FINITE ELEMENT METHODS

B.Tech. III Year II Semester

Course Code	Category	Hours/ Week			Credits	Maximum Marks		
		L	T	P		CIA	SEE	TOTAL
ME3204PC	Core	3	0	0	3	25	75	100
Contact Classes: 52	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 52		

Prerequisites: Mechanics of Solids

I. COURSE OVERVIEW:

The aim of this course to enable students to understand fundamental theory of the FEA method, generate the governing FE equations for systems governed by partial differential equations, understand the use of the basic finite elements for structural applications using truss, beam and plane elements under static and dynamic loading; understand the application and use of the FE method for heat transfer problems.

II. COURSE OBJECTIVES:

The aim of the course is to provide the participants an overview on Finite Element Method, Material models, and Applications in Civil Engineering. At the end of the course, the participants are expected to have fair understanding of:

- Basics of Finite Element Analysis.
- Available material models for structural materials, soils and interfaces/joints.
- Modeling of engineering systems and Soil-Structure Interaction (SSI).
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications

III. COURSE OUTCOMES:

At the end of the course, the student will be able to, Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer. Formulate and solve problems in one dimensional structures including trusses, beams and frames. Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems. ANSYS, ABAQUS, NASTRAN, etc...

IV. COURSE SYLLABUS:

UNIT – I:

Introduction to Finite Element Methods: General Procedure - Engineering Applications - Stress and Equilibrium, Strain - Displacement relations. Stress - strain relations: Finite Elements: 1- Dimensional, 2 - Dimensional, 3-Dimensional & Interpolation Elements

One Dimensional Problems: 1-D Linear and 1-D Quadratic Elements - 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.

UNIT – II:

Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations.

Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beamelement, Load Vector, Deflection.

UNIT – III:

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. Two dimensional four noded Isoparametric elements and numerical integration.

UNIT – IV:

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensionalanalysis of thin plate.

UNIT – V:

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam.

Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation. Techniques such as semi-automatic and fully automatic use of software such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements.

TEXT BOOKS:

1. Finite Element Methods: Basic Concepts and applications/Alavala/PHI
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson

REFERENCE BOOKS:

1. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
2. Finite Element Analysis / SS Bhavikatti / New Age
3. Finite Element Method/ Dixit/Cengage