22MEHO206	ADVANCED FINITE ELEMENT METHODS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To develop a thorough understanding of the advanced finite element analysis techniques.
2. An ability to effectively use the tools of the analysis for solving practical problems arising in engineering design.
3. To understand and solve the Finite Element 1-D structural and 2-D structural problems.
4. To develop and understand the dynamic problems in structures
5. To Gain the knowledge of FEM for heat transfer analysis and flow analysis

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear,etc., Historical Perspective of FEM and applicability to mechanical engineering design problems. Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions, Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss- Legendre scheme of numerical integration, Nodal degrees of freedom. Compatibility conditions, Assembly and boundary considerations.

UNIT II	**ONE DIMENSIONAL PROBLEMS**	**9**	**0**	**0**	**9**

Structural problems with one dimensional geometry. Formulation of stiffness matrix, consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies with emphasis on boundary conditions and introduction to contact problems. Beams and Frames: Review of bending of beams, higher order continuity (C0 and C1 Continuity), interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer codes involving 1-D elements.

UNIT III	**TWO DIMENSIONAL PROBLEMS**	**9**	**0**	**0**	**9**

Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric problems; Triangular and Quadrilateral elements, higher order elements, subparametric, Isoparametric and superparametric elements. General considerations in finite element analysis of two dimension problems. Introduction plate bending elements and shell elements.

UNIT IV	**DYNAMIC ANALYSIS**	**9**	**0**	**0**	**9**

FE formulation in dynamic problems in structures using Lagragian Method, Consistent and lumped mass models, Formulation of dynamic equations of motion and introduction to the solution procedures. Modelling of structural damping and formulation of damping matrices, Model analysis, Mode superposition methods and reduction techniques.

UNIT V	**FEM IN HEAT TRANSFER & FLUID MECHANICS**	**9**	**0**	**0**	**9**

Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Formulation for 2-D and 3-D heat conduction problems with convective boundaries. Introduction to thermo-elastic contact problems. Finite element applications in potential flows; Formulation based on Potential function and stream function. Design case studies

TOTAL(45L) : 45 PERIODS

REFERENCES:

1. K. J. Bathe, Finite Element Procedures, Prentice-Hall of India Private Limited, New Delhi, 1996
2. J. C. Simo and T. J. R. Hughes, Computational Inelasticity, Springer-Verlag New York, Inc., New York, 1998

3.	Cook and Robert Davis etal, “Concepts and Applications of Finite Element Analysis”, 4th Edition, John Wiley and Sons, 2001.
4.	Segerlind L.J, “Applied Finite Element Analysis”, 2nd Edition, John Wiley, 1984.
5.	O. C. Zienkiewicz and R. L. Taylor, Finite Element Method: Volume 2 Solid Mechanics, Fifth Edition, Butterworth-Heinemann, Oxford,

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the concept of the finite element method for solving design problems.	Apply
CO2	Formulate and solve manually problems in 1-D structural systems involving bars, trusses, beams and frames.	Apply
CO3	Develop 2-D FE formulations involving triangular, quadrilateral elements, and higher-order elements	Create
CO4	Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis	Apply
CO5	Apply the knowledge of FEM for heat transfer analysis and flow analysis	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	3	1	0	0	0	1	1	0	0	0	1	2	0
CO2	3	1	3	3	3	0	0	1	1	0	0	0	0	0	3
CO3	3	1	3	3	2	0	0	1	1	0	0	0	0	0	0
CO4	3	2	3	3	2	0	2	2	1	0	0	0	1	2	0
CO5	3	1	1	1	1	0	0	0	1	0	0	0	1	1	0
Avg	**3.0**	**1.2**	**2.6**	**2.2**	**1.6**	**0.0**	**0.4**	**1.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.6**	**1.0**	**0.6**
3/2/1 – indicates strength of correlation (3 – high, 2- medium, 1- low)															