III Year B.Tech. Mechanical Engg. II-Semester

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ME322 FINITE ELEMENT ANALYSIS

Course Description & Objective:

This course deals with the theory and application of the finite element methods for analyzing structural systems and heat transfer problems.

Course Outcomes:

The students can follow the terminology and basics associated with finite element method. The manual problems solving skills also help to use the analysis package efficiently.

1. *Familiarize with the energy methods used for FEM procedure*
2. *Able to solve 1D static structural bar problems subjected to axial loading*
3. *Able to solve the plane truss problems under different loading*
4. *Able to solve the 2D plane problems associated with plane stress and plane strain by using 3 noded triangular elements*
5. *Familiarize with the higher order elements used for solving 2D problems*
6. *Able to solve complicated integral equations by using numerical methods*

UNIT - I Fundamental Concepts and Energy Methods:

Introduction, Historical background, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Potential energy method. The Rayleigh - Ritz method, Galerkin's method, bar problems only.

One Dimensional problems : Finite element modeling coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions, Simple bar / stepped bar problems by using two noded line elements.

UNIT - II Two-dimensional Problems Using Constant Strain Triangles:

Introduction, Finite element modeling, Constant strain triangle, Problem modeling and boundary conditions.

Plane Trusses: Global and local d.o.f, Truss element stiffness matrix, Analysis of Plane trusses up to four members only.

UNIT - III Two-dimensional Isoparametric Elements and Numerical Integration:
Introduction, shape functions of four-node quadrilateral elements. Numerical integration: 1D,2D Gauss Quadrature (up to 2 / 2 x 2 Gauss points).
Analysis of Beams: Introduction, Finite element formulation, Load vector, element stiffness matrix, boundary considerations, Shear force and bending moment.

UNIT - IV Heat Transfer Analysis:
One dimensional analysis of plane walls, fins. Two dimensional analysis of plane walls.

UNIT - V Dynamic Analysis:
Dynamic considerations, Formulation of finite element model, elemental mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar.

TEXT BOOKS:

1. Chandraputla, Ashok and Belegundu, “Introduction to Finite Elements in Engineering”, 3rd ed., PHI Publishers, 2009.
2. S.S. Rao, “The Finite Element Methods in Engineering”, 4th ed., Pergamon, 2011.

REFERENCE BOOKS:

1. J.N. Reddy, “An introduction to Finite Element Method”, 3rd ed., Tata McGraw Hill, 2005.
2. Alavala, “Finite Element Methods”, 2nd ed., PHI, 2008.
3. Kenneth H. Huebner, Donald L. Dewhirst, “The Finite Element Method for Engineers”, 4th ed., John Wiley & Sons (ASIA), 2007.
4. C.S. Krishna Murthy, “Finite Element Analysis”, 2nd ed., Tata MC graw Hill, 2009.