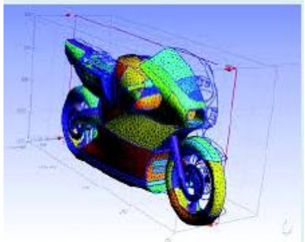

16ME306 FINITE ELEMENT METHODS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	30	10	10	10	5

Course Description and Objective:

This course explores the fundamental concepts of finite element methods, a numerical method to find the approximate solutions of various field problems. The objective of this course is to emphasize analysis and provide solutions using FEM for thermal and structural problems.

Course Outcomes:

The student will be able to:

- understand the concept of plane stress and plane strain.
- recognize the behavior and usage of each type of elements covered
- perform numerical integrations in FE methodologies
- analyze and solve field problems using appropriate packages

SKILLS:

✓ *Implement energy method concepts to solve beam problems.*

✓ *Identify displacements, stresses of 1D structural problems*

✓ *Formulate iso-parametric elements.*

✓ *Provide solutions for thermal and structural problems.*

UNIT - 1 **L – 9**

FUNDAMENTAL CONCEPTS: Introduction, Historical background, Stresses and Equilibrium; Boundary conditions; Strain-Displacement relations; Stress-Strain relations; Plane stress; Plane strain problems; Potential energy, The Rayleigh - Ritz and Galerkin's method. Problems on energy methods (Bar problems only).

UNIT - 2 **L - 9**

ONE DIMENSIONAL PROBLEMS: Finite element modeling, coordinates and shape functions. Assembly of global stiffness matrix and load vectors. Finite element equations; Treatment of boundary conditions: elimination approach and penalty approach; derivation of quadratic shape functions. Problems on 1D stepped bar/ simple bars with linear elements only.

UNIT - 3 **L - 9**

TWO-DIMENSIONAL PROBLEMS USING CONSTANT STRAIN TRIANGLES: Introduction; Finite element modeling; Constant strain triangle; element equations: element stiffness matrix; element body load vector; element traction load vector; derivations and problems; problem modeling and boundary conditions.

ANALYSIS OF TRUSSES: Introduction; local coordinate system; relation between local and global coordinate systems; element stiffness matrix; stress in truss elements; problems on simple trusses up to three members only.

UNIT - 4 **L - 9**

TWO-DIMENSIONAL ISOPARAMETRIC ELEMENTS AND NUMERICAL INTEGRATION: Shape functions of four-node quadrilateral elements. Numerical integration: Gauss one point and two point quadrature; derivations of Gauss points and weights; (limited to two points only); problems on 1D bar elements and 2D quadrilateral elements.

ANALYSIS OF BEAMS: Introduction; Finite element formulation; Load vector; element stiffness matrix; boundary considerations; Shear force and bending moment.

ACTIVITIES:

- *Calculate stress and strain in 1D elements.*
- *Analyze plane stress and plane strain for 2D elements.*
- *Compute deflections and stresses in beams for different boundary conditions.*
- *Determine the temperature gradient across a wall.*

UNIT - 5 **L - 9**

HEAT TRANSFER ANALYSIS: One dimensional analysis of plane walls, fins. Two dimensional analysis of plane walls.

ANALYSIS SOFTWARE: various commercial analysis packages; problem solving methodology by using software: preprocessing; solution; post-processing; element library; mesh generation.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS: Total hours: 30

1. Determination of stress; deformation and axial strain for 1D bar element.
2. Determination of the joint displacements; forces; stress in each member of the truss; support reactions.
3. Nodal displacements and the stress concentration for plane stress and plane strain problems
4. Deflections; Von Mises stress; Reaction Forces; shear force and bending moment diagrams.
5. Temperature distribution within the concrete and brick walls under steady-state conditions.
6. Thermal analysis of rectangular and circular fins.
7. Steady-state temperature and heat flux variations during radiation
8. Mesh generation: Manual / automatic on simple rectangular plane area
9. Natural frequencies for different types of beams.
10. One-dimensional transient heat transfer in plates and shells.

TEXT BOOKS:

1. Chandrupatla, Ashok and Belegundu , "Introduction to Finite Elements in Engineering", 3rd edition, PHI Publishers, 2009.
2. S.S. Rao, "The Finite Element Methods in Engineering", 4th edition, Pergamon, 2005.

REFERENCE BOOKS:

1. J.N. Reddy, "An Introduction to Finite Element Method", 3rd edition, Tata McGraw Hill, 2005.
2. Alavala, "Finite Element Methods", 2nd edition, PHI, 2008.
3. Kenneth H. Huebner and Donald L. Dewhirst, "The Finite Element Method for Engineers", 4th edition, John Wiley and Sons (ASIA), 2007.
4. C.S. Krishna Murthy, "Finite Element Analysis", 2nd edition, Tata McGraw Hill, 2005.