Course Code	Course Title	L	T	P	C
17CE002	MATRIX METHODS AND FINITE ELEMENT ANALYSIS	3	1	2	5

Course Objectives:

1. To study the energy concepts, analysis of structures by stiffness and flexibility approaches
2. To introduce finite element method and its importance in civil engineering applications.
3. To familiarize students in deriving shape functions of different elements.
4. To expose the students to write global stiffness matrix and its solution techniques.
5. To familiarize the students in the field of iso-parametric elements.

Course Outcomes:

At the end of the course student will be able

1. Apprehend the knowledge of analysis of structures using matrix method and flexibility method
2. Solve problems in beams, frames and trusses
3. Develop computer programs for matrix methods
4. Apprehend the knowledge of basics of Finite Element Method
5. Formulate element properties for structural engineering problems
6. Apply Finite Element Method for common structural Engineering problems

Activities:

1. Determination of the static and kinematic indeterminacy of frames and trusses
2. Analyze any truss structure using direct stiffness method and its solution techniques (use any programming software for analysis)
3. Analyze any beam in ANSYS with different boundary conditions and compare the results using finite element technique.
4. Solve any plane strain problem using constant strain triangle and compare the result with four node Iso parametric element

Skills:

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

UNIT-I: Stiffness Method

Indeterminacy - Static, Kinematic– Degrees of Freedom – Structure stiffness matrix for beams, frames and trusses using displacement transformation matrix and coordinate transformation matrix - Internal forces due to thermal expansion and lack of fit

UNIT –II: Flexibility Method

Flexibility method applied to statically determinate and indeterminate structures; Choice of redundant; Primary structure- General formulation- Structures flexibility matrix using force transformation matrix – Internal forces due to thermal expansion and lack of fit.

UNIT-III: Introduction and Basics of FEM

A brief history of FEM, Need of the method, Equilibrium equations boundary conditions, Compatibility; Strain-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. Madhujit Mukhopadhyay and Sheikh Abdul Hamid "Matrix and finite element analysis of structures"
2. Daryl L.Logan, "Finite Element Method", Thomson Canada Ltd., India Edition, 2016
3. Singiresu.S.Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, India
4. Edition, 2001.
5. Pandit.G.S and Gupta.S.P, "Structural Analysis – a Matrix Approach", Tata Mc Graw Hill Publishing Company, 2004
6. Rajasekaran.S, "Finite Element Analysis in Engineering Design", S.Chand and Company Ltd., 2003.

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 Analysis: Theory and Programming by C. S. Krishnamoorthy, Tata McGraw-Hill, 1995
5. Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc.,1996.

LABORATORY EXPERIMENTS

Using ANSYS (ANY 5)

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 Portal frame in Ansys
6. Analysis of Plates in Ansys