ME491: FINITE ELEMENT METHODS
CREDITS = 5 (L=3, T=0, P=2)

Course Objective: Formulate and solve structural, thermal and fluid flow problems using numerical methods.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory		Practical		Total Marks
				ESE	CE	ESE	CE	150
3	0	2	5	70	30	30	20	

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).	06
2	**Numerical Integration:** Central Difference Method, Newmark's Methods, Wilson's method, Gauss quadrature.	04
3	**Line Elements and Applications:** Concepts of Modelling and discretization, Shape functions, elements and Degrees-of-Freedom, Strain – displacement relation, Local and Global equations 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, stress at a point in 3D, Plane stress, plane strain.	14

Unit No.	Topics	Teaching Hours
4	**2D Elements:** 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.	08
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.	07
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.	05
	TOTAL	**44**

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. Outline the concept of Finite Element Method for solving problems
2. Apply Numerical Integration technique
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 problem