FINITE ELEMENT ANALYSIS
(Professional Elective- IV)

Course Code: 20CE1167	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Pre-requisites:

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain the basics of FEM
CO2: Explain the shape functions and strain displacement matrix
CO3: Determine element stiffness matrix and assemble them
CO4: Analyse bars and trusses using FEM
CO5: Analyse beams, plates using FEM

UNIT–I **(10 Lectures)**

INTRODUCTION TO FEM:

Introduction – Limitations of methods of structural analysis – Mathematical modeling of physical Problem - Concept of FEM through perimeter of circle – History, merit and demerits and applications of FEM – FEM based software – Steps involved in FEM as applicable to Structural mechanics problems.

Learning outcomes:

1. Identify relevant software a given physical problem (L2)
2. Discuss the steps involved in FEM (L2)
3. Model a physical problem in FEM (L3)

UNIT–II **(10 Lectures)**

CHOICE OF DISPLACEMENT MODELS:

Introduction – Discretization – Choice of Elements shapes - Choice of displacement model – Requirements Ideal displacement model - Factors affecting nature and degree of polynomial for displacement models.

FORMULATION OF SHAPE FUNCTION AND STRAIN DISPLACEMENT MATRIX:

Introduction – Properties of Shape Functions - Methods of Determination – Shape functions for1D bar and beam element, 2D CST element.

Learning outcomes:

1. Identify a shape function for an element (L2)
2. Formulate the shape function for any element (L2)
3. Discuss about the strain displacement matrix for any element (L2)

UNIT – III **(10 Lectures)**

ELEMENT STIFFNESS MATRIX AND ASSEMBLY:

Introduction - Element Stiffness Matrix based on minimization of total potential Energy; Stiffness Matrix for 2 noded truss element, 2 noded Beam element, 3 noded CST – Assemblage of Element Stiffness Matrices and load matrix- Static Condensation

Learning outcomes:

1. Formulate a stiffness matrix (L2)
2. Formulate a stiffness for any given element (L2)
3. Apply static condensation for stiffness equation (L3)

UNIT-IV **(10 Lectures)**

1D BAR AND TRUSS USING FEM:

Introduction - Analysis of stepped bars and tapered bars- Analysis of plane Truss - Truss withinitial Strain/Rise in Temperature

Learning outcomes:

1. Analyse a bar for stresses (L4)
2. Demonstrate capability for analysis of stepped bar (L3)
3. Apply the concept of temperature stresses for trusses (L3)

UNIT-V **(10 Lectures)**

BEAMS AND PLATES USING FEM:

Introduction - Analysis of simply supported beam – Analysis of propped cantilevers, fixed beams, and continuous beams for various loadings, Introduction to analysis of plates for in-plane loading.

Learning outcomes:

1. Analyse beams using FEM(L4)
2. Model plane stress problems(L3)
3. 3.Analyse in-plane loaded plates (L4)

TEXT BOOKS:

1. Reddy, J.N., "Introduction to Finite Element Method", Mc Graw Hill, 3rd Edition, 2002.
2. Bhavikatti, S.S. "Finite Element Analysis" New Age international, 2nd Edition, 2010.

REFERENCES:

1. Klaus-Jurgen Bathe, "Finite Element Methods", Prentice Hall 1stEdition 2003.
2. Chandrupatla,T.R., and Belegunde, A.D, "Introduction to Finite Elements in Engineering",PHI, 3rd Edition, 2010.