Course Specification

(Postgraduate Programs)

Course Title:	**Ordinary Differential Equations and Dynamical Systems**
Course Code:	**MAT 7233**
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:					
This course deals with the mathematical structure of differential equations. It covers the abstract theory of ordinary differential equations aiming at understanding some mathematical models. More precisely it deals with the study of well-posedness, existence of solution(s), and uniqueness. Of particular interest is to know how to find and/or compute solutions and to provide methods of solvability. The theory is extended to linear systems of differential equations as well as to Hamiltonian systems. Finally a qualitative study is given with regards to the questions of stability and behavior of solutions. Methods such as Lyapunov Direct method are employed to identify, analyze, and interpret the asymptotic behavior of solutions.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
This course provides a deep exposition of the theory of ordinary differential equations (ODEs) and systems of ODEs. It strongly focuses on theoretical, analytical techniques, and their applications. The interests of this course include existence, uniqueness, stability, and behavior of linear and nonlinear ODEs as well as systems of ODEs. This course could form the basis for further courses on partial differential equations, dynamical systems, bifurcation theory, mathematical modeling, and related topics.					

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	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 name the fundamentals of the operator and spectral theories.	K1, K2	4 lecture hours\week	Direct: Regular Exams
1.2	To describe the weak topology and weak and weak* convergence.	K1, K2	• 4 lecture hours\week • Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	To develop techniques of proof in differential inequalities.	S1, S2	Self-study	Direct: • Participations • Short Quizzes
2.2	To develop oral communication and technical writing skills through existence theory in ODEs.	S4	Real-life problems	Direct: Homework and Mini projects
2.3	To use Internet in searching for examples of systems of ODEs.	S3	Real-life problems	Direct: Short Quizzes
2.4	To carry out deep short proofs in dynamical systems.	S1, S2	Self-study	Direct: Participations
3.0	Values, autonomy, and responsibility			
3.1	To execute his class duties with independence and responsibility.	V1, V2	Personal questions	Direct: Participation
3.2	To lead team works.	V1, V3	Teamwork and class discussions.	Direct: Homework and Mini projects

C. Course Content

No	List of Topics	Contact Hours
1.	Ordinary differential equations: Grownwall's inequality, existence of solutions via Picard–Lindelöf theorem and Cauchy-Peano theorem; global properties of solutions; Analytic differential equations and dependence on initial conditions and parameters; examples of non-uniqueness; the Kneser theorem; Solution curves, maximal and minimal solutions; comparison theorem; sufficient conditions for uniqueness..	20
2.	Systems of ODEs: Fundamental solutions, matrix exponent, solutions of linear systems with constant coefficients; linear systems with periodic coefficients; Floquet's theorem; linear Hamiltonian systems.	20
3.	Dynamical Systems: Stability of dynamical systems, Lyapunov functions, stability of linear and perturbed linear systems, Lyapunov's direct method, asymptotic behavior and stability, stability of periodic orbits, Poincare-Bendixon Theorem.	20
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	• P. Hasieh & Y. Sibuya, Basic *Theory of Ordinary Differential Equations*. Universitext. *Springer-Verlag, New York,* 1999 (Main reference) • L. Perko, Differential Equations and Dynamical Systems; Texts in Applied Mathematics, vol. 7, Springer, 3rd Edition, 2001. • M.W. Hirsch, S. Smale, and R.L. Devaney, Differential Equations, Dynamical Systems, and Introduction to Chaos; Academic Press, Elsevier, 3rd Edition, 2013. • A. Coddington & N. Levinson, Theory of Ordinary Differential Equation. McGraw-Hill, 1984.

Supportive References	1. W. Water, Ordinary Differential Equations, Graduate Texts in Mathematics, Springer-Verlag, New York, 1998. 2. L. Perko, Differential Equations and Dynamical Systems; Texts in Applied Mathematics, vol. 7, Springer, 3rd Edition, 2001. 3. M.W. Hirsch, S. Smale, and R.L. Devaney, Differential Equations, Dynamical Systems, and Introduction to Chaos; Academic Press, Elsevier, 3rd Edition, 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

Assessment Areas/Issues	Assessor	Assessment Methods
		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)