MEPE4001 COMPUTATIONAL TECHNIQUES IN MECHANICAL ENGINEERING (3-0-0)

Course Objectives

The course aims to:

1. Introduce computational techniques used in solving engineering problems.
2. Develop numerical skills for analyzing mechanical engineering systems.
3. Familiarize students with mathematical modeling and computational algorithms.
4. Apply numerical methods to fluid flow, heat transfer, solid mechanics, and optimization problems.
5. Introduce modern computational tools used in engineering analysis and design.

Course Outcomes (COs)

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

- Formulate engineering problems into mathematical models.
- Apply numerical methods for solving algebraic, differential, and optimization problems.
- Analyze engineering systems using computational techniques.
- Utilize computational tools for simulation and design.
- Interpret and validate numerical solutions for mechanical engineering applications.

MODULE – I (6 Hours)

Mathematical Modeling and Numerical Analysis

Introduction to computational techniques, role of computational methods in engineering, mathematical modeling of engineering systems, sources of numerical errors, accuracy and precision, truncation and round-off errors, convergence and stability. Solution of algebraic and transcendental equations: Bisection method, Regula-Falsi method, Newton-Raphson method, Secant method. Applications to engineering problems.

MODULE – II (8 Hours)

Matrix Methods and Numerical Solution of Equations

Simultaneous linear algebraic equations, Gauss elimination method, Gauss-Jordan method, LU decomposition, Gauss-Seidel iterative method, eigenvalue problems, interpolation and curve fitting, Newton's interpolation, Lagrange interpolation, least squares approximation, engineering applications.

MODULE – III (8 Hours)

Numerical Differentiation, Integration and Differential Equations

Numerical differentiation, numerical integration using Trapezoidal rule, Simpson’s 1/3 and 3/8 rules, solution of ordinary differential equations using Euler’s method, Modified Euler method, Runge-Kutta methods, predictor-corrector methods, applications in mechanical engineering systems.

MODULE – IV (8 Hours)

Computational Techniques in Heat Transfer and Fluid Flow

Finite difference formulation of heat conduction problems, one-dimensional and two-dimensional steady-state heat conduction, transient heat conduction, numerical solution of fluid flow problems, discretization concepts, introduction to finite difference, finite volume and finite element methods, computational solution of engineering transport problems.

MODULE – V (6 Hours)

Optimization, Simulation and Engineering Applications

Introduction to optimization techniques, unconstrained and constrained optimization, linear programming, engineering design optimization, introduction to simulation techniques, Monte Carlo methods, computational tools for mechanical engineering, applications in:

- Heat transfer
- Fluid mechanics
- Machine design
- Manufacturing processes
- Energy systems

Introduction to MATLAB/Python-based engineering computations.

Text Books

1. Numerical Methods for Engineers, McGraw-Hill.
2. Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill.
3. Numerical Methods in Engineering with Python, Cambridge University Press.

Reference Books

1. Numerical Methods for Scientific and Engineering Computation, New Age International.
2. Applied Numerical Methods for Engineers, Pearson Education.
3. Advanced Engineering Mathematics, Wiley.
4. Engineering Optimization: Theory and Practice, Wiley.