IV B. TECH - I SEMESTER
FINITE ELEMENT METHODS

Course Code: ME7T3 **Credits: 3**
Lecture: 3 periods/week **Internal assessment: 30 marks**
Tutorial: 1 periods/week **Semester end examination: 70 marks**

COURSE OBJECTIVES:

- Implement the basics of FEM to relate stresses and strains.
- Formulate the design and heat transfer problems with application of FEM.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.

COURSE OUTCOMES

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

1. Implement numerical methods to solve mechanics of solids problems.
2. Formulate and Solve axially loaded bar Problems.
3. Formulate and analyze truss and beam problems.
4. Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
5. Formulate and solve Axi-symmetric and heat transfer problems.

Pre-Requisites
Engineering Mathematics-II, Mechanics of Solids, Heat Transfer.

UNIT I
FUNDAMENTAL CONCEPTS:
Discrete and continuous systems, Stress and Equilibrium, Boundary conditions, Strain-displacement relations, stress-strain relations, potential energy and equilibrium, The Rayleigh-Ritz method, Formulation of Finite Element Equations.

UNIT II
AXIALLY LOADED BARS:
Fundamental concepts, two node bar element, Shape functions, Element Stiffness Matrix and Load Vectors, Assembly of element stiffness matrices and load vectors, treatment of boundary conditions, Temperature effects, Examples of Axially Loaded Members.

UNIT III
ANALYSIS OF PLANE TRUSSES:
Plane Trusses, Local and Global Coordinate systems, Element Stiffness Matrix, Stress Calculations, Example of plane Truss with three members.
ANALYSIS OF BEAMS: Two nodes beam Element, shape functions, element stiffness matrix and load vectors, simple problems on beams with distributed and point loads.

UNIT IV

TWO DIMENSIONAL PROBLEMS:

Finite Element Modeling, isoperimetric formulation Constant Strain Triangle (CST) Element Stiffness, Force terms, Stress calculation, Problem modeling and boundary conditions. Plane Stress and plane Strain Problems using CST Element, formulation of 4-noded quadrilateral element. Problems on isoperimetric formulation of 4-noded quadrilateral element.

UNIT V

AXISYMMETRIC PROBLEMS:

Axisymmetric formulations, Element matrices, Boundary conditions.

ONE DIMENSIONAL SCALAR FIELD PROBLEMS:

Heat transfer: equilibrium equations, heat conduction in plane walls, convection heat transfer in fins, finite element formulation, simple problems.

Learning resources

Text books:

1. Introduction to Finite Elements in Engineering (revised 4th edition), by Tirupathi R. Chandrupatla, Ashok D. Belegundu, Pearson Education Limited, 2011.

Reference books:

1. Concepts and Applications of Finite Element Analysis", (4th edition), by Cook, Robert Davis et al", Wiley, John & Sons, 2001.
2. Finite Element procedures in engineering analysis",(2nd edition), by K J Bathe, Prentice- Hall India Pvt. Ltd., 1996.
3. A first course in the finite element method" (4th edition), by Daryl L. Logan, Cengage Learning India, 2007.
4. Finite Element Analysis, (1st edition) by G. Lakshmi Narasaiah", BS Publications, 2009.