هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA

2024
TP-153

Course Specification
(Bachelor)

Course Title:	**Introduction to Stochastic Processes**
Course Code:	**STA 1354**
Program:	**Bachelor of Science in Applied Statistics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**2 October 2024**

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
3 (2 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐University	☐College	☒ Program	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (.....)					
Level 6 / Year 3					
4. Course General Description:					
This course provides students with a foundational understanding of stochastic processes and their applications in various fields. This course explores the mathematical framework for modeling random phenomena that evolve over time, an essential aspect of applied statistics. Students will learn about key concepts such as Markov chains, Poisson processes, and queuing systems, emphasizing their theoretical underpinnings and practical applications. The curriculum includes both discrete and continuous-time processes, enabling students to analyze and interpret real-world scenarios where uncertainty and randomness play significant roles.					
5. Pre-requirements for this course (if any):					
STA 1203					
6. Co-requisites for this course (if any):					
None					
7. Course Main Objective(s):					
• To provide students with a solid foundation in the fundamental concepts of stochastic processes, including key definitions, types, and properties. • To equip students with the skills to apply theoretical principles of stochastic processes to real-world problems across various fields, such as finance, engineering, and telecommunications. • To provide hands-on experience with simulation techniques for studying stochastic processes, enabling students to visualize and understand complex behaviors. • To foster analytical skills that allow students to critically evaluate and interpret the results of stochastic models in practical applications. • To instill an understanding of the ethical implications of using stochastic models, emphasizing the importance of transparency and integrity in statistical modeling.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom		

No	Mode of Instruction	Contact Hours	Percentage
	• E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	30
2.	Laboratory/Studio	0
3.	Field	0
4.	Tutorial	30
5.	Others (specify)	0
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	To describe the basics of stochastic modeling of real-world systems related to the physical sciences, computer science, and (possibly) finance.	K1, K2	Lectures, problem solving, Classroom discussions	Direct: Regular Exams, Assignments, Practical exam
1.2	To define exponential distribution to model arrival times, the Poisson process, and outline its application to continuous time Markov chains	K1, K2	Lectures, problem solving, Classroom discussions	Direct: Regular Exams, Lab Assignments, Practical exam
1.3	To state the concept of conditional probability, Markov chain, Branching process, Poisson process, and Birth and Death process.	K1, K3	Lectures, problem solving, Classroom discussions	Direct: Regular Exams, Assignments, Practical exam
2.0	Skills			
2.1	To use probability and matrix theory to solve stochastic models.	S1, S2	Lecturing, Interactive learning.	Direct: Assignments, Practical exam
2.2	To evaluate stochastic process problems mathematically and using software.	S1, S2, S5	Use of statistical software, Lecturing, Interactive learning.	Direct: Lab Exam, Assignments, Min project, Practical exam
2.3	To assess how sensitive stochastic models are to changes that might occur in model variables.	S2, S3, S4	Lecturing, Interactive learning.	Direct: Assignments, Practical exam

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.4	To interpret and explain the solution for a stochastic process application.	S3, S4	Lecturing, Interactive learning, Use of statistical software.	Direct: Assignments, Practical exam, Lab Assignments.
3.0	**Values, autonomy, and responsibility**			
3.1	To appply stochastic modeling techniques autonomously to solve real-world problems.	V1, V2	Interactive learning, Group interaction, Problem solving.	Direct: Practical exam, Assignments, Mini-projects
3.2	To reflect on the societal implications of stochastic processes and their applications.	V1, V3	Group interaction, Problem solving.	Direct: Assignments, Mini-projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Basic probability:** Random variable, Limit Theorems, Stochastic Processes.	**7**
2.	**Conditional Probability and Conditional Expectation:** Introduction, The Discrete Case, The Continuous Case, Computing Expectations by Conditioning, Computing Probabilities by Conditioning, Some Applications, An Identity for Compound Random Variables.	**12**
3.	**Markov Chains:** Introduction, Chapman–Kolmogorov Equations, Classification of States, Limiting Probabilities, Some Applications, Mean Time Spent in Transient States, Branching Processes, Time Reversible Markov Chains, Markov Chain Monte Carlo Methods, Markov Decision Processes, Hidden Markov Chains.	**13**
4.	**The Exponential Distribution and the Poisson Process:** Introduction, The Exponential Distribution, The Poisson Process, Generalizations of the Poisson Process.	**10**
5.	**Continuous-Time Markov Chains:** Introduction, Continuous-Time Markov Chains, Birth and Death Processes, The Transition Probability Function $P_{ij}(t)$, Limiting Probabilities.	**9**
6.	**Renewal Theory and its Applications:** Introduction. Distribution of $N(t)$. Limit Theorems and Their Applications. Renewal Reward Processes. Regenerative Processes. Semi-Markov Processes. The Inspection Paradox. Computing the Renewal Function. Applications to Patterns. The Insurance Ruin Problem.	**9**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Homeworks, Quizzes, Mini-projects**	**During the term**	**10%**
2.	**First Midterm**	**Week 5-6**	**25%**

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
3.	Second Midterm	Week 10-11	25%
4.	Final Exam	Week 16-17	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• ***Introduction to Probability Models,*** S. Ross, 11th Edition, Academic Press, 2014. ISBN: 9780123756862 (Main Reference). • ***Introduction to Stochastic Processes With R,*** Robert P. Dobrow, John Wiley & Sons, Inc, 2016. (Main Reference)
Supportive References	1. ***An Introduction to Stochastic Modeling,*** M. A. Pinsky and S. Karlin, 4th Edition, Academic Press Elsevier, 2011. 2. ***Introduction to Probability,*** D. Bertsekas and J. Tsitsiklis, 2nd Edition; Athena Scientific, 2008. 3. ***Fundamentals of Probability with Stochastic Processes,*** 3rd Edition; Saeed Ghahramani, Prentice Hall, 2004.
Electronic Materials	Course Website: Learning Management Systems (Blackboard)
Other Learning Materials	None

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology equipment (projector, smart board, software)	The rooms should be equipped with data show and Smart Board. All computers should be equipped with the following software: ▪ Microsoft Excel ▪ IBM SPSS ▪ R-Project ▪ MATLAB
Other equipment (depending on the nature of the specialty)	See the Attached File

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Student and teaching staff	Surveys and Questionnaires
Effectiveness of	Course Coordinator	Peer Reviews

Assessment Areas/Issues	Assessor	Assessment Methods
Students assessment		
Quality of learning resources	**Students and teaching staff**	**Classroom Observations**
The extent to which CLOs have been achieved	**Student Representatives**	**Student Performance Evaluations (exams, projects) CLOs Excel sheet.**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL**
REFERENCE NO.	**8/1446**
DATE	**(08/10/2024) 05/04/1446**