B.Tech IV Year I Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AME73 – FINITE ELEMENT ANALYSIS

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Course Objectives: The objectives of the course are to make the students learn about

- Familiarize basic principles of finite element analysis procedure.
- Explain theory and characteristics of finite elements that represent engineering structures.
- Apply finite element solutions to structural, thermal, dynamic problem.
- Learn to model complex geometry problems and solution techniques.
- Understand the importance of Quality standards in manufacturing.

UNIT – 1: Introduction to finite element methods **12 Hrs**

Introduction to finite element methods for solving field problems, applications, Stress and equilibrium, Boundary conditions, Strain-Displacement relations, Stress- strain relations for 2D and 3D Elastic problems. Potential energy and equilibrium, Rayleigh-Ritz method, Formulation of Finite Element Equations.

One dimensional Problem: Finite element modelling of ID bar elements, coordinates and shape functions. Requirements for Convergence and Interpolation functions, Pascal's Triangle, Assembly of global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the numerical methods involved in Finite Element theory **L2**
- Understand direct and formal (basic energy and weighted residual) methods for deriving finite element equations. **L2**
- Understand the concept of nodes and elements **L2**
- Understand the general steps of finite element methods. **L2**

UNIT – II: Parametric representation & Geometric Modelling of Solids **10Hrs**

Analysis of trusses: Stiffness Matrix for 1D truss element, Stress Calculations and Problems with maximum of three elements.

Analysis of beams: Element Stiffness Matrix and Load vector for 1 D beam element, Hermite shape functions and simple problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the use of the basic finite elements for structural applications using truss and beam. **L2**
- Formulate and analyze truss and beam problems. **L6**

UNIT – III: Two dimensional Problems **10Hrs**

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load Vector, Stresses.

Finite element modeling of Axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the formulation of two – dimensional elements (Triangular Elements). **L2**
- Apply the formulation techniques to solve two – dimensional problems using triangle elements **L3**
- Formulate and solve axisymmetric problems **L6**

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UNIT – IV: Quadrilateral Elements **8 Hrs**

Quadrilateral Elements: Isoparametric, Sub parametric and Super parametric elements, Modelling of 4 noded and 8 noded quadrilateral elements and simple problems. Numerical Integration.

Steady state heat transfer analysis: One dimensional analysis of composite slab and fin.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the formulation of two – dimensional elements (Quadrilateral Elements). **L2**
- Apply the formulation techniques to solve two – dimensional problems using quadrilateral elements. **L3**
- Explain the application and use of the Finite Element Methods for heat transfer problems **L2**
- Formulate and solve heat transfer problems. **L6**

UNIT – V: Dynamic analysis **8Hrs**

Analysis of a 1D uniform shaft subjected to torsion – Simple problems

Dynamic analysis: Formulation of finite element model, element – mass matrices, evaluation of Eigen values and Eigen vectors for a bar and shaft.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand problems involving dynamics using Finite Element Methods. **L1**
- Evaluate the Eigen values and Eigen Vectors for steeped bar. **L6**

Text Books:

1. Chandraputla, Ashok & Belegundu, Introduction to Finite Element in Engineering, Prentice Hall.
2. S.S.Rao, The Finite Element Methods in Engineering, Elsevier Butterworth Heinemann 2nd Edition

Reference Books:

1. J N Reddy, An introduction to the Finite Element Method, McGraw – Hill, New York, 1993.
2. S.Md.Jalaludeen, Finite Element Analysis in Engineering, 2nd Edition, Anuradha Publications, 2016.
3. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley, New York, 1989.
4. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs,1982.
5. G.Lakshmi Narasaiah, Finite Element Analysis, 1st Edition, B.S. Publications, 2008.
6. O C Zienkiewicz and R L Taylor, the Finite Element Method, 3rd Edition. McGraw-Hill, 1989.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concepts behind variational methods and weighted residual methods in FEM. **L1**
- Identify the application and characteristics of FEA elements such as bars, beams, and isoparametric elements, and 3-D element. **L2**
- Develop element characteristic equation procedure and generation of global stiffness equation will be applied. **L5**
- Able to apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form. **L6**
- Able to identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer and fluid flow. **L2**

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