

III Year I Semester

Code: 20ME5314

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FINITE ELEMENT METHODS

Course Objectives:

1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses performed by others
4. Learn to model complex geometry problems and solution techniques.

UNIT-I INTRODUCTION TO FINITE ELEMENT METHOD

Stress and equilibrium, strain – displacement relations, stress –strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problem.

UNIT-II DISCRETIZATION OF DOMAIN

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, bandwidth, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT-III ANALYSIS OF TRUSSES

Finite element modelling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT-IV TWO-DIMENSIONAL ELEMENTS

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions.

Higher order an disoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two-dimensional four node disoparametric elements.

UNIT-V Steady State Heat Transfer Analysis

One dimensional analysis of a fin and two-dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.

References:

1. Finite Element Method with applications in Engineering / Y M Desai, Eldho & Shah / Pearson publishers
2. An introduction to Finite Element Method / J N Reddy / Mc Graw Hill
3. The Finite Element Method for Engineers – Kenneth H.Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons(ASIA) Pte Ltd.
4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Methods / Chen
6. Finite Element Analysis: for students & Practicing Engineers / G.Lakshmi Narasaiah / BSP Books Pvt. Ltd.

Course Outcomes:

Upon successful completion of this course you should be able to:

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and axisymmetric elements and 3-D element.
3. Develop element characteristic equation procedure and generation of global stiffness equation will be applied.
4. Able to apply Suitable boundary conditions to a global structural equation and reduce it to a solvable form.
5. Able to identify how the finite element method expands beyond the structural domain for problems involving dynamics, heat transfer, and fluid flow.