4/4 B.Tech. SEVENTH SEMESTER

CE7T5A **FINITE ELEMENT ANALYSIS** **Credits : 3**

Lecture: 3 periods/week **Internal assessment: 30 marks**

Tutorial: 1 period /week **Semester end examination: 70 marks**

Pre-requisites: Strength of Materials, Advanced Structural Analysis, Mathematics

Learning objectives:

- To know the analysis of structures through finite element method with displacement based approximation and isoparametric approximation.

Course outcomes:

At the end of course the student will have:

1. Understand the basic concepts of finite element method and theory of elasticity.
2. Understand fundamental terminology involved in displacement based approximation and analysis of 1-Dimensional FEM.
3. Analyse 2-Dimensinal and 3-Dimensional FEM through displacement based approximation.
4. Understand fundamental terminology involved in Isoparametric based approximation and axisymmetric analysis of FEM.
5. Comprehend solution techniques for utilization of FEM and Dynamic analysis of FEM.

UNIT -I

INTRODUCTION

Concepts of FEM – Steps involved – merits & demerits – energy principles – Discretization – Rayleigh –Ritz method of functional approximation.

PRINCIPLES OF ELASTICITY

Equilibrium equations – strain displacement relationships in matrix form – Constitutive relationships for plane stress, plane strain and Axi-symmetric bodies of revolution with axi-symmetric loading.

UNIT –II

ELEMENT MATRICES

Displacement models – generalized coordinates – shape functions – convergent and Compatibility requirements – Geometric invariance – Natural coordinate system – area and volume coordinates

ONE DIMENSIONAL FEM

Stiffness matrix for bar element - shape functions for one dimensional elements – one dimensional problems.

UNIT –III

TWO DIMENSIONAL FEM

Generation of element stiffness and nodal load matrices for 3-node triangular element and four node rectangular elements, Different types of elements for plane stress and plane strain analysis.

THREE DIMENSIONAL FEM

Generation of element stiffness and nodal load matrices for Tetrahedral element and Hexahedral elements.

UNIT-IV

ISOPARAMETRIC FORMULATION

Concepts of, iso-parametric elements for 2D analysis -formulation of CST element, 4 –noded and 8-noded iso-parametric quadrilateral elements –Lagrangian and Serendipity elements.

AXI-SYMMETRIC ANALYSIS

Basic principles-Formulation of 4-node iso-parametric axi-symmetric element

UNIT V

SOLUTION TECHNIQUES

Numerical Integration, Static condensation, assembly of elements and solution techniques for static loads.

DYNAMIC ANALYSIS FEM

Dynamic Equations of Motion, Consistent and Lumped Mass Matrices, Consistent Mass Matrices in Global Coordinate System, Free Vibration Analysis.

Learning resources:

Text books:

1. Finite Elements Methods in Engineering, (3^{rd} edition), by Tirupati Chandrepatla,R. and Ashok Belegundu, D.,Pearson Education Publications, 2002.
2. The Finite element method in Engineering by Singresu.S.Rao, Elsevier Butterworth–Heinemann Publications, 2005
3. Finite element analysis by David Hutton, V., Tata Mcgraw-Hill, New Delhi, 2005.

Reference books:

1. Concepts and Applications of Finite Element Analysis ,(4^{th} edition) by Robert Cook, D., David.S., Malkus and MichaelPlesha, E., Jhon Wiley & Sons, 2007.
2. Finite Element analysis by S.Md.Jalaludeen, Anuradha Publications, 2012.
3. Text book of Finite Element analysis, (4th edition) by Seshu, P., Prentice Hall of India, 2012.

e-learning resources:

http://nptel.ac.in/courses.php

http://jntuk-coeerd.in/