Course Specification

(Postgraduate Programs)

Course Title:	**Numerical Methods for Differential Equations**
Course Code:	**MAT 6241**
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 is the follow up of MAT 6141 course taught in Master 1. It is the second part of numerical methods devoted to ODEs. In this course, all fundamentals' methods will be exhibited and detailed, for ODEs and for systems of ODEs. Boundary value problems, finite difference will also be considered in this course. Error & convergence analysis will be analyzed. Moreover, MATLAB software will be used as support for implementation of numerical methods.				
5. Pre-requirements for this course (if any):				
MAT 6141.				
6. Pre-requirements for this course (if any):				
None.				
7. Course Main Objective(s):				
The course purpose is • To give an overview of different numerical methods for solving Ordinary differential equations; • To compare the various methods by studying their convergence, consistency and stability; • To deal numerically with different type of Differential equations (IVPs, BVPs, systems of ODEs); • To develop student's skills in the implementation of numerical methods.				

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 list different numerical schemes for solving ordinary differential equations.	K1, K2	2 lecture hours\week	Regular Exams
1.2	Outline the analysis of convergence, stability, and consistency	K1, K2	• 2 tutorial hours\week • Self-study	Assignments Short Quizzes
2.0	**Skills**			
2.1	To develop techniques of proof for ordinary differential equations.	S1, S2	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for Euler schemes and implicit methods.	S4	Self-study	Participations
2.3	To use Internet in searching for Taylor and Runge-Kutta methods.	S3	Deep problems	Short Quizzes
2.4	To evaluate out deep and not short proofs for convergence analysis and stability.	S1, S2	Self-study	Participations
3.0	**Values, autonomy, and responsibility**			
3.1	Apply personal skills to complete tasks independently	V1, V2	Personal questions	Participation

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.2	Compare, contrast, and integrate different perspectives while producing group work.	V1, V3	Team work	Homework and Mini-projects

C. Course Content:

No	List of Topics	Contact Hours
1.	**Introduction:** Preliminaries. Existence; Uniqueness, and wellposedness; Stability and Asymptotic Stability.	16
2.	**Ordinary Differential Equations (single step method):** Implicit and Explicit Euler schemes, Local and global error, Taylor and Runge-Kutta methods, Error and convergence analysis, stability.	22
3	**Ordinary Differential Equations (multistep method):** Predictor corrector methods; Implicit Methods and Stiff Equations; Convergence, Stability and Consistency of these methods.	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 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	1. **J.D. Lambert,** *Numerical Methods for Ordinary Differential Systems, The Initial Value Problem, John Wiley and Sons, 1997* **J.C. Butcher,** *Numerical Methods for Ordinary Differential Equations, John Wiley and Sons, 2008*
Supportive References	*a)* **A. Stanoyevitch,** *Introduction to Numerical Ordinary and Partial Differential Equations Using MATLAB, Wiley 2005.* **b) L. F. Shampine, I. Gladwell, and S. Thompson**, *Solving ODEs with Matlab;* **Cambridge University Press.** *c)* **A. Gilat, V. Subramaniam**; *"Numerical Methods for Engineers and Scientists, An Introduction with Applications using MATLAB".*

	d) **D.F. Griffiths, Desmond J. Higham,** *Numerical Methods for Ordinary Differential Equations, Initial Value Problems, Springer, 2010.* • **S. Ahmad , A. Ambrosetti,** *A Textbook on Ordinary Differential Equations, Springer 2014.*
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**	**Direct:** Questionnaire.
	Course Responsible	**Direct:** Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Indirect: Second examiner checklist-Course report.	**Direct :** Questionnaire. **Indirect :** Eternal assessoral report.
Effectiveness of students' assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Quality of learning resources	Students	**Indirect:** Second examiner checklist-Course report.
	Faculty (Academic Advisory-GCC)	**Direct:** course Entrance/Exit. **Indirect:** Observations - Accreditation review.
	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.
	Course Responsible	
The extent to which CLOs have been achieved	Course Responsible	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.

Assessment Areas/Issues	Assessor	Assessment Methods
	Program Leaders	**Indirect:** Exams.
Other		

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)