Department of …… Computer Science & IT….

College of ……… Science……….

University of ……Salahaddin…….

Subject: … Numerical Methods…………

Course Book – (Year 2 /Course 2)

Lecturer's name: (Dalya Abdullah Anwer)

Academic Year: 2023/2024

Course Book

1. Course name	**Numerical Analysis**
2. Lecturer in charge	**Dalya Abdullah Anwer**
3. Department/ College	**Computer science/science**
4. Contact	**e-mail:dalya.anwar@su.edu.krd**
5. Time (in hours) per week	**Theory: 2** **Practical: 2**
6. Office hours	**Thursday 10-11 am**
7. Course code	
8. Teacher's academic profile	**- Acquired a BSc from College Computer Science and Mathematics- Department of Mathematic in Mosul University in 2004** **- Graduated with a MSc in Applied Mathematics From the University of Mosul in 2006.** **- I have been working in the Department of Computer Science as an assistant lecturer since 2007.**
9. Keywords	**Errors, Numerical solution of nonlinear equation, Numerical polynomials interpolation, Numerical Derivative & Numerical Integration**

10. Course overview:

Numerical analysis involves the design, analysis, and implementation of approximation methods for various problems. This module introduces the concepts of numerical analysis starting with the Mathematical Preliminaries then presenting the Solution of Equations in One Variable, Interpolation and Polynomial Approximation, The Iterative Methods for Solving Nonlinear of Equations and the Curve Fittings.

This course is offered to undergraduates and introduces students to the formulation, methodology, and techniques for numerical solution of Mathematics problems. Topics covered include: fundamental principles of digital computing , error propagation, the solution of nonlinear equation, roots of nonlinear equations, numerical interpolation, differentiation and integration.

The main goal of the module is to give students a clear understanding and deep knowledge how the typical of "real life" mathematical, physical, or engineering problems are to be solved in the modern setting. As opposed to tendency in lower-level mathematical courses to teach recipes for "exact" solving particular problems fitting into very special form, this module provides the idea of approximate solving wide variety of applied standard problems on a computer by numerical methods.

11. Course objective:

The objective of numerical analysis is to solve complex numerical problems using only the simple operations of arithmetic, to develop and evaluate methods for computing numerical results from given data. The method of computation is called algorithms. An algorithm is a finite sequence of rules for performing computations on a computer such that at each instant

the rules determine exactly what the computer has to do next.

The course will develop numerical methods aided by technology to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integrals. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.

1. **derive appropriate numerical methods to solve algebraic and transcendental equations**
2. **develop appropriate numerical methods to approximate a function**
3. **develop appropriate numerical methods to solve a differential equation**
4. **derive appropriate numerical methods to evaluate a derivative at a value**
5. **perform an error analysis for various numerical methods**
6. **prove results for various numerical root finding methods**
7. **derive appropriate numerical methods to calculate a definite integral**
8. **code various numerical methods in a modern computer language**

12. Student's obligation

Students must attend weekly theoretical and practical lectures.

A report will be expected for the Practical part and solve Homework in theoretic and Practical.

Students must also attend two exams during the course: one theoretical and the other practical.

13. Forms of teaching

- **Weekly handouts will be uploaded online for both theoretical and practical lectures.**
- **A projector will be used in the class, as well as a whiteboard, to convey the necessary Information to students.**

14. Assessment scheme

15 %	**Theory examination**
35%	**Practical examination**
50%	**Final exam**
100 %	**Total**

15. Student learning outcome:

Knowledge and understanding

- Understand how numerical methods presented in the course work for solving various standard mathematical problems in realistic settings.

Cognitive skills (thinking and analysis).

- Select the appropriate algorithm to solve the problem based on criterion of its suitability for present-day computers Interpret correctly machine output and provide a good understanding of the problems of error analysis and convergence of algorithms.

Communication skills (personal and academic).
- Apply effectively numerical algorithms presented in the course based on ready-to-use computer programs. Understand issues of algorithms complexity and programmability.

At the end of the Course Students will be able to

1. **approximate a function using an appropriate numerical method**
2. **solve a differential equation using an appropriate numerical method**
3. **evaluate a derivative at a value using an appropriate numerical method**
4. **perform an error analysis for a given numerical method**
5. **prove results for numerical root finding methods**
6. **calculate a definite integral using an appropriate numerical method**
7. **code a numerical method in a modern computer language.**

16. Course Reading List and References:

1. **Mathews, J. H. and Fink, K. D., (2004): Numerical methods using Matlab.4th edition, Prentice Hall.**
2. **Gerald, C. F. and Wheatley (1984) : Applied numerical Analysis. 3rd edition, Addison-Wesley.**
3. **Any other relevant book, journal, or website.**
4. **In addition to the above, the students will be provided with handouts.**

17. The Topics:	**Lecturer's name/DalyaA.Anwer/(2hrs) for all Topics**
Week 1:Course overview **The module's structure will be explained in this lecture.** **The importance of the module, its objectives andoutcomes will be covered. Plus, a short history of Numerical Analysis will be mentioned.** **Week 2,3:(Errors)** **Introduction to Error define.Errors Measurement,Absolute error.Relative Error.(Errors Cont….) Sources of errors.Error in operation mathematic.** **Week 4,5:(Numerical solution of nonlinear equation)** **Bisection algorithm.solve example.False-position algorithm.Newton-Raphson algorithm.solve example.Secant algorithm ,Solve Example.**	

Week 5,6,7(Numerical polynomials interpolation) Interpolation algorithm,Lagrange algorithm, Solve Example.Newton difference algorithm , Solve Example. **Week 8,9:Curve fitting (least square algorithm), Solve Example.** **Week 10,11:(Numerical Derivative & Numerical Integration) Numerical Derivative(Newton &Lagrange), Solve Example.** **Week 12,13:Numerical Integration Solve Example. Simpson method with examples.Numerical Integration :Trapezoidal method with examples.** **Week 14:Numerical solution of ordinary differential equations: Euler's method.Runge-Kutta method, multi-step methods, etc..** **Week 15:Exam**	
18. Practical Topics	
Week 1: Introduction to matlab program, plot in matlab **Week 2,3: Introduction to matrix in matlab, examples ,m-file in matlab, examples.** **Week 4,5,6: programming,for,if,while with examples,writing program for bisection,false position,newton raphson.** **Week 7,8,9: Polynomial in matlab, polyval,roots,polyder,writing program for Lagrang ,least square.** **Week 10: Forward/Backward Formula, and Lagrange's Formula.** **Week 11,12: Write program for Trapezoidal rule, and Simpson's rule.** **Week 13,14: Write program to Euler's method, Runge-Kutta method, multi-step methods** **Week 15:exam.**	**Lecturer's name** **Dalya. A. Anwar** **(2 hrs)**
19. Examinations: **Fill in the blank with suitable answer:** **1. False position formula method for solve nonlinear equation on interval [a b] is ---------- .** **2.** Newton-Raphson formula for compute √ ____ ---------- **is .** Evaluate I=∫ + with n=4 using trapezoids and Simpsons' rule.	

20. Extra notes:
21. Peer review