A. Course Handout

Institute/School/College Name	Chitkara University Institute of Engineering & Technology		
Department/Centre Name	Department of Computer Science & Engineering		
Programme Name	Bachelor of Engineering- Computer Science & Engineering (Artificial Intelligence)		
Course Name	Applied Probability and Random Process	**Session**	2024-25
Course Code	22AS019	**Semester/Batch**	4th/2023
Lecture/Tutorial (Per Week)	4-0-0	**Course Credit**	4
Course Coordinator Name	Dr. Manpreet Kaur		

1. Objectives of the Course

The course offers a broad range of learning and understanding of the subject, the main objectives of the course are:

- To provide the knowledge of random variables including sum of random variables, various probability distributions, and functions of random variables.
- To impart the knowledge about variance and covariance of random variables, generating functions, system of gambling, and central limit theorem with applications.
- To make the student understand and apply the concept of random processes, characterizations, sum processes, counting process, and Poisson processes.
- To teach about the reliability and its failure rate, mean time to failure, mean time between failure, and some system configuration related to reliability.
- To make the student understand and apply the concept of stochastic processes, Markov chain, Markov processes, and basics of Queuing theory.

2. Course Learning Outcomes

At the end of the course, students will be able to:

	Course Outcomes	POs	CL	KC	Sessions
CLO01	To understand the concept of random variables including sum of random variables, various probability distributions, and functions of random variables	PO1, PO2, PO3,PO4,PO11, PO12	K2	Factual Conceptual	**15**
CLO02	To interpret variance and covariance of random variables, generating functions, system of gambling, and central limit theorem with applications.	PO1, PO2, PO3,PO4,PO11, PO12	K3	Fundamental Conceptual	**14**
CLO03	To apply the concept of random processes, their characterizations, sum processes, counting process, and Poisson processes in real life problems.	PO1, PO2, PO3,PO4,PO11, PO12	K3	Conceptual Procedural	**22**
CLO04	To interpret reliability and its failure rate, mean time to failure, mean time between failure, and some system configuration related to reliability and to apply the concept of stochastic processes, Markov chain, Markov processes, and basics of Queuing theory in real life problems	PO1, PO2, PO3,PO4,PO11, PO12	K3	Conceptual Procedural	**9**
Total Contact Hours					60

CLO-PO Mapping grid |Program outcomes (POs) are available as a part of Academic Program Guide

Course Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO01	M	H									M	M		M	M
CLO02	M	H		M							M	M		M	
CLO03	M	H		M							M	M	H		
CLO04	H	H	M	M	H	M					M	M		M	H

3. ERISE Grid Mapping

Feature Enablement	Level(1-5, 5 being highest)
Entrepreneurship	2
Research	4
Innovation	3
Skills	5
Employability	4

4. Recommended Books:

B01: M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Academic Press, Elsevier.

B02: B. V. Ramana, Higher Engineering Mathematics, 6th Edition, Tata McGraw-Hill Education.

B03: A. Papoulis, S. U. Pillai, Probability, Random Variables, and Stochastic Processes, 4th Edition, Tata McGraw -Hill Education.

B04: J. Medhi, Stochastic Processes, 3rd Edition, New Age International Publishers.

B05: L. S. Srinath, Reliability Engineering, 3rd Edition, East-West Press Private Limited.

B06: W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Edition, John Wiley and Sons.

B07: R. V. Hogg, J.W. McKean, A. T. Craig, Introduction to Mathematical Statistic, 8th Edition, Pearson.

5. Other readings & relevant websites

S.No.	Link of Journals, Magazines, websites and Research Papers
1.	Probability, Statistics & Random Processes | Free Textbook | Course (probabilitycourse.com)
2.	Markov process | mathematics | Britannica
3.	Stochastic Processes - an overview | Science Direct Topics
4.	https://tinyurl.com/2rxe9mtd
5.	https://tinyurl.com/y7c2nmx7

6. Course Plan

Lecture Number	Topics	Recommended Books
1-2	**Prerequisite:** Review of mathematical probability: sample spaces; events; independence; conditional probability, the law of total probability, and Bayes' theorem. Probability distributions: binomial, poisson, and normal distributions.	B01
3-4	Random variables: Types of random variables, sum of random variables (discrete and continuous).	B01
5-6	Jointly distributed random variables, independent random variables, and conditional distributions.	B01
7-9	Discrete uniform distributions, exponential distributions, and continuous uniform distributions with applications.	B01
FA-1		
10-12	Function of one, two, and *n* random variables.	B02
13-14	Expectation: definition and properties of the expected value, expected values of sums of random variables with applications.	B02
15-17	Covariance functions and their properties, variance and covariance of sum of random variables	B02
18-20	Moment generating function and joint moment generating function.	B02
ST-1		
21-24	Characteristic function, joint characteristic function, chebyshev's and markov inequality, and the law of large numbers (strong and weak).	B03
25-26	Convergence concept in sequence of random variables.	B03
27-30	The idea and applications of the central limit theorem. System of gambling and the Borel-Cantelli lemma (statement only).	B03
31-34	Random processes: stationarity and ergodicity. Strict sense and wide sense stationary processes. Characterization and classification of a random process.	B03
35-38	Discrete-time processes: sum process, binomial counting process. Poisson and some of associated random processes.	B03
39-42	Introduction and definition of Reliability. Failure data analysis, mean failure rate, mean time to failure (MTTF).	B03
ST-2		
43-46	Mean time between failure (MTBF), reliability in terms of hazard rate and failure density.	B03
47-50	Stochastic processes, Stationarity and Ergodicity.	B04
51-53	Random walks and Markov chains, Probability vectors, Stochastic matrices, Fixed points and regular stochastic matrices.	B04
54-55	Higher transition probabilities and the Chapman-Kolomogrov equation.	B04
FA-2		
56-58	Classification of states, stationary distribution and limiting probabilities, transition states and absorption probabilities.	B04
59-60	Markov processes and basics of queuing theory including networks in queues.	B04
ST-3		

END TERM	

7. Delivery/Instructional Resources

Session Number	Topics	PPT *(link of ppts on the central server)*	Web References	Audio-Video
1-2	**Prerequisite:** Review of mathematical probability: sample spaces; events; independence; conditional probability, the law of total probability, and Bayes' theorem. Probability distributions: binomial, poisson, and normal distributions.	https://tinyurl.com/y979n7x6	https://tinyurl.com/yr5a25ub	https://tinyurl.com/39k79um5
3-4	Random variables: Types of random variables, sum of random variables (discrete and continuous).	https://tinyurl.com/35cspdk4	https://tinyurl.com/244h7wau	https://tinyurl.com/yc5hwdre
5-6	Jointly distributed random variables, independent random variables, and conditional distributions.		https://tinyurl.com/2p8eymaj	
7-9	Discrete uniform distributions, exponential distributions, and continuous uniform distributions with applications.	https://tinyurl.com/3236c5xd	https://tinyurl.com/7dycmy9c	https://tinyurl.com/5b3sbafm
10-12	Function of one, two, and *n* random variables.	https://tinyurl.com/38rsvavb		https://tinyurl.com/3tx4nxne
13-14	Expectation: definition and properties of the expected value, expected values of sums of random variables with applications.	https://tinyurl.com/ycy3ahsj	https://tinyurl.com/2sh7znnj	https://tinyurl.com/4c2pjywz
15-17	Covariance functions and their properties, variance and covariance of sum of random variables	https://tinyurl.com/5f8ud54e		
18-20	Moment generating function and joint moment generating function.	https://tinyurl.com/2nzk7kch	https://tinyurl.com/2nj8kjsa	https://tinyurl.com/73vzuudy

21-24	Characteristic function, joint characteristic function, chebyshev's and markov inequality, and the law of large numbers (strong and weak).		https://tinyurl.com/2s3s7w6w	
25-26	Convergence concepts.			https://tinyurl.com/2p9e2zzp
27-30	The idea and applications of the central limit theorem. System of gambling and the borel-cantelli lemma (statement only).	https://tinyurl.com/53sekm9y	https://tinyurl.com/34kw47vd	https://tinyurl.com/ycyrwuf4
31-34	Random processes: stationarity and ergodicity. Strict sense and wide sense stationary processes. Characterization and classification of a random process.	https://tinyurl.com/j3naytwr	https://tinyurl.com/2s4bas92	https://tinyurl.com/4zcvmkn4
35-38	Discrete-time processes: sum process, binomial counting process. Poisson and some of associated random processes.	https://tinyurl.com/yc8h6tem	https://tinyurl.com/ms6nsy9k	https://youtu.be/3z-M6sbGIZ0
39-42	Introduction and definition of Reliability. Failure data analysis, mean failure rate, mean time to failure (MTTF).	https://tinyurl.com/49xktnkp	https://tinyurl.com/3vsb532n	https://tinyurl.com/2harjtmf
43-46	Mean time between failure (MTBF), reliability in terms of hazard rate and failure density.		https://tinyurl.com/yc6htk2e	https://tinyurl.com/yc8kb42y
47-50	Stochastic processes, Stationarity and ergodicity.	https://tinyurl.com/5ydbudwf	https://tinyurl.com/muhp4vrj	https://tinyurl.com/yx5xaw4z
51-53	Random walks and Markov chains, probability vectors, stochastic matrices, fixed points and regular stochastic matrices.		https://tinyurl.com/bddnxuus	
54-55	Higher transition probabilities and the Chapman-Kolomogrov equation.	https://tinyurl.com/bdfzhbkj	https://tinyurl.com/2b2vtrys	https://tinyurl.com/ms9wzfkk
56-58	Classification of states, stationary distribution and limiting probabilities, transition states and absorption probabilities.	https://tinyurl.com/yvezywpb	https://tinyurl.com/2p8vtfaj	

59-60	Markov processes and basics of queuing theory including networks in queues.	https://tinyurl.com/yc8ck6jf	https://tinyurl.com/87vrwtma	https://tinyurl.com/4dbjfy6w

8. Action plan for different types of learners

Slow Learners	Average Learners	Fast Learners
Multiple Remedial Extra Classes Encouragement for improvement using Peer Tutoring	Doubt-sessions Pre-coded algorithms to illustrate concepts and notions E-notes and E-exercises to read in addition to pedagogic material	More Practice assignments on real life problems Engaging students to hold hands of slow learners by creating a Peer Tutoring Group Participation in Hackathons, competitions.

9. Evaluation Scheme & Components

Evaluation Component	Type of Component	No. of Assessments	Weightage of Component	Mode of Assessment
Component 1	Formative assessment	FA1	10%	Offline
Component 2	Sessional Tests(STs)	ST1	30%	Online
		ST2	30%	Online
	End Term Examination	01	60%	Offline
Total		100%		

10. Details of Evaluation Components

Evaluation Component		Description	Syllabus Covered	Timeline of Examination	Weightage (%)
Component 1		FA1	Upto 15%	Week 5	10%
Component 2		ST1	Upto 40%	Week 6	30%
		ST2	41- 80%	Week 13	30%
		End Term Examination*	100%		60%
Total		100%			

*As per Academic Guidelines minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

Evaluation Components

Type of Assessment	Timeline of Conduct	Total Marks	Question Paper Format			
			1 Marks	2 Marks	5 Marks	10 Marks
Formative Assessment-I	Week 5	10			2	
Sessional Test 1	Week 6	30	10	5		
Sessional Test 2	Week 18	30	10	5		
End Term Examination		60	10	5	4	2

11. Syllabus of the Course

Subject: Applied Probability and Random Process	**Subject Code: 22AI019**

Lecture NO.	Topic (s)	No. of Lectures	Weightage %
1-9	**Prerequisite:** Review of mathematical probability: sample spaces, events, independence, conditional probability, the law of total probability, and Bayes' theorem. Probability distributions: binomial, poisson, and normal distributions. Random variables: Types of random variables, sum of random variables (discrete and continuous). Jointly distributed random variables, independent random variables, and conditional distributions. Discrete uniform distributions, exponential distributions, and continuous uniform distributions with applications.	9	11
10-20	Function of one, two, and *n* random variables. Expectation: definition and properties of the expected value, expected values of sums of random variables with applications. Covariance functions and their properties, variance and covariance of sum of random variables. Moment generating function and joint moment generating function.	11	20
21-46	Characteristic function, joint characteristic function, Chebyshev's and Markov inequality, and the law of large numbers (strong and weak). Convergence concepts. The idea and applications of the central limit theorem. System of gambling and the Borel-Cantelli lemma (statement only). Random processes: stationarity and ergodicity. Strict sense and wide sense stationary processes. Characterization and	26	49

	classification of a random process. Discrete-time processes: sum process, binomial counting process. Poisson and some of associated random processes. Introduction and definition of reliability. Failure data analysis, mean failure rate, mean time to failure (MTTF). Mean time between failure (MTBF), reliability in terms of hazard rate and failure density.		
47-60	Stochastic processes, stationarity and ergodicity. Random walks and markov chains, probability vectors, stochastic matrices, fixed points and regular stochastic matrices. Higher transition probabilities and the Chapman-Kolomogrov equation. Classification of states, stationary distribution and limiting probabilities, transition states and absorption probabilities. Markov processes and basics of queuing theory including networks in queues.	14	20

This document is approved by

Designation	**Name**	**Signature**
Course Coordinator	Ms. Manpreet Kaur	
Program Head	Dr Reetu Malhotra	
Dean	Dr Mohit Kumar Kakkar	
Date (DD/MM/YYYY)		