هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAA
2024
TPG-153

Course Specification

(Postgraduate Programs)

Course Title:	**Finite Markov Chains and Applications**
Course Code:	**MAT 6249**
Program:	**Master of Science in Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**1446/04/05 (08/10/2024)**

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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	
B.	☐Required		☒ Elective		
3. Level/year at which this course is offered: Level 3-4 / Year 2					
4. Course General Description:					
This course describes the most important ideas, theoretical results, and applications in Finite state Markov Chains. The course includes the essential fundamentals of finite Markov chains, Markov property, Transition matrix, Steady states, recurrences and ergodicity, long-run behavior, discrete time renewal theory. Moreover some examples from biology, social science, electrical engineering, information science…. will be considered through the course.					
5. Pre-requirements for this course (if any):					
None					
6. Pre-requirements for this course (if any):					
None					
7. Course Main Objective(s):					
The main purpose of this course is to provide the student with the elementary concepts and theorems in Finite Markov Chains and their applications in real life.					

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**	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 write the main properties of discrete-time Markov chains.**	**K1, K2**	**2 lecture hours\week**	**Direct: Regular Exams**
1.2	**To list relevant properties of finite Markov chains and their applications in the real life.**	**K1, K2**	**• 2 tutorial hours\week Self-study**	**Direct: Short Quizzes**
2.0	**Skills**			
2.1	**To develop techniques of proof for homogeneous finite Markov chains.**	**S1, S2**	**Self-study**	**Direct: • Participations Short Quizzes**
2.2	**To develop oral communication and technical writing skills through transience, recurrence, and ergodicity.**	**S4**	**Real-life problems**	**Direct: Homework and Mini projects**
2.3	**To use Internet in searching for of discrete-time renewal processes.**	**S3**	**Real-life problems**	**Direct: Short Quizzes**
2.4	**To show out deep and not short proofs for Perron-Frobenius theorem.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			
3.1	**To work individually.**	**V1, V2**	**Personal questions**	**Direct: Participation**
3.2	**To work in groups.**	**V1, V3**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content:

No	List of Topics	Contact Hours
1.	**Basics on Probability:** Review on probability, random variables, independence, conditional probability, expectation, conditional expectation, generating function, characteristic function, random vector, change of variable, convergence, law of large number.	**13**
2.	**Discrete-time Markov chains:** Markov property, homogeneous Markov chain, transition matrix, Markov recurrence, topology of transition matrix, steady state, regeneration.	**13**
3.	**Recurrence and Ergodicity:** Recurrence and transience states, a criterion of recurrence, structure of the transition matrix, invariant measure, a positive recurrent criterion, the ergodic theorem, the renewal reward theorem.	**13**
4.	**Long-Run Behavior:** Coupling, convergence to steady state, the positive recurrent case, the null recurrent case, convergence rate via coupling, the Perron-Frobenius theorem, quasi-stationary distributions, Dobrushin's ergodic coefficient.	**11**
5.	**Discrete-time Renewal Theory:** The renewal process, the renewal equation, the renewal theorem, regenerative processes, renewal equation for regenerative process, regenerative theorem.	**10**
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 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	**P. Bremaud,** Markov Chains; Second Edition, Springer 2020. **(Main Reference)**
Supportive References	• **J. G. Kemeny, J. L. Snell,** Finite Markov Chains, Springer 1976. • **E. Seneta,** Nonnegative matrices and Markov Chains, Springer 2006. • **A. S. Poznyak, K. Najim, E. Gomez-Ramirez,** Self-Learning Control of Finite Markov Chains, Marcel Dekker, Inc. 2000
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 are 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	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

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