Department of Software Engineering

College of Engineering

University of Salahaddin-Erbil

Subject: Numerical Analysis and Probability

Course Book – *Second Year* *Spring Semester*

Kanar Shukr Muhamad, **BSc, MSc in Software Engineering**

Academic Year: 2023/2024

Course Book

1. Course name	**Numerical Analysis**
2. Lecturer in charge	**Kanar Shukr Muhamad**
3. Department/ College	**Software Engineering\Engineering**
4. Contact	**e-mail: kanar.muhamad@su.edu.krd**
5. Time (in hours) per week	**Theory: 2** **Practical: 2**
6. Office hours	**Are stated in the time table**
7. Course code	
8. Teacher's academic profile	Kanar Shukr Muhamad Lecturer at Software and Informatics Engineering Department College of Engineering – Salahaddine University Hawler – Kurdistan **Current**: Data Structures and Algorithms (2nd year), **Past:** Programming Algorithms (1st Year), Programming Principles (1st Year), Procedural Programming (1st year), Digital Design (1st year), Data Structures and Algorithms (2nd year), Object Oriented Programming (2nd year) , Numerical Analysis and Probability(2nd year), Engineering Analysis (3rd year) and Data Security (4th year). **Education:** BSc of Software Engineering – college of Engineering – Salahaddine University (2005) MSc of Software Engineering – college of Engineering – Salahaddine University (2009) https://academics.su.edu.krd/kanar.muhamad/
9. Keywords	**Numerical Analysis, Numerical Methods**

10. Course overview:

Numerical Analysis is a method for mathematical problem to be formulated as numerical structure so that it can be easily solved using computer programming. The methods include the most important mathematical formulas, such as, non-linear equation, set of linear equations, differential equation, Integration, …etc.

11. Course objective:

- Utilize the computer to solve engineering problems
- being familiar with some numerical methods (approximation of functions, solution of nonlinear equations, approximate determination of a derivative and an integration solution of differential equations) which are suitable for modelling various problems of practice.
- Fundamental knowledge from the probability theory (random event, probability, characteristics of random variable).
- Determine errors present in numerical solutions to engineering problems
- Integrate programming and numerical methods to solve complex engineering problems

12. Student's obligation

- Commitment to the Class and schedule.
- Cheating is prohibited and the student will be awarded zero.
- In case there is an assignment, deadline date must be aced. No delay will be accepted.

13. Forms of teaching

A compilation of lecture slides is provided in the class and will form the core of the course. However, additional materials may offer during the presentation of the course such as software, tutorials and websites.

14. Assessment scheme

The following grade system is used for the evaluation of the module exam:

The module exam is based on the summation of two categories of evaluations:

First: (50%) of the mark is based on the academic semester effort which includes

- Normal Exams- practical Exams- Quizzes- Activities- Reports- HomeWorks- Assignments.

Second: (50%) of the mark is based on final examination that is comprehensive for the

whole of the study materials reviewed during the academic semester.

Note:

There will be randomly quizzes. Each quiz will be given at the beginning of the class period and covers materials covered in the previous lectures.

15. Student learning outcome:

Upon completion of this course, students will be able to solve engineering problems using scientific programming techniques (algorithm development and implementation). Specific problems that students are expected to formulate and solve include:

- Root finding; solutions for nonlinear algebraic equations
- Solving sets of linear equations
- Interpolation and curve fitting models
- Numerical Differentiation and Integration
- Numerical solution of ordinary differential equations
- Engineering applications (optimization, etc.)

16. Course Reading List and References:

The following references are recommended:

- D. Faires and R. Burden, Numerical Analysis, any edition,
- Gilat, A., and Subramaniam, V., Numerical Methods for Engineers and Scientists: An Introduction with Applications Using MATLAB, any edition, , ISBN 978-0-471- 73440-6.
- Chapra, S.C., Canale, R.P.: Numerical Methods for Engineers. any Edition., New York
- Loftus, J., Loftus, E.: Essence of Statistics. Second Edition, Alfred A. Knopf, New York
- Matlab Software

17. The Topics:	**Lecturer's name:** kanar Sh. Muhamad

Week	**Description**
1	Lect1(Introduction and Error Analysis)
2	Lect2(Significant Figures and Rounding Significant Digits)
3	Lect3(Significant Figure Mixed Operations and Error Propagations)
4	Lect4(Equations, Solution of Equations, Newton Raphson Method)
5	Lect5(Steffensen Method, Budan Theorem and Bisection Method)
6	Lect6(Solution of linear simultaneous, Graphical Method)

7	Lect7(Gauss – Jacobi Iteration Method and Gauss–Seidel Method)
8	Lect8(Interpolation and Least Square Regression)
9	Lect9(Numerical Integration and Numerical Differentiation)
10	Lect10(Newton's interpolating polynomials)
11	Lect11(Lagrange Method and Least polynomial Interpolation)
12	Lect12(Spline Interpolation Method)
13	Lect13(Secant Method)
14	Lect14(Review)

18. Practical Topics (If there is any)

Numerical Methods and Analysis

- An Introduction with Applications Using MATLAB
- Implementing most of the studied numerical algorithms and methods

19. Examination:

1) According to the methods used to solve non-linear equations, make a comparison-based performance as in the following table:

Methods	Convergence Certainty	Convergence Speed
Bisection	Yes	Very slow
Regula-falsi	Yes	Slow
Secant	Maybe	Fast
Newton-Raphson	Maybe	Very fast

2) Use the Bisection method to find the root of $x^3 - 0.165x^2 + 3.993\times10^{-4} = 0$, given the initial value of $\mathbf{x_l = 0.00}$ $\mathbf{x_u = 0.11}$ with 10 iterations and find the absolute relative approximate error at the end of each iteration,

Answer:

$\mathbf{x_m}$	$\lvert\epsilon_a\rvert$ %	$\mathbf{f(x_m)}$
0.055	----------	$\mathbf{6.655\times10^{-5}}$
0.0825	**33.33**	$\mathbf{-1.622\times10^{-4}}$
0.06875	**20.00**	$\mathbf{-5.563\times10^{-5}}$
0.06188	**11.11**	$\mathbf{4.484\times10^{-6}}$
0.06531	**5.263**	$\mathbf{-2.593\times10^{-5}}$
0.06359	**2.702**	$\mathbf{-1.0804\times10^{-5}}$

3) Answer with the correct number of significant figures.

1- 13.023 * 123.1 = **1603 (4 significant figures)**

2- 0.543 – 0.2 = **0.3 (1 <u>significant)</u>**

4) Find a root of an equation $f(x)=x^3-x-1$ using Steffensen's method, ; Where; Accuracy=0.001,

20. Extra notes:

21. Peer review پێداچوونەوەی هاوەڵ