INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

FINITE ELEMENT METHODS								
VI Semester: AE								
Course Code	**Category**	**Hours /Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED26	**Core**	3	-	-	3	40	60	100
Contact Classes:48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:48**		
Prerequisite: Mechanics of Solids								

I. COURSE OVERVIEW:

This Finite Element Analysis (FEA) course provides a foundational understanding of numerical methods for engineering problem-solving. This course includes the basics of FEA, mathematical foundations and modeling concepts for solving static, thermal and dynamic problems using FEA processes. This course equips students with the skills necessary for tackling real-world engineering challenges using Finite Element Analysis.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The foundation in FEA principles covering historical context, ensuring a grasp of fundamental concepts.
II. The modeling and analyzing trusses and beams, enabling students to address structural engineering challenges.
III. The continuum mechanics principles to 2-D and axisymmetric problems, gaining expertise for accurate FEA simulations of complex structures.
IV. The steady-state heat transfer analysis to simulate and analyze thermal behavior in diverse engineering scenarios.
V. The dynamic problems, learning to formulate mass and damping matrices and solve transient problems.

III.COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Explain the discretization concepts and shape functions of structural members for computing displacements and stresses.
CO 2 Make use of shape functions of truss and beam elements for obtaining stiffness matrix and load vector to compute nodal displacement, stresses.
CO 3 Apply the discreet models of CST element for estimating displacement and stress.
CO 4 Make use of axi-symmetric modelling concepts to solids of revolution for stress approximation.
CO 5 Apply numerical techniques to heat transfer problems to compute the temperature gradients under various thermal boundary conditions
CO 6 Develop the governing equations for the dynamic systems to estimate circular frequency and mode shapes, in correlation with modern tools

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Boundary conditions. Strain - displacement relations. Stress-strain relations for 2-D and 3-D elastic problems, Rayleigh-Ritz method.

One Dimensional Problem: 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.

MODULE –II: ANALYSIS OF TRUSSES AND BEAMS (10)

Analysis of Trusses: Stiffness matrix for plane Truss Elements, stress calculations and problems.
Analysis of beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element and simple problems.

MODULE –III: CONTINUUM ELEMENTS (11)

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load vector and stresses.
Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements Two dimensional four noded isoparametric elements and problems**.**

MODULE –IV: STEADY STATE HEAT TRANSFER ANALYSIS (09)

Steady state Heat Transfer Analysis: One dimensional analysis of composite wall, slab, rectangular and circular fins and two-dimensional analysis of thin plate with CST's.

MODULE –V: DYNAMIC ANALYSIS (08)

Dynamic Analysis: Formulation of finite element model, element – Mass matrices, evaluation of Eigen values, Eigen Vectors and Natural frequencies for a stepped bar and beam, convergence requirements, mesh generation, techniques such as semi-automatic and fully automatic use of software such as ANSYS, HYPERMESH, NASTRAN etc.

V.TEXT BOOKS:

1. Tirupathi R. Chandraputla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, 3rd Edition, 2003.
2. Rao. S.S, "Finite Element Methods in Engineering", Butterworth and Heinemann, 2000.
3. Reddy J.N, "An Introduction to Finite Element Method", McGraw Hill, 2000

VI. REFERENCE BOOKS:

1. Krishnamurthy, C.S, "Finite Element Analysis", Tata McGraw Hill, 2000.
2. K. J. Bathe, E. L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, 4th Edition, 2003.
4. Larry J Segerlind, "Applied Finite Element Analysis", John Wiley and Sons, 2nd Edition, 1984.

VII. WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. https://lwlin.me.berkeley.edu/me128/FEMNotes.pdf
3. https://www.jousefmurad.com/fem/the-finite-element-method-beginners-guide/

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology

6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation