Course Specification

(Postgraduate Programs)

Course Title:	Stochastic Differential Equations
Course Code:	MAT 7203
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 3 / Year 2					
4. Course general Description:					
The course covers the basic principles of the theory of stochastic differential equations. Topics include the stochastic calculus on Brownian motion, the construction of the Ito integral, the Ito formula, and the integral calculus. Moreover, the concept of stochastic differential equation is introduced, some uniqueness and existence results are proved, and some solvability methods are given.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The aim of this course is first to use the stochastic calculus on Brownian motion and understand the concept of the Ito integral and the Ito isometry in one and many dimension. The Ito formula is used to obtain explicit integral calculus and then to solve the martingale representation theorem. The concept of stochastic differential equations is presented and the solvability of some classical examples is considered.					

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 outline the concept of Ito integral and computation methods using the Brownian motion and the Ito isometry.	K1, K2	4 lecture hours\week	Direct: Regular Exams
1.2	To record some examples of stochastic differential equations and their solutions.	K1, K2	• 4 lecture hours\week • Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	To develop techniques of proof in Brownian Motion.	S1, S2	Self-study	Direct: • Participations • Short Quizzes
2.2	To develop oral communication and technical writing skills through study of stochastic integrals.	S3	Real-life problems	Direct: Homework and Mini projects
2.3	To use Internet in searching for Ito formula,	S4	Real-life problems	Direct: Short Quizzes
2.4	To demonstrate deep proofs in stochastic	S1, S2	Self-study	Direct: Participations

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	differential equations.			
3.0	**Values, autonomy, and responsibility**			
3.1	**To work with responsibility and independence.**	**V1, V3**	**Personal questions**	**Direct: Participation**
3.2	**To work with cooperation and collaboration in team groups.**	**V1, V2**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content

No	List of Topics	Contact Hours
1.	**Brownian Motion:** Basics on Probability Theory, Introduction to Continuous-Time Stochastic Process, Definition of Brownian Motion, Stochastic Calculus on Brownian Motion.	**15**
2.	**Stochastic Integrals:** Construction of the Ito Integral, Ito Isometry, Properties of the Ito Integral, Extension of the Ito Integral, Multi-Dimensional Ito Integral, Comparison with Stratonovich Integrals.	**15**
3.	**Ito Formula:** One Dimensional Ito Formula, Ito Process, Integral Calculus, Multi-Dimensional Ito Formula, The Martingale Representation Theorem.	**15**
4.	**Introduction to Stochastic Differential Equations:** Definition and Elementary Examples, Existence and Uniqueness Result, Weak and Strong Solution, Resolution Methods.	**15**
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%**
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	**B. Oksendal,** *Stochastic Differential Equations,* 6th Edition, Springer-Verlag, 2006. **(Main Reference)**
Supportive References	1. **H.H. Kuo,** Introduction to Stochastic Integration, Springer-Verlag 2006. 2. **P.E. Kloeden and E. Platen,** Numerical Solutions of Stochastic Differential Equations, Springer-Verlag, 2013.
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 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,**

Assessment Areas/Issues	Assessor	Assessment Methods
		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)