3/4 B.Tech. FIFTH SEMESTER

FE **FINITE ELEMENT METHODS** **Credits: 4**

Lecture:- 4 periods/week **Internal assessment: 30marks**
Tutorial: _ **Semester end examination: 70 marks**

Objectives:

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

Learning outcomes:

At the end of course the students will be able to:

1. Implement numerical methods to solve mechanics of solids problems.
2. Develop the stiffness equation for common FEA elements to assemble in to global equation.
3. Develop FE equations from the mathematical models and apply boundary conditions to bring it to a solvable form.
4. Determine engineering design parameters for bar, beam structure, 2-D planar problems and scalar field problems.
5. Evaluate the natural frequencies of bar, beam structures.

Pre-Requisites

Mathematics, Mechanics of Solids, Heat Transfer.

UNIT – I
FUNDAMENTAL CONCEPTS:
Discrete and continuous systems, Stress and Equilibrium, Boundary condition, 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, Element Stiffness Matrix and Load Vectors, Assembly of element stiffness matrices and load vectors, treatment of boundary conditions, Examples of Axially Loaded Members.

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.

UNIT – V
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 - VI
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.

UNIT – VII
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

UNIT – VIII
DYNAMIC ANALYSIS:
Introduction, Lumped and consistent mass matrices for bar and beam elements, simple Eigen value and Eigen vector problems of bars and beams**.**

Learning resources

Text books:

1. Introduction to Finite Elements in Engineering, (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.