FINITE ELEMENT METHOD

(SYLLABUS)

Course Code	23CE4602A	Year	III	Semester	II
Course Category	Professional Elective- III	Branch	CIVIL	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Eng Mathematics, EM, SOM, SA
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks:	100

Course Objectives (COs):

- To introduce the fundamental principles and mathematical formulation techniques of the Finite Element Method (FEM) for analyzing engineering structures and continua.
- To develop the ability to formulate finite element equations for various physical problems using variational and weighted residual methods.
- To provide the knowledge to derive element stiffness matrices and force vectors for basic structural elements like bars, trusses, beams, and plane stress/strain conditions.
- To enable students to use FEM for structural analysis problems including static, thermal, and modal analysis, and interpret the results.
- To familiarize students with iso-parametric formulations, numerical integration techniques, and the application of FEM in complex real-world civil engineering systems.

Course Outcomes:

Course will enable the student to:

CO	Statement	BL
CO1	Formulate finite element equations for simple structural problems using energy and variational principles.	**L3**
CO2	Compute element stiffness matrices and stresses for truss and beam elements using finite element formulations.	**L3**
CO3	Assemble and analyze global stiffness matrices of trusses, beams, and frame systems.	**L3**
CO4	Interpret displacements, strains, and stress resultants in plane stress, plane strain, and axisymmetric problems.	**L4**
CO5	Model and analyze planar structural systems using isoparametric finite elements and numerical integration techniques.	**L4**

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	1	–	–	–	–	–	–	1	3
CO2	3	3	3	2	3	–	–	–	–	–	–	1	3
CO3	3	2	3	1	2	–	–	–	–	–	–	1	3
CO4	2	2	3	2	2	–	–	–	–	–	–	1	3
CO5	3	2	3	3	3	–	–	–	–	–	–	2	3

Syllabus

Unit No	Content	Mapped COs
I	**Introduction:** Review of stiffness method-Principle of Stationary potential energy-Potential energy of anelastic body-Rayleigh-Ritz method of functional approximation-variational approaches- weighted residual methods	CO1, CO2
II	**Finite Element formulation of truss element:** Stiffness matrix-properties of stiffness matrix–Selection of approximate displacement functions-solution of a planetruss-transformation matrix and stiffness matrix for a 3-D truss-Inclined and skewed supports-Galerkin's methodfor1-Dtruss– Computation of stress in a truss element.	CO1, CO2
III	**Finite element formulation of Beam elements:** Beam stiffness-assemble age of beam stiffen matrix- Examples of beam analysis for concentrated and distributed loading-Galerkin's method – 2 D arbitrarily oriented beam element–inclined and skewed supports–rigid plane frame examples.	CO2, CO3
IV	**Finite element formulation** for plane stress, plane strain and axi symmetric problems-Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axi-symmetric problems-comparison of CST and LST elements–convergence of solution-interpretation of stresses.	CO3, CO4
V	**Iso-parametric Formulation:** Iso-parametric bar element- plane bilinear Iso-parametric element – quadratic plane element-shape functions, evaluation of stiffness matrix, consistent modal load vector- Gauss quadrature-appropriate order of quadrature–element and mesh instabilities–spurious zero energy modes, stress computation-patch t	CO4, CO5

Learning Resource(s)

Text Book(s)

1. A first course in the Finite Element Method–Daryl L.Logan, Thomson Publications.
2. Concepts and applications of Finite Element Analysis–Robert D.Cook, Michael EPlesha, JohnWiley & Sons Publications

Reference Book(s)

1. Introduction to Finite Elements in Engineering-Tirupati R.Chandrupatla, Ashok D. Belgunda, PHI publications.
2. Finite Element Methods (For Structural Engineers) Wail N Rifaie, Ashok K Govil, New Age International(P)Limited

Web Materials:

1. https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. https://archive.nptel.ac.in/courses/105/105/105105041/