



National University

Of Computer & Emerging Sciences Karachi



Course Outlines of BS (CS) Degree Program

Course Instructor	Dr. Fahad Riaz / Dr. Khsuro Mian / Mr. Shahid Ashraf / Mr. Nadeem Khan / Mr. Mairaj / Mr. Moheez / Mr. Usama Antuley	Semester	Spring
Batch/Section(s)	2022	Year	2024
Course Title	Numerical Computing (CS-2008)	Credit Hours	3
Prerequisite(s)	MT1003- Calculus and Analytical Geometry	Course TA	

Text Book	Numerical Analysis , 9th Edition by Burden and Faires
Ref. Book (1)	Numerical Methods in Engineering with Python 3 by Jaan Kiusalaas
Ref. Book (2)	Applied Numerical Methods with Matlab for Engineers and Scientist, 3rd Edition by Steven C, Chapra

Course Objective:

- To introduce the students to the mostly used computing methods in the different fields of engineering and sciences.
- The emphasis will be on understanding the algorithm of the various methods for computing and on applying these to obtain the approximate solutions for various mathematical problems.
- Python will be used as tool for implementation and application of these computing methods.

Course Description:

The Numerical computing includes: Error concept and analysis , Roots of nonlinear algebraic equations of one variable, Direct and iterative method for system of linear equations, Linear interpolation with 2nd and 3rd dimensional , Interpolating polynomials , Differences , Operators and their relation , Numerical differentiation and integration , Numerical solution of differential equation, Iteration for nonlinear system of equation

PLO	Assigned Program Learning Outcome (PLO)
02	Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.
03	Design/Develop Solutions: Design solutions for complex computing problems and design systems, components, and processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
05	Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

CLO	Course Learning Outcome (CLO) Statements	Domain	Taxonomy level	PLO	Tools
01	<i>Analyze Error and difference operators of numerical methods and compute the roots of algebraic and transcendental function of nonlinear equations of single variable.</i>	Cognitive	4	02	A1 M1,F
02	<i>Apply numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations.</i>	Cognitive	3	03	A2 M2,F
03	<i>Demonstrate the capability of using numerical analysis library or software for solving related problems of interpolation, differentiation, integration, the solution of linear and nonlinear equations related to the program domain</i>	Cognitive	2	05	L0,L1,L2, L3, M1, M2,F
<i>Tools: A = Assignment(A1,A2), M = Midterm (M1,M2), F=Final, L=Lab Task(L0,L1,L2,L3.L4)</i>					

Tentative Weekly Lectures Schedule

Week	Contents / Topics		
1	Error analysis: Introduction of Numerical Computing , Chopping Roundoff and truncation error , Absolute ,relative and percentage error. Taylor polynomial, .Significant figures, Nested arithmetic, loss of significance.	Ex # 1.1: 1,2,11,13 Ex # 1.2: 1,4, 5-8,13	CLO 1
2	Solution(Root) of equations in one variable: The Bisection or Binary-search method. Fixed Point iteration. ($x=g(x)$) Session of Lab(Session 0: Introduction to Python) CLO3	Ex # 2.1: 1-6,12,13 Ex: 2.2: 1-6,9-11, 14	A1 CLO 1 L0
3	Newton's Raphson and Secant Method. Method of False position (Regula falsi).	Ex # 2.3: 1-10	CLO 1
4	Interpolation and Polynomial approximation: Lagrange interpolation polynomial of degree one, two and three with error term Session of Lab(Session 1: Finding roots of linear and nonlinear Equations) CLO3	Ex# 3.1: 1,2,5,6	L1 CLO2
5	Divided difference table and interpolating polynomial. Newton Forward and Backward difference formula	Ex # 3.3: 1-6 and 9	CLO2
6	Mid 1 Exam		
7	Newton centered difference (stirling) formula. Session of Lab(Session 2: Interpolation) CLO3	Ex # 3.3: 1-6 and 9	CLO2 L2
8	Numerical differentiation : Differentiation using Forward and Backward differences 3-point Endpoint and Midpoint formula & error bound 5-point Endpoint and Midpoint formula & error bound	Ex # 4.1: 1,2,5,6, 18,25,26	CLO2
9 & 10	Numerical Integration: Trapezoidal and Simpson's rule with error term. Closed & open Newton-Cotes formulas with error term Composite Numerical Integration: Trapezoidal , Simpson's and Midpoint formula with bound error	Ex # 4.3: 1,2,5-10, 22 Ex # 4.3: 1-4, 7,8, 11	CLO2

11	Mid 2 Exam		
12	Differential Equations: Euler's method with bound error, 2-RK method , Mid Point formula Modify Euler and Huen's method , 4-RK method Session of Lab(Session 3:Numerical Differentiation & Integration) CLO3	Ex # 5.2: 1,2,5 Ex # 5.4: 1-4, 5-8, 9-12 , 13-16	CLO2 L3

13	Direct Method for solving linear system: LU decomposition (Dolittle and Crout), Positive definite matrices LDL ^t Factorization , cholesky method	Ex # 6.5: 1,2,3-6 Ex # 6.6: 1-3,5, 11,12	CLO2
14	Iterative Techniques: Iterative methods for solving linear system Gauss-Siedel and Jacobi's methods Session of Lab (Session 4: Finding Solution of system of equations) CLO 3	Ex # 7.3: 1,2,3,4	CLO2 L4
15	Power Method for finding Eigen values Optimization : Gradient Descent Method One-Dimensional Optimization: Golden-Section Search and Parabolic Interpolation	Ex # 9.3: 1,2,3	CLO2
16	Revision		

Course Teacher : _____

All Lab Sessions are mapped to CLO 3. A guest speaking session will be arranged in week 12th for Numerical Optimization Lecture.

Grading Criteria:**Marks Distribution:**

Particulars	% Marks
1. Quiz	06
2. Assignments + Lab Task/Project	14
3. First Mid Exam	15
4. Second Mid Exam	15
5. Final Exam	50
Total:-	100

Important Instructions to be followed for this Course

- Be in classroom on time. Any student who arrives more than 5 min late in the class would be marked LATE. Anybody coming to class more than 15 minutes late will be marked ABSENT.
- Turn off your cell phones or any other electronic devices before entering the class.
- Maintain the decorum of the class room all the time.
- Avoid a conversation with your classmates while lecture is in progress.
- Use parliamentary language in the class room as well as in assignments. Refrain from using impolite, vulgar or abusive language in the class room as well as in class presentations and assignments.
- Submit your assignments on time, no assignment will be accepted after the deadline.
- There would be no re- take of any quiz.

Instructions / Suggestions for satisfactory progress in this course:

- On average, most students find at least three hours outside of class for each class hour necessary for satisfactory learning.
- Chapters should be read and homework should be attempted before class.
- Do not get behind. You are encouraged to work with other students. Plus, I am always available during office hours to help you.
- The homework assigned is a minimum. You may always work extra hours on your own.
- Use the few minutes you usually have before the start of each class to review the prior meetings' notes and homework. This will save us valuable in-class time to work on new material.
- Develop a learning habit rather than memorizing.
- Work in groups, whenever appropriate.
- Apply the learned principles and gained knowledge.
- Be creative in thinking, but stick to the topic assigned for discussions, assignments and presentations.
- Always bring your text Books with you in the class.

Note: Students are welcome all the time to get help from the Teacher.

Signature: Usama Antuley

Date:15-01-2024