MS8944: PROBABILITY AND MARKOV CHAIN MODELS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Probability and Markov Chain Models

Subject Code
MS - Decision Analytics and Operations
Course Number
8944

Academic Unit
Decision Analytics and Operations (DAOS)

College/School
College of Business (CB)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This advanced course aims to equip PhD students with a deep understanding of the theoretical foundations and practical applications of stochastic modeling and analysis. The curriculum will focus on the core topics of Markov chains and queuing systems, providing a solid grounding in the mathematical and statistical principles underpinning these stochastic processes. Through the use of two seminal textbooks, students will explore the formulation and solution of probability models, with an emphasis on their relevance to operations management and other real-world contexts. The course will delve into the properties and behavior of Markov chains, including stationary distributions, transient analysis, and the application of these concepts to various problem domains. Additionally, students will learn about queuing theory and its analytical techniques for modeling and optimizing service systems. By the end of the program, students will possess the knowledge and skills necessary to conduct advanced research, develop innovative stochastic models, and tackle challenging problems in their respective fields of study.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Demonstrate familiarity with the fundamental definitions, concepts, and principles in the field of stochastic modeling and processes		x		
2	Analyze and apply key theoretical results and properties of stochastic processes, particularly Markov chains, to solve problems			x	
3	Evaluate the behavior and performance of basic stochastic systems, such as queuing models, and interpret the analytical findings			x	
4	Synthesize the course concepts and techniques to develop probability models that address operations management-related applications and challenges				x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Interactive lecture	Students will actively participate in interactive lectures and small-group discussions to develop a comprehensive understanding of the fundamental concepts, analytical techniques, and practical applications in the field of stochastic modeling and processes, with a focus on Markov chains and queuing systems.	1, 2, 3, 4	3 hours/week
2	Homework and case study	Students will complete assigned homework, problem sets, and case study analyses to reinforce the theoretical knowledge, apply the course concepts to real-world operations management challenges, and engage in independent research and collaborative problem-solving with peers.	1, 2, 3, 4	3 hours/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Homework assignments	1, 2, 3	30	
2	Mid-term test	1, 2, 3	30	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task

Homework assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

ABILITY to APPLY the methodology and knowledge to solve problems

Excellent

(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Mid-term test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
EVIDENCEof knowledge of subject matter and capability to formulate, analyze the fundamental probability models and their applications

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
EVIDENCEof knowledge of subject matter and capability to formulate, analyze the fundamental probability models and their applications

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal

(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Homework assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
ABILITYtoAPPLYthe methodology and knowledge to solve problems

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Notevenreaching marginal levels

Assessment Task
Mid-term test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
EVIDENCE of knowledge of subject matter and capability to formulate, analyze the fundamental probability models and their applications

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Notevenreaching marginal levels

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
EVIDENCE of knowledge of subject matter and capability to formulate, analyze the fundamental probability models and their applications

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Notevenreaching marginal levels

Part III Other Information

Keyword Syllabus

- Random variables, expectation, moment generating functions, limit theorem, conditional probability, conditional expectation
- Markov chains, Poisson process, birth-death process, uniformization
- Renewal reward processes,
- Queuing theory: networks of queues, M/M/1, M/G/1, M/M/k queues
- Simulation
- Other applications in operations management

Reading List

Compulsory Readings

	Title
1	Introduction to Probability Models, Academic Press, Tenth Edition Author: Sheldon M. Ross ISBN-10: 0123756863 ISBN-13: 978-0123756862
2	Modeling and Analysis of Stochastic Systems. Chapman & Hall, 2020.3rd Edition (Author: Vidyadhar G. Kulkarni).ISBN 9780367736798

Additional Readings

	Title
1	Nil.