Course Name: **Finite Element Methods**
Course Code: **MA-733**
Contact Hours/Week: **4L**
Course Credits: **04**
Course Type: **Program Elective-III**

Course Objectives

- To provide the student with the finite element method of solving the linear and nonlinear differential equations.
- To improve the student's skills in the finite element method.
- To impart the knowledge of FEM implementation using MATLAB.

Course Content

Introduction: Overview – Basic ingredients of the FEM, Early comparison with alternative solution methodologies like finite difference methods. The concepts in FEM: One-dimensional problems (2-point 2nd-order BVP), Axial deformations of a bar, Strong and weak forms, Essential vs. natural boundary conditions, Variational formulations (Principle of virtual work, principle of minimum potential energy), Approximations (Rayleigh-Ritz & Galerkin), Accuracy – error measures, discretization, interpolation, and approximation, Finite element basis functions (linear and quadratic elements), Assembly, Problems with smooth and non-smooth solutions, Convergence. Generalization to two dimensions: Membrane, plane strain and plane stress problems, Triangular and quadrilateral elements, Generalization to higher-order BVP. Mesh Generation and Solvers: Introduction to mesh generation techniques, Structured and unstructured meshes, Quality measures and refinement strategies, Linear static analysis using FEM. Applications: Steady-state and transient heat conduction, Convection and radiation boundary conditions, Application of FEM to heat transfer problems and reaction diffusion equations.

Course Outcomes

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

CO1. Apply numerical methods to obtain approximate solutions to mathematical problems.
CO2. Analyse and evaluate the accuracy of Finite element methods.
CO3. Understand the use and significance of finite element methods for computation.

Books and References

1. J. N. Reddy, An introduction to the Finite Element Method, 3rd edition, McGraw-Hill, 2006.
2. O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, 7th edition, Butterworth Heinemann, 2013.
3. T. J. R. Hughes, The Finite Element Method, Prentice-Hall, 1986.
4. Vidar Thomee, Galerkin Finite Element Methods for Parabolic Problems, Springer Verlag, 2006.