Course Specification

(Postgraduate Programs)

Course Title:	**Ordinary Differential Equations**
Course Code:	**MAT 6233**
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)**

Table of Contents

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	☐Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: Level 3-4 / Year 2					
4. Course general Description:					
This course deals with the mathematical structure of differential equations rather than applications and mathematical modeling. Nevertheless, the course covers the rigorous, abstract theory of ordinary differential equations aiming at understanding mathematical models and make "real-world predictions" described by differential equations; it deals with the study well-posed Ness, existence of solution(s), and uniqueness. Next, once a model is well-posed, it is of interest to know how to find and/or compute its solution and to provide a straightforward way in the study of differential equations through a package of theorems like Picard–Lindelöf theorem, Cauchy-Peano Theorem, and Knesser Theorem. This investigation is extended to linear systems of differential equations as well as to Hamiltonian systems. Also, a qualitative study is needed with regards to the questions of stability and behavior of possible 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 is an elective course in the master program of mathematics. It provides in depth exposition of the theory of ordinary differential equations (ODEs) and systems and ODEs. It strongly focuses on theoretical, analytical techniques, and their applications. The interests of this module include existence, uniqueness, the stability, and behavior of ODEs and 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	30
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	Identify a solid understanding of the qualitative theory of ODEs and linear systems.	K1, K2	3 lecture hours\week	Direct: Regular Exams
1.2	Describe stability methods used to analyze and interpret the asymptotic behavior of solutions	K1, K2	• 2 tutorial hours\week • Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	Use techniques of proof in the stability of solutions of ODEs.	S1, S2	Self-study	Direct: • Participations • Short Quizzes
2.2	Develop oral communication and technical writing skills through linear systems of differential equations.	S4	Real-life problems	Direct: Homework and Mini projects
2.3	Analyze Internet in searching for Lyapunov's Direct Method for stability.	S3	Real-life problems	Direct: Short Quizzes
2.4	Choose out deep and not short proofs of Picard–Lindelöf, Cauchy-Peano, and Poincare-Bendixon Theorems.	S1, S2	Self-study	Direct: Participations
3.0	Values, autonomy, and responsibility			
3.1	Work with independence and responsibility.	V1, V2	Personal questions	Direct: Participation
3.2	Lead team works.	V1, V3	Teamwork and class discussions.	Direct: Homework and Mini projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Fundamental theory of ordinary differential equations:** Grown wall'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; Kinser's Theorem; Solution curves, maximal and minimal solutions; comparison theorem; sufficient conditions for uniqueness.	**22**
2.	**General Theory of linear systems:** Fundamental solutions, matrix exponent, solutions of linear systems with constant coefficients; linear systems with periodic coefficients; Fouquet's theorem; linear Hamiltonian systems.	**16**
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.	**22**
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	a. **P. Hsieh & Y. Sibuya,** *Basic Theory of ODE*, Springer, 1999 **(Main reference)** b. **L. Perko,** *Differential Equations and Dynamical Systems*; Texts in Applied Mathematics, vol. 7, Springer, 3rd Edition, 2001. c. **M.W. Hirsch, S. Smale, and R.L. Devaney,** *Differential Equations, Dynamical Systems, and Introduction to Chaos*; Academic Press, Elsevier, 3rd Edition, 2013 d. **Brauer, J. Nohel,** *The Qualitative Theory of ODE*, An Introduction, Dover Publications, 1989. • **Walter,** *Ordinary Differential Equations*, Graduate Texts in Mathematics, Springer-Verlag, New York, 1998.
Supportive References	1. **K. Schmitt, R. Thompson,** *Nonlinear Analysis and Differential Equations*, 2004.

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	1446/04/05 (08/10/2024)