

3ME45: FINITE ELEMENT METHODS
CREDITS - 4 (LTP: 3,1,0)

Course Objective:

To formulate and solve structural, thermal and fluid flow problems using numerical methods.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P		C	Theory Marks		Practical Marks	
			ESE		CE	ESE	CE	
3	1	0	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	Fundamentals Of Continuum Mechanics: Equilibrium of continuum-Differential formulation, Energy Approach-Integral formulation. Overview of approximate methods for the solution of the mathematical models: Rayleigh-Ritz methods, Methods of Weighted Residuals (Galerkin, Least-squares & Collocation methods), Piecewise Interpolation.	8
2	FE Modelling And Discretization: Concepts of Modelling and discretization, Shape functions, elements and Degrees-of-Freedom, Strain – displacement relation, Local and Global equations.	6
3	1D Elements: 1D Linear and Quadratic elements, Elimination and Penalty Approach, Properties of global stiffness matrix, Formulation of Truss element, Plane truss: Stiffness and Force matrix. Beam element - Euler – Bernoulli Element formulation, plane frames.	8
4	2D Elements: Plane stress, plane strain, Triangular (CST, LST): Shape function, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector. Quadrilateral Elements (Q4, Q8): Shape function, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector. Axisymmetric problems and applications. Case studies	8
5	Dynamic Problems: Formulation of dynamic problems, selection of appropriate element, consistent and lumped mass matrices for 1-D and 2-D element, Solution of eigenvalue 1-D problems: Transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method.	7
6	Scalar Problems: Steady state heat transfer: Element formulations, treatment to boundary conditions with application to 1-D heat conduction, heat transfer through thin fins; Potential flow problems.	5
Total		42

List of References:

1. Chandrupatla T. R., Belegunda A. D., "*Introduction to Finite Element in Engineering*", PHI.
2. Logan D., "*A first Course in the Finite Element Methods*", Thompson Learning
3. Reddy J. N., "*An Introduction to Finite Element Methods*", McGraw-Hill.
4. Cook R. D., "*Concepts and Applications of Finite Element Analysis*", Wiley India

Course Outcomes (COs):

At the end of this course students will be able to ...

1. Formulate and solve continuum mechanics problems.
2. Outline the concept of Finite Element Method for solving problems.
3. Formulate and solve 1D problems.
4. Formulate and solve 2D finite element problems.
5. Formulate and solve dynamic finite element problems.
6. Formulate and solve heat transfer and fluid flow problems.

