Course Specification

(Postgraduate Programs)

Course Title:	Random Dynamical Systems
Course Code:	MAT 7205
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 random dynamical systems. Topics include infinite dimensional Dynamical Systems (DS) on probability spaces, Metric Dynamical Systems, Cocycles over a DS, Random Dynamical Systems (RDS), fundamental examples of RDS and invariant measures for RDS.					
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 to use the translation shift and the Wiener shift as metric dynamical systems to understand the concept of random dynamical system as a cocycle over a dynamical system. It is also concerned with the analysis of different types of random dynamical systems. Understanding the concepts of invariant measure and random fixed point for a random dynamical system is a very important issue of this course.					

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 define the concept of cocycle over a metric dynamical system given by translation and Wiener shifts.**	**K1, K2**	**4 lecture hours\week**	**Direct: Regular Exams**
1.2	**To record the concept of random dynamical systems and the associated invariant measures.**	**K1, K2**	• **4 lecture hours\week** • **Self-study**	**Direct: Short Quizzes**
2.0	**Skills**			
2.1	**To develop techniques of proof in measurable and dynamical systems.**	**S1, S2**	**Self-study**	**Direct:** • **Participations** • **Short Quizzes**
2.2	**To develop oral communication and technical writing skills through random differential equations.**	**S3**	**Real-life problems**	**Direct: Homework and Mini projects**
2.3	**To use Internet in searching for invariant measures.**	**S4**	**Real-life problems**	**Direct: Short Quizzes**
2.4	**To carry out deep proofs in factorization of measures.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.1	**To work independently.**	**V1, V3**	**Personal questions**	**Direct: Participation**
3.2	**To collaborate and work in team works.**	**V1, V2**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content

No	List of Topics	Contact Hours
1.	**Measurable Dynamical Systems (DS):** Definition, Measure Preserving DS, Stochastic Processes and DS, DS Defined by the Translation Shift, Wiener DS.	**15**
2.	**Random Dynamical Systems (RDS):** Cocycle over a DS, Measurable RDS, Continuous RDS, Smooth RDS, Linear RDS, Two-sided Time RDS, Perfection of a Crude Cocycle.	**15**
3.	**Fundamental Examples of RDS:** Discrete Time RDS, Random Iteration, Continuous Time RDS 1, Random Differential Equations, Continuous Time RDS 2, Stochastic Differential Equations.	**15**
4.	**Invariant Measures for RDS:** Skew Product Defined By a RDS, Factorization of Measures, Invariance in Terms of Factorization, Invariant Product Measure, Random Fixed Points, Invariant Measures for Continuous RDS.	**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	**L. Arnold,** *Random Dynamical Systems*; Springer-Verlag, 1998. **(Main Reference)**
Supportive References	• **R. Bhattacharya and M. Majumdar,** Random Dynamical Systems: Theory and Applications, Cambridge Univ. Press, 2007. • **A. Swischuk and S. Islam,** Random Dynamical System in

	Finance, CRC Press, Taylor and Francis Group, 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, 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)