Course Specification

(Postgraduate Programs)

Course Title: Probability Theory	
Course Code:	**MAT 7101**
Program:	**Doctor of Philosophy in Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**None**

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
4 (4 Lectures, 0 Lab, 0 Tutorial)					
2. Course type					
A.	☐ University	☐ College	☒ Program	☐ Track	☐ Others
B.	☒ Required		☐ Elective		
3. Level/Year at which this course is offered: Level 2 / Year 1					
4. Course general Description:					
The course covers the basic principles of the measure-theoretic probability theory. Topics include the axioms of probability, random variables and vectors, independence of events and variables; modes of probabilistic convergence, laws of large numbers; characteristic functions, the central limit theorem, conditional probability and expectation, introduction to martingales.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The objective of this course is first to understand general concepts in measure-theoretic probability theory: random variable, independence, and different type of convergence, laws of large numbers, and the Central Limit Theorem. As application, limit theorems are used to approximate probabilities of average and sums of independent identically-distributed random variables. Finally the conditional expectation with respect to a sigma-field is introduced and applied to martingales.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning	0	0%
3	Hybrid • Traditional classroom • E-learning	0	0%
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	60

2.	Laboratory/Studio	0
3.	Field	0
4.	Tutorial	0
5.	Others (specify)	0
Total		60

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

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	To list the different types of convergences, the laws of large numbers, and the central limit theorem.	K1, K2	4 lecture hours\week	Direct: Regular Exams
1.2	To reproduce the notions of conditional expectation and martingale	K1, K2	• 4 lecture hours\week • Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	To develop techniques of proof in probability theory.	S1, S2	Self-study	Direct: Participations Short Quizzes
2.2	To develop oral communication and technical writing skills through random variables.	S3	Real-life problems	Direct: Homework and Mini projects
2.3	To use Internet in searching for different types of modes of convergences.	S4	Real-life problems	Direct: Short Quizzes
2.4	To write out deep proofs in applications of Central Limit Theorem.	S1, S2	Self-study	Direct: Participations

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.0	Values, autonomy, and responsibility			
3.1	To execute assignments and homework with independence and responsibility.	V1, V3	Personal questions	Direct: Participation
3.2	To cooperate with team works.	V1, V2	Teamwork and class discussions.	Direct: Homework and Mini projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Foundations of Probability:** Probability Space and Random Variables, Distribution Function of a Random variable, Random Elements, Vectors and Joint Distributions, Expectation and Moments, Inequalities for Moments and Probabilities.	12
2.	**Independence:** Independent Events and Classes, Independent Random Elements, Independent Random Variables, Addition of Independent Random variables, Borel–Cantelli Lemma and zero-one Law.	12
3.	**Convergence and Related Topics:** Modes of Probabilistic Convergence: Almost Sure Convergence, Convergence in Probability, Convergence in Order Mean, Convergence in Distribution, Relationships Between Forms of Convergence, Series of Independent Random Variables, Laws of Large Numbers.	12
4.	**Characteristic Functions and Central Limit Theorem:** Definition and Simple Properties, Characteristic Function and Moments, Inversion and Uniqueness, Continuity Theorem for Characteristic Functions, Some Applications (Central Limit Theorem).	12
5.	**Conditioning and Martingales:** Conditional Expectation Given a Sigma-Field, Conditional Probability Given a Sigma-Field, Definition and Basic Properties of Martingales	12
	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 semester	30%
2.	Midterm	Week 9-10	30%

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
3.	Final Exam	Week 15-16	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	**R. Leadbetter et al.,** *A Basic Course in Measure and Probability, Theory for Applications*, Cambridge University Press 2014. **(Main Reference)**
Supportive References	• **R G. Tucker,** A Graduate Course in Probability, Probability and Mathematical Statistics, Dover publications, 2014. • **E. Cınlar,** Probability and Stochastics, Graduate Texts in Mathematics, 261, Springer, 2011.
Electronic Materials	None
Other Learning Materials	None

2. Educational and Research Facilities and Equipment Required:

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.
Other equipment (depending on the nature of the specialty)	None

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	During the semester and at the end of the course each student will complete two evaluation forms.
Effectiveness of Students assessment	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that

Assessment Areas/Issues	Assessor	Assessment Methods
		need to be made if necessary.
Quality of learning resources	Students	During the semester and at the end of the course each student will complete two evaluation forms.
The extent to which CLOs have been achieved	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Other	None	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

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