/SEC/VAC: Core				
Theory / Practical / Composite: Theory				
No of Modules: 1				
Course Outcome:				
1. **Remember** the fundamental principles of combinatorics, set theory, and the various definitions of probability, including classical, statistical, and axiomatic approaches				
2. **Understand** the conceptual framework of random variables, probability mass/density functions, and cumulative distribution functions, along with the properties of moment generating functions				
3. **Apply** core probability theorems, such as Bayes' Theorem and the theorem of total probability, and the properties of standard univariate discrete and continuous distributions to solve real-world problems.				
4. **Analyze** the relationships between bivariate random variables by determining joint, marginal, and conditional distributions and assessing correlation and linear regression parameters.				
5. **Evaluate** the appropriateness of using specific probability distributions and inequalities, such as Markov and Chebyshev, to model complex datasets and inform decision-making processes.				
6. **Create** comprehensive probabilistic models for multivariate scenarios by synthesizing concepts of independence, univariate distributions, and bivariate normal properties to predict outcomes in real-life applications				
SYLLABUS				
UNIT	**CONTENT**	**HOURS or NUMBER OF CLASSES**	**CO Mapping**	**COGNITIVE LEVEL**
1.	Permutation and combination. Sets and Venn diagrams. Random experiment, outcomes, sample space, events. Classical, statistical and axiomatic definitions of probability. Subjective probability.	**10**	**CO1**	**K1**
2.	Poincare's theorem. Boole's and Bonferroni's inequality (applications). Probability of occurrence of at least m and exactly m events out of n events, n (n>m) being finite. Conditional Probability, multiplication law of probability, theorem of total probability. Bayes	**16**	**CO3**	**K3**

	theorem and its applications. Independence and conditional independence. Real world applications of Probability.			
3.	Definition and illustrations of random variables. PMF, PDF, CDF (graphs and properties). Empirical distribution function. Moments and quantiles. Moment generating functions. Markov and Chebyshev's inequality.	**6**	**CO2, CO5**	**K2, K5**
4.	Uniform, Hypergeometric, Binomial, Poisson, Negative Binomial, Geometric distributions (genesis, properties and applications).	**6**	**CO3, CO6**	**K3, K6**
5.	Rectangular, Exponential, Gamma, Beta, Normal, Log normal, Cauchy, Pareto, Logistic, Double exponential, Pareto distributions (genesis, properties and applications).	**6**	**CO3, CO5, CO6**	**K3, K5, K6**
6.	Bivariate random vector. Mean, dispersion and correlation matrix. Distribution function, conditional & marginal distributions. Concept of bivariate copula. Independence of random variables. Bivariate normal distribution and its properties. Ideas of correlation and linear regression.	**8**	**CO4, CO6**	**K4, K6**

Text Books

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Ross, S. (2018): A First Course in Probability, 9^{th} Edition, Pearson.
3. Bertsekas, D.P. & Tsitsiklis, J.N. (2008): Introduction to Probability, 2^{nd} Athena Scientific. Nashua, NH.
4. K.L. Chung: Elementary Probability Theory with Stochastic Process.

Web Resources

1. https://www.coursera.org/learn/introductiontoprobability
2. https://www.udemy.com/topic/statistics/

Evaluation	CIA: 30 Semester exam: 70 Total: 100	

Paper Structure for Theory Semester Exam Module:	Short Questions (5 Marks each)	Long Questions (15 Marks each)
	5 out of 7	3 out of 5

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	**Remember** the fundamental principles of combinatorics, set theory, and the various definitions of probability, including classical, statistical, and axiomatic approaches	K1
CO2	**Understand** the conceptual framework of random variables, probability mass/density functions, and cumulative distribution functions, along with the properties of moment generating functions	K2
CO3	**Apply** core probability theorems, such as Bayes' Theorem and the theorem of total probability, and the properties of standard univariate discrete and continuous distributions to solve real-world problems.	K3
CO4	**Analyze** the relationships between bivariate random variables by determining joint, marginal, and conditional distributions and assessing correlation and linear regression parameters.	K4
CO5	**Evaluate** the appropriateness of using specific probability distributions and inequalities, such as Markov and Chebyshev, to model complex datasets and inform decision-making processes.	K5
CO6	**Create** comprehensive probabilistic models for multivariate scenarios by synthesizing concepts of independence, univariate distributions, and bivariate normal properties to predict outcomes in real-life applications	K6