Department of Mathematics

College of Science

Salahaddin University-Erbil

Subject: Numerical Methods for Differential Equations

Course Book: Fourth year (First Course)

Lecturer's name: Fuad W. Khdhr

Academic Year: 2023-2024

Course Book

1. Course name	Numerical Methods for Differential
2. Lecturer in charge	Fuad Wahid Khdhr
3. Department/ College	Mathematics / Science
4. Contact	e-mail: fuad.khdhr@su.edu.krd Tel: +9647504493156
5. Time (in hours) per week	For example Theory: 2
6. Office hours	
7. Course code	**SMC1 201**
8. Teacher's academic profile	"My name is **Fuad Wahid Khdhr**, I born in Erbil, Iraq in 1981. I graduated from mathematics Department / College of Science in Salahaddin University-Erbil in 2004-2005, in Erbil, Iraq. I got Master of Science in mathematics (Numerical Analysis) in 2010. I got PhD in mathematics (Numerical Analysis) in 2021. I am working as a lecturer in mathematics department / college of science / Salahaddin University-Erbil".
9. Keywords	

10. Course overview:

This course covers numerical techniques for solving differential equations, including both ordinary differential equations (ODEs) and partial differential equations (PDEs). The focus is on the development, analysis, and implementation of these methods, with an emphasis on practical application and accuracy.

Course Objectives:

1. Understand the basic concepts and theory behind numerical methods for differential equations.
2. Learn various numerical techniques for solving ODEs and PDEs.
3. Develop skills in implementing numerical methods using appropriate software tools.
4. Analyze the stability, convergence, and accuracy of numerical solutions.
5. Apply numerical methods to real-world problems in science and engineering.

11. Course objective:

Understand Fundamental Concepts:

Grasp the basic principles and theoretical foundations of numerical methods for solving ordinary and partial differential equations.

Learn Numerical Techniques:

Acquire knowledge of various numerical methods, including Euler's method, Runge-Kutta methods, multistep methods for ODEs, and finite difference, finite element, and spectral methods for PDEs.

Develop Implementation Skills:

Gain proficiency in implementing numerical algorithms using programming languages and software tools such as MATLAB and Python.

Analyze Numerical Solutions:

Develop the ability to analyze the stability, convergence, and accuracy of numerical methods and their solutions.

Apply Methods to Real-World Problems:

Apply numerical methods to model and solve practical problems in science, engineering, and other fields, understanding the significance and limitations of numerical solutions.

Handle Advanced Numerical Challenges:

Explore advanced topics such as adaptive methods, multigrid techniques, and high-performance computing, preparing for complex and large-scale problem-solving.

Conduct Verification and Validation:

Learn to verify and validate numerical solutions to ensure their correctness and reliability in practical applications.

Communicate Technical Information:

Develop skills to effectively communicate numerical results and methodologies through reports and presentations.

12. Student's obligation

- **a.** Students must come on time and remain in the classroom for the duration of scheduled classes and Labs.
- **b.** Students own an obligation to write tests and final examinations at the times scheduled by the teacher or the College.

13. Forms of teaching

I give hard copy of My lecture notes to students before coming lecturer time. first I remember students about previous lecture, and then I start new lecture. At the end of the lecture give a homework for the next lecture. During this proses I am use presentation and whiteboard.

14. Assessment scheme

1. ***Toturial:*** 15% Toturial and quizzes.
2. ***Theoretical:*** 25% (Midterm exams and other activities).
3. ***Final Exam: Theoretical:*** 40% .

15. Student learning outcome:

By the end of the course, students will be able to:

- **a.** Develop and implement numerical algorithms for solving differential equations.
- **b.** Analyze the performance of numerical methods in terms of accuracy, stability, and efficiency.
- **c.** Apply numerical methods to solve practical problems in engineering, physics, and other sciences.
- **d.** Use software tools to model and solve differential equations numerically.

16. Course Reading List and References:

[1] Numerical Methods for Ordinary Differential Equations" by J.C. Butcher .
[2] Finite Difference Methods for Ordinary and Partial Differential Equations" by R.J. LeVeque.
[3] An Introduction to Numerical Methods and Analysis" by J.F. Epperson

17. The Topics:	Lecturer's name

First Course **Chapter One: Introduction to Differential Equations:** Euler's Method Runge-Kutta Methods Multistep Methods (Adams-Bashforth, Adams-Moulton) Stability and Convergence Analysis Stiff Equations and Implicit Methods **Chapter Two Numerical Methods for PDEs:** Finite Difference Methods Finite Element Methods Spectral Methods Stability and Convergence Analysis Applications in Heat Equation, Wave Equation, and Laplace's Equation **Chapter Three: Advanced Topics:** Adaptive Methods Multigrid Methods Numerical Linear Algebra Techniques High-Performance Computing for Large-Scale Problems	14 week (3 hours)

18. Examinations:

Questions in the examination will be arranged the matching mode by way of the examples and exercises that I give delivered in the lecture notes.
Sometimes will be have extra mark in examination for worthy students.

20. Extra notes:

Answers of examination will be find in the board's declaration mathematics department after every examination.