Course Description Form

1. Course Name
Numerical Analysis II
2. Course Code:
MATH315
3. Semester / Year
Second / 2023/2024
4. Description Preparation Date
1ST Feb 2024
5. Available Attendance Forms
Full time attendance
6. Number of Credit Hours (Total) / Number of Units (Total)
75/4
7. Course administrator's name (mention all, if more than one name)
Course leader name: **Dr. Omar Al-Tameemi** Email: omar.ismael@nahrainuniv.edu.iq Tutorial Assistant name: Ass. Lec. **Abbas Ibrahim Khleaf** Lab staff names: **1- Lec. Dr. Ibtisam Kamil** **2- Lec. Raneen zaid** **3- Ass. Lec. Haneen Abdulkareem** **4- Ass. Lec. Nabaa Husain** 5- **Ass. Lec. Batol Imkhelf** **6- Ass. Lec Iman Khalid** 7- **Ass. Lec. Yasemen Moen** 8- **Ass. Lec. Farah Lateef**

8. Course Objectives	
Course Objectives	• Develop appropriate numerical methods to solve a differential equation. • Derive appropriate numerical methods to solve a linear system of equations. • Derive appropriate numerical methods to solve a system of nonlinear equations. • Perform an error analysis for various numerical methods • Code various numerical methods in a modern computer language.

9. Teaching and Learning Strategies

Strategy	Subject content will be presented in a combination of online materials and in the lectures. Lectures will take the form of an interactive session (3 hours per week) where the material is covered in depth. Students are expected to revise the online material before each lecture. Computer labs (2 hours per week) will focus on the practical implementation of numerical methods. Direct feedback will be provided during the computer labs. Further feedback on progress will be provided using the check-in Assignments which are spaced throughout the semester. Students will be encouraged to develop code-sharing practices in the computer labs, and to tackle problems collaboratively, as well as being able to work on solving problems individually. A central aim of this is to prepare students for real-world coding environments, which consist of a mix of collaboration with intense periods of individual work. Real world problems examples will enable the students to tackle an authentic and challenging problem in science or mathematics that can be approached using the methods given in this subject.

10. Course Structure (Theory)

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	3 hrs of lecture +1 hr tutorial	Introduction to Numerical Solution of Ordinary Differential Equations	Introduction to Numerical Solution of Ordinary Differential Equations	Lectures notes, In class presentations, Examples of Practical	Quizzes , Weekly homework, Team and homework problems , Open questions that have

2	3 hrs of lecture +1 hr tutorial		Finite Difference Method	Applications, Tutorial	a definite answer , (Oral questions)
3	3 hrs of lecture +1 hr tutorial		Euler and Modified Euler Methods		
4	3 hrs of lecture +1 hr tutorial		Explicit and Implicit Methods		
5	3 hrs of lecture +1 hr tutorial		Runge-Kutta Method, of 2 and 4 Orders		
6	3 hrs of exam +1 hr tutorial	Midterm exam			
7	3 hrs of lecture +1 hr tutorial	Direct Methods for Solving Linear Systems Iterative Techniques in Matrix Algebra	Linear Systems of Equations, Pivoting Strategies	Lectures notes, In class presentations, Examples of Practical Applications, Tutorial	Quizzes , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
8	3 hrs of lecture +1 hr tutorial		Linear Algebra and Matrix Inversion, The Determinant of a Matrix, Matrix Factorization		
9	3 hrs of lecture +1 hr tutorial		Norms of Vectors and Matrices		
10	3 hrs of exam +1 hr tutorial	Midterm exam			

11	3 hrs of lecture +1 hr tutorial	Direct Methods for Solving Linear Systems Iterative Techniques in Matrix Algebra	Iterative Techniques for Solving Linear Systems: Jacobi Iterative Gauss–Seidel Iterative	Lectures notes, In class presentations, Examples of Practical Applications, Tutorial	Quizzes , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
12	3 hrs of lecture +1 hr tutorial		Error Bounds and Iterative Refinement		
13	3 hrs of lecture +1 hr tutorial	Numerical Solutions of Nonlinear Systems of Equations	Fixed Points for Functions of Several Variables		
14	3 hrs of lecture +1 hr tutorial		Newton's Method		
15	4hrs	Review			

Course Structure (Lab)

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	2 hours of Lab.	Introduction to Numerical Solution of Ordinary Differential Equations	Finite Difference Method	Lab Lectures, Practical Applications, Tutorial	Exams , Weekly homework, Lab quizzes
2	2 hours of Lab.		Euler and Modified Euler Methods		
3	2 hours of Lab.		Taylor Methods		
4	2 hours of Lab.		Explicit and Implicit Methods		
5	2 hours of Lab.		Runge-Kutta Method, of 2 and 4 Orders		

6	2 hours of Lab.	Midterm exam			
7	2 hours of Lab.	Direct Methods for Solving Linear Systems Iterative Techniques in Matrix Algebra	Forward and Backward substitution	Lab Lectures, Practical Applications, Tutorial	Exams , Weekly homework, Lab quizzes
8	2 hours of Lab.		Gauss Elimination		
9	2 hours of Lab.		LU factorization		
10	2 hours of Lab.	Midterm exam			
11	2 hours of Lab.	Direct Methods for Solving Linear Systems Iterative Techniques in Matrix Algebra	Jacobi Iterative Gauss–Seidel Iterative	Lab Lectures, Practical Applications, Tutorial	Exams , Weekly homework, Lab quizzes
12	2 hours of Lab.		Error Bounds and Iterative Refinement		
13	2 hours of Lab.	Numerical Solutions of Nonlinear Systems of Equations	Fixed Points for Functions of Several Variables		
14	2 hours of Lab.		Newton's Method		
15	2hrs	Review			

11. Course Evaluation

Formative assessment 40%: Theory (15% Midterm exams + 10% homework) + 15% lab assessment.
Summative assessment 60%: Theoretical final exam 50% + Lab final exam 10%)

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	Burden, R. L., Faires, J. D., & Burden, A. M. (2015). Numerical analysis. Cengage learning.
Main references (sources)	J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, Springer-Verlag, ISBN 0-387- 90420-4
Recommended books and references (scientific journals, reports…)	C.T. Kelley, Iterative methods for linear and nonlinear equations, Society of Industrial and Applied Mathematics
Electronic References, Websites	