WOLLO UNIVERSITY
COLLEGE OF ENGINEERING
DEPARTMENT OF PRE-ENGINEERING

Program	**Regular**		
COURSE OUTLINE			
Module Name	Advanced Mathematics	**Prerequisite**	Math 1071 and computer programming
Module code	M2073	**Course EtCTS**	6
Course Title	Numerical Methods	**Course category**	Supportive/general
Course Code	Math 2072	**Target group**	Engineering students
Year/Semester	2/II	**Contact hours**	**3** Lec. and **3** lab/week
Instructor's Information	Name: Office No. Consultation hrs: Phone No: Email:		

Course Description

This course covers basic concepts in error estimation, solutions of non-linear equations, solutions of system of linear equations and non-linear equations, finite differences, numerical interpolations, numerical differentiation and numerical integration, approximation theory, numerical methods for ODEs, and methods for solving eigen value problems.

COURSE OBJECTIVES:

On completion of the course, successful students will be able to:

- understand estimation of errors in mathematical modeling,
- understand a range of iterative methods for solving non-linear equations,
- understand a range of direct and iterative methods for solving linear and non-linear systems of equations,
-comprehend the convergence properties of the numerical methods,
-grasp practical knowledge of polynomial interpolation, numerical differentiation and integration,
-examine how a small change in the data and ill-conditioned algorithms affect the solution of the mathematical problems,
- understand the roles of finite differences,
- use numerical methods for approximating functions,
-apply interpolation,
- derive numerical methods for solving initial value problems,
- investigate the stability and convergence properties of numerical methods,
- identify the numerical methods that preserve the quantitative behavior of solution,
- solve eigenvalue problems,
-Apply numerical methods in Engineering problems,
- translate mathematical algorithms into computer programming and interpret computer outputs.

COURSE CONTENTS

Chapter 1: Basic Concepts in Error Estimation (3 + 3 hrs)

1.1 Introduction to Number system and Errors
1.2 Sources of errors
1.3 Types of errors
1.4 Propagation of errors
1.5 Instability

Chapter 2: Solutions of Nonlinear Equations (9 + 9 hrs)

2.1 Locating roots
2.2 Bisection method
2.3 False position and Secant methods
2.4 Iteration Methods
2.5 Newton-Raphson Method
2.6 Conditions for convergence

Chapter 3: Solving System of Equations (9 + 9 hrs)

3.1 Direct methods for system of linear equations (SLE)
- 3.1.1 Gaussian method
- 3.1.2 Gaussian method with partial pivoting
- 3.1.3 LU decomposition method

3.2 Indirect methods for SLE
- 3.2.1 Gauss Seidel method
- 3.2.2 SOR

3.3 Systems of non-linear equations using Newton's method

Chapter 4: Interpolations and Curve fitting (15 + 15 hrs)

4.1 Finite differences (Shift operators, forward and backward difference operators)
4.2 Newton interpolation formula (forward and backward formulas)
4.3 Lagrange's interpolation formula
4.4 Newton divided difference interpolation formula
4.5 Least-square regression
- 4.5.1 Discrete least-square approximation
- 4.5.2 Continuous least-square approximation
- 4.5.3 Approximation of functions by orthogonal polynomials (such as Chebyshev, Legendre and Fourier series)

4.6 Application of interpolations
- 4.6.1 Differentiation
- 4.6.2 Integration (Trapezoidal, Simpson's rule, Gauss-Quadrature (1^{st} and 2^{nd} rule) and Romberg's Integration)

Chapter 5: Numerical Methods for Ordinary Differential Equations (6 +6 hrs)

5.1 Taylor's method of order n
5.2 Euler's methods
5.3 Runge-Kutta methods

Chapter 6: Eigenvalues Problems (6 + 6 hrs)

6.1 Basic properties of eigenvalues and eigenvectors
6.2 The power method for finding dominant eigenvalues
6.3 Householder's method and the QL algorithm

Mode of delivery	Parallel
Teaching & learning Methods	Lecture, Questioning and answering, Pair Discussion, Reading assignment Evaluation, lab
Assessment Method	Test ……...…… 20%

	Lab. Quiz. ……5 % Assignment ……..……..... 10% Lab.project with presentation……...15% Final Exam ……..…… 50% Total…….…….. 100%
Text book	➢ Burden, R.L., and Faires, J.D., ***Numerical analysis***, 9th ed., PWS publishing, Boston, 1993. ➢ Chapra, S.C., and Raymond, P.C., **Numerical Methods for Engineering**, 6th ed.,
References	➢ Grewal, B.S., ***Numerical Methods in Engineering and Science***, Khanna, New Delhi, 1994. ➢ Yang, Won-young, **Applied Numerical Methods Using MATLAB**, 3rd ed. ➢ John F. Mathews Numerical methods using MATLAB, third edition.
Course policy	All students are expected to abide by the code of conduct of students and the Senate Legislation of the University throughout this course. Academic dishonest including cheating, fabrication, and plagiarism will not be tolerated at any stage during your studies and will be reported to concerned bodies for action. While team work is highly encouraged, dependence and copying ones work and submitting other's work is considered as serious act of cheating and shall be penalized. If you are having problems with the assignments or tests, contact the instructor as soon as possible. Students are expected to attend class regularly. A student attends at least 85% in lecture classes and 100% in lab class to sit for final exam. Punctuality is equally important. If you must bring a cell phone to class, make sure that it is absolutely silent and does not disturb any one. The teaching-learning process shall be disrupted by no means.