**University of Engineering & Technology Lahore**

**Department of Mechatronics & Control Engineering**

**Course Title:**

Numerical Analysis

**Course ID:**

MA-240

**Semester:**

5th

**Pre-Requisite:**

Algebra, Calculus, Differential Equations

**Course Objectives:**

Numerical analysis studies the means of obtaining numerical results for mathematical expressions. Demand for high accuracy is increasing as computational engineering matures. Today's engineers and physicist are less interested in qualitative features of numerical solutions and more concerned with numerical accuracy. There exist many problems in science and engineering which have no analytical solution. Numerical techniques are the best tools to provide an approximate solution to those problems. The understanding of the numerical methods helps the students to deal the real life cases in a better way. Estimating about the errors, optimization, transforming the problems in algebraic equations and numerical solution of differential equations are the major aspect to learn numerical tools.

**Course Outline:**

* Basic Definitions of Numerical Analysis, Algorithm, Numerical Algorithm etc.
* Error Analysis
* Types of Errors
* Introduction to Taylor Series
* Absolute Error
* Absolute Relative Error
* Effect of rounding errors in Arithmetic operations
* True error/Approximated percentage relative error
* Bisection method
* Regula Falsi Method
* Newton Raphson Method
* The Secant Method
* Method of Successive Approximation
* Gauss Elimination Method
* Gauss Jordon Method
* Inverse of a matrix using Gauss Elimination Method
* Jacobi Iterative Method
* Gauss Seidel Method
* Method of Factorization or Triangularization
* Inverse of a matrix using LU method
* Crout’s Method
* Computation Scheme by Crout’s Method
* Golden Section Search Method
* Quadratic Interpolation
* Newton’s Method
* Principles of Least Squares
* Operators and related proofs
* Principles laws of curve fitting and laws reducible to linear laws
* Method of group of averages
* Interpolation
* Newton’s Forward Difference Interpolation
* Newton’s Backward Difference Interpolation
* Lagranges Interpolation
* Derivatives by using Newton’s Forward and Backward Difference Formula
* Numerical Integration, Trapezoidal Rule, Simpson’s 1/3rd Rule, Simpson’s 3/8th Rule
* Euler’s Method

**Evaluation Methodology:**

Quiz # 1 10%

Mid Semester 30%

Quiz # 2 10%

End Semester 40%

C.P 10%

**Books:**

* Numerical Analysis by Chapra A. Canale
* Numerical Analysis by Viday Murti
* Numerical Analysis by Saeed Akhtar Bhatti

**Lecture Delivery Plan:**

**Week 1**

Basic Definitions of Numerical Analysis, Algorithm, Numerical Algorithm etc.

Error analysis, Types of Errors, Introduction to Taylor Series, Absolute Error, Relative Error with examples.

**Week 2**

Absolute Error, Absolute Relative Error, Percentage Absolute and Percentage Relative Error. Effect of rounding errors in arithmetic operations.

**Week 3**

True error/Approximated percentage relative error, Root finding of functions, Bisection Method, Regula Falsi Method, Newton Raphson's Method.

**Week 4**

The Secant Method, Method of Successive Approximations, Gauss Jordon Method, Gaussian Elimination Method

**Week 5**

Inverse of a matrix using Gauss Elimination Method, Jaccobi's Iterative Method.

**Week 6**

Gauss Seidel Method, Method of Factorization (LU-Decomposition Method).

**Week 7**

Inverse of a matrix using LU-Method, Crout's Method.

**Week 8**

Quiz # 1 + Mid Semester Exam

**Week 9**

Golden Section Search Method, Quadratic Interpolation,

**Week 10**

Newton's Method, Principles of Least Squares, Operators, Principles laws of curve fitting and laws reducible to linear laws

**Week 11**

Method of group of averages, Interpolation, Newton's forward difference interpolation, Newton's backward difference interpolation

**Week 12**

Lagrange's Interpolation, Derivatives by using Newton's forward and Newton's backward difference interpolation

**Week 13**

Numerical Integration, Trapezoidal Rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Euler's Method

**Week 14**

Improved Euler's Method, Modified Euler's method

**Week 15**

Runge-Kutta first, second, third and fourth order method.

**Week 16**

Quiz # 2 + End Semester Exam

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| **LECTURE DELIVERY PLAN** | | |
| **Week 1** | Basic Definitions of Numerical Analysis, Algorithm, Numerical Algorithm etc. Error analysis, Types of Errors, Introduction to Taylor Series, Absolute Error, Relative Error with examples | CLO 1 |
| **Week 2** | Absolute Error, Absolute Relative Error, Percentage Absolute and Percentage Relative Error. Effect of rounding errors in arithmetic operations | CLO 1 |
| **Week 3** | True error/Approximated percentage relative error, Root finding of functions, Bisection Method, Regula Falsi Method, Newton Raphson's Method | CLO 1 |
| **Week 4** | The Secant Method, Method of Successive Approximations, Gauss Jordon Method, Gaussian Elimination Method | CLO 1 |
| **Week 5** | Inverse of a matrix using Gauss Elimination Method, Jaccobi's Iterative Method. | CLO 2 |
| **Week 6** | Gauss Seidel Method, Method of Factorization (LU-Decomposition Method) | CLO 2 |
| **Week 7** | Inverse of a matrix using LU-Method, Crout's Method | CLO 2 |
| **Week 8** | Quiz # 1 + Mid Semester Exam | CLO 1/ CLO 2 |
| **Week 9** | Golden Section Search Method, Quadratic Interpolation | CLO 2 |
| **Week 10** | Newton's Method, Principles of Least Squares, Operators, Principles laws of curve fitting and laws reducible to linear laws | CLO 2 |
| **Week 11** | Method of group of averages, Interpolation, Newton's forward difference interpolation, Newton's backward difference interpolation | CLO 3 |
| **Week 12** | Lagrange's Interpolation, Derivatives by using Newton's forward and Newton's backward difference interpolation | CLO 3 |
| **Week 13** | Numerical Integration, Trapezoidal Rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Euler's Method | CLO 3 |
| **Week 14** | Improved Euler's Method, Modified Euler's method | CLO 3 |
| **Week 15** | Runge-Kutta first, second, third and fourth order method | CLO 3 |
| **Week 16** | Quiz # 2 + End Semester Exam | CLO 2/ CLO 3 |

**Current Teacher Incharge:**

Dr. Anjum Pervaiz

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