

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Professional Elective -III: Finite Element Analysis
Course Code:	2ET1010703T
Pre-requisite Course:	Zeal to learn the Subject

Course Objectives:

1. To introduce the basics and application of Finite Element Method
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To illustrate the principle of mathematical modeling of engineering problems
4. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	SEE		CCA		SEE		CCA						
	L	T	P	Total	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction: Introduction to FEM, engineering applications, advantages, General steps, Element types, Principles of Elasticity: Strain displacement relations, Stress strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions.	04	10
2	One- Dimensional Element: Formulation of a linear bar element, Shape Functions Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary conditions elimination method and penalty method. Numerical Problems on straight and stepped bars.	10	25
3	Trusses and Beams: Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, stiffness matrix and load vector (No derivations), Numerical Problems on beams carrying concentrated, UDL and couples.	10	25
4	Two-dimensional Element: Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Lagrangian and serendipity elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymmetric– triangular elements. Convergence criteria, pascal triangle.	08	20
5	Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars. Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governing equation, boundary conditions, Numerical problems on composite wall, 1D heat transfer in thin fins.	04	10

6	FEM for Plates and Shells: Introduction to Plate Bending Problems; Finite Element Analysis of Thin Plate; Finite Element Analysis of Thick Plate; Finite Element Analysis of Skew Plate; Introduction to Finite Strip Method; Finite Element Analysis of Shell.	04	10
---	---	----	----

Reference Books:

1. Reddy, J. N., “An Introduction to the Finite Element Method”, Tata McGraw Hill, 2nd Ed, 2003.
2. Krishnamoorthy, C. S., “Finite Elements Analysis: Theory and Programming”, Tata McGraw Hill, 2nd Ed, 1994.
3. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi.
4. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann.
5. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_me43/preview

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand the fundamental concepts of the theory of the finite element method.	1 Understanding
CLO2	Develop element characteristic equation and generation of global equation.	2 Understanding 3 Applying
CLO3	Apply suitable boundary conditions to a global equation for bars, trusses and beams.	3 Applying
CLO4	Evaluate the governing FE equations for solving 1D and 2D problems.	3 Applying 5 Evaluating
CLO5	Apply the FE analysis for practical applications in static and dynamic condition.	3 Applying 4 Analyze
CLO6	Apply the FE method for thermal, potential flow and transient problems.	5 Evaluating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	H	M	–	–	–	–	–	–	–	–	–	M	M	L
CLO2	H	H	M	–	M	–	–	–	–	–	–	–	H	M
CLO3	M	H	M	–	M	–	–	–	–	–	–	–	H	M
CLO4	M	H	–	H	M	–	–	–	–	–	–	–	H	H
CLO5	M	H	M	M	H	–	–	–	–	–	–	–	H	H
CLO6	M	H	–	H	H	–	–	–	–	–	–	M	H	H

H: High, M: Medium, L: Low