Course Code	Course Title	L	T	P	C
20SE006	FINITE ELEMENT ANALYSIS	3	1	2	5

PRE-REQUISITE COURSES: APPLIED MATHEMATICS

COURSE OBJECTIVES:

The main objective of the course is to understand the energy concepts, matrix methods, shape functions, basic finite element concepts, analysis of truss elements, beam elements, structural frames and to familiarize the field of iso-parametric elements**.**

COURSE OUTCOMES:

At the end of the course student will be able

CO's	Course Outcomes	PO's
1	Understand the energy concepts	1
2	Apprehend the knowledge of analysis of structures using matrix methods	3
3	Understand the Basic Finite Element Concepts	1
4	Analysis of Trusses, Beam Bending, Structural Frames using Finite Element Methods	3
5	Develop computer programs for matrix methods	2

SKILLS

- ✓ Ability to determine the static and kinematic indeterminacy of frames and trusses
- ✓ Ability to analyze any truss structure using direct stiffness method and its solution techniques (use any programming software for analysis)
- ✓ Ability to analyze any beam in ANSYS with different boundary conditions and compare the results using finite element technique.
- ✓ Ability to solve any plane strain problem using constant strain triangle and compare the result with four node iso parametric element

UNIT-I:

ENERGY CONCEPTS AND MATRIX METHODS: Transformation of Coordinates - Basic assumptions - Static and kinematic indeterminacy - Principles of superposition - Strain energy.

Matrix Methods: Properties of stiffness and flexibility matrices- solution of simple problems

UNIT-II:

FLEXIBILITY AND STIFFNESS METHOD: Flexibility method applied to statically indeterminate structures, Stiffness method applied to kinematically indeterminate structures, Analysis of continuous beam, plane truss and plane frames, thermal expansion and lack of fit.

UNIT-III:

INTRODUCTION AND BASICS OF FEM: Introduction, A brief history of FEM, Need of the method, Equilibrium equations boundary conditions, Methods of weighted residuals, Compatibility; train-displacement relations, Linear constitutive relations, Principle virtual work; Principle of stationary potential energy. Different types of elements, Shape functions.

UNIT-IV:

ANALYSIS OF TRUSSES, BEAMS AND FRAMES: Stiffness matrix for an axial element – transformation of vectors – plane truss analysis – beam stiffness – solution for beam problems – Two-Dimensional beam element – rigid plane frames.

UNIT-V:

PLANE STRESS AND PLANE STRAIN PROBLEMS: Basic concepts of plane stress and plane strain – derivation of stiffness matrix for constant – strain, linear strain triangular elements – rectangular elements – iso parametric elements – Lagrange and Serendipity elements – axisymmetric elements.

TEXT BOOKS:

1. Krishnamoorthy, C. S, Finite Element Analysis - Theory and Programming, McGraw - Hill, 1995.
2. Introduction to Finite Elements in Engineering by R.T. Chandrupatla and A.D. Belegundu, Prentice Hall of India, 1997
3. Madhujit Mukhopadhyay and Sheikh Abdul Hamid "Matrix and finite element analysis of structures"

REFERENCES:

1. Moshe. F. Rubinstein, "Matrix Computer Analysis of Structures", Prentice Hall, 1986.
2. Weaver. J.R and Gere. J. M, "Matrix Analysis of Framed Structures", CBS Publishers, New Delhi, 1986.
3. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing house, Daryagang, New Delhi, 2009.
4. Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc.,1996.

LABORATORY EXPERIMENTS

List of Experiments

Analyze any 3 of the following problems by using ANSYS

1. Analysis of Beams with UDL Loads and different Boundary Conditions.
2. Analysis of Beam with Multiple Loads.
3. Analysis of 2D Trusses.
4. Non Linear Analysis of Cantilever Beams.
5. Analysis of plate With/Without Central Hole

Analyse any 4 of the following problem

1. Direct Stiffness approach by MATLAB
2. Design of RCC and Steel by programs in Excel
3. Structural modeling- Analysis for vertical and horizontal loading
4. Buckling of columns and Plates
5. Free and Forced vibration problems
6. Plane Stress and Strain problems
7. Non-Linear Finite Element Analysis – Simple Problems

REFERENCES:

1. STAAD.Pro – manual volume 1 and 2, Bentley Systems India, Private Limited, New Delhi.
2. ETABS - Integrated Building Design Software, CSI, Berkeley, California.
3. SAP 2000- Linear and Non-linear Static and Dynamic Analysis and Design, CSI, Berkeley, California.
4. ANSYS Structural Analysis Guide, ANSYS, Inc., Canonsburg, PA, USA.
5. MATLAB - Beginners Guide to MATLAB, Math Works, Inc., Clarkson University, New York.
6. MS Excel 2013 – Microsoft Corporation, USA.