III B.TECH - II SEMESTER
FINITE ELEMENT METHODS

Course Code: ME6T6FE3 **Credits: 3**
Lecture: 3 periods/week **Internal assessment: 30 marks**
Tutorial: 1 periods/week **Semester end examination: 70 marks**

COURSE OBJECTIVES:

- Development of numerical formulation to solve Engineering structural and field problems with an intension to extension of the procedure to address complicated problems that cannot be solved by classical analytical methods.

COURSE OUTCOMES:

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

1. Apply governing principles of the structural mechanics problems at element level and develop element equations
2. Assemble element matrices based on local-global connectivity to generate total system equations
3. Impose boundary conditions and solve for unknown field variables
4. Interpret results from the calculated field variables.
5. Analyze of linear static structural and steady state heat transfer problems

Prerequisites: Mechanics of Materials, 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, Galerkin method.

UNIT II
AXIALLY LOADED BARS:
Fundamental concepts, two node bar element, Shape functions, Natural Coordinates, Element Stiffness Matrix and Load Vectors, Assembly of element stiffness matrices and load vectors, treatment of boundary conditions, solution to axially loaded bar problems. Temperature Effects, thermal stress problems

UNIT III
ONE DIMENSIONAL SCALAR FIELD PROBLEMS:
Heat transfer: Equilibrium equations, heat conduction in plane walls, convection heat transfer in fins.
FLUID FLOW THROUGH POROUS MEDIUM:
Basic Differential equation, finite element formulation, simple problems

UNIT IV

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 V

TWO DIMENSIONAL PROBLEMS:

Finite Element Modeling, Constant Strain Triangle (CST) Element Stiffness, Force terms, Stress calculation, Problem modeling and boundary conditions. Plane Stress and plane Strain Problems using CST Element.

ISOPERIMETRIC FORMULATION:

Isoperimetric, sub and super parametric formulations, numerical integration, formulation of 4 node quadrilateral element. Problems on isoperimetric formulation of 4 node quadrilateral element

DYNAMIC ANALYSIS:

Introduction, Lumped and consistent mass matrices for bar and beam elements, simple and Eigen value Eigen vector problems of bars and beams.

Learning Resources

Text Books:

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

Reference Books:

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