FINITE ELEMENT MODELLING

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AME014	Core	3	1	-	4	30	70	100
Contact Classes: 60	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES:

The course should enable the students to:

I Introduce basic concepts of finite element methods including domain discretization, polynomial interpolation and application of boundary conditions.
II Understand the theoretical basics of governing equations and convergence criteria of finite element method.
III Develop of mathematical model for physical problems and concept of discretization of continuum.
IV Discuss the accurate Finite Element Solutions for the various field problems.
V Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.

COURSE OUTCOMES (COs):

CO 1 Describe the concept of FEM and difference between the FEM with other methods and problems based on 1-D bar elements and shape functions.
CO 2 Derive elemental properties and shape functions for truss and beam elements and related problems.
CO 3 Understand the concept deriving the elemental matrix and solving the basic problems of CST and axi-symmetric solids.
CO 4 Explore the concept of steady state heat transfer in fin and composite slab.
CO 5 Understand the concept of consistent and lumped mass models and slove the dynamic analysis of all types of elements.

COURSE LEARNING OUTCOMES (CLOs):

1. Understand the numerical methods and development of mathematical models for physical system.
2. Identify mathematical model for solution of common engineering problems in the field of aeronautical, mechanical and civil.
3. Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundaryconditions.
4. Remember the steps involved in finite element methods while solving the model of physicalproblem.
5. Apply numerical methods for solving one dimensional barproblems.
6. Identify the mathematical models for two-dimensional, three-dimensional truss and beamelements.
7. Solve the equations of truss and beamelements.
8. Calculate stress strain and strain energy for common engineeringproblems.
9. Derive element matrix by different methods by applying basic laws in mechanics and integration byparts.
10. Demonstrate the ability to evaluate and interpret FEA analysis results for design and developmentpurposes.
11. Formulate simple and complex problems into finite elements and solve structural and thermalproblems.
12. Derive the element stiffness matrices for triangular elements and axisymmetric solids and estimate the load vector and stresses.
13. Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thinplate.
14. Understand the concepts of mass and spring system and derive the equations for various structuralproblems.
15. Calculate the mass matrices; Eigen values Eigen vectors and natural frequency for dynamicproblems.
16. Model multi-dimensional structural and heat transfer problems by using automatic and fully automatic software such as ANSYS, NISA, NASTRAN.

UNIT I	INTRODUCTION TO FEM	Classes: 09
Introduction to fem for solving field problems, basic equations of elasticity, stress–strain and strain displacement relations for 2D-3D elastic problems, boundary conditions, one dimensional problem, finite element modeling coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, quadratic shape functions.		
UNIT II	**ANALYSIS OF TRUSSES AND BEAMS**	**Classes: 09**
Analysis of trusses stiffness matrix for plane truss elements, stress calculations and problems analysis of beams: element stiffness matrix for two nodes, two degrees of freedom per node beam element and simple problems.		
UNIT III	**2-D ANALYSIS**	**Classes: 09**
Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, estimation of load vector,stresses. Finite element modeling of axisymmetric solids subjected to axisymmetric loading with triangular elements, two dimensional four noded iso parametric elements.		
UNIT IV	**STEADY STATE HEAT TRANSFER ANALYSIS**	**Classes: 09**
Steady state heat transfer analysis: 1-D heat conduction of slab 1D fin elements, 2D heat conduction, analysis of thin plates, and analysis of a uniform shaft subjected to torsion, problems.		
UNIT V	**DYNAMIC ANALYSIS**	**Classes: 09**
Dynamic analysis: Dynamic equations, lumped and consistent mass matrices, eigen values and eigen vectors for a stepped bar, beam; Finite element, formulation to 3D problems in stress analysis, convergence requirements, mesh generation, techniques such as semi-automatic and fully automatic use of software such as ANSYS, NISA, NASTRAN.		

Text Books:

1. Tirupathi K., Chandrapatla, Ashok D. Belagundu, "Introduction to Finite Elements in Engineering", 1st edition, 2013.
2. S. S. Rao, "The Finite Element Methods in Engineering", Elsevier, 4th Edition, 2013.
3. J. N. Reddy, ―An Introduction to Finite Element Methods, McGraw-Hill, 1stEdition, 2013.

Reference Books:

1. Alavala, "Finite Element Methods", TMH, 1st Edition, 2012.
2. O.C. Zienkowitz, "The Finite Element Method in Engineering Science", McGraw-Hill, 1st Edition,2013.
3. Robert Cook, "Concepts and Applications of Finite Element Analysis", Wiley, 1st Edition,2013.
4. S. Md. Jalaludeen, "Introduction of Finite Element Analysis", Anuradha publications, 1st Edition,2010.

Web References:

1. http://nptel.ac.in/courses/112104116/
2. http://nptel.ac.in/courses/112104116/
3. http://nptel.ac.in/courses/112104116/ui/TableofContents.html

E-Text Books:

1. https://www.google.co.in/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-#q=fem%20notes
2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved
3. http://kth.se/social/upload/5261b9c6f276543474835292/main.pdf
4. http://engineeringstudymaterial.net/tag/finite-element-analysis-books/
5. http://www.faadooengineers.com/threads/8846-FINITE-ELEMENTS-METHODS-ebook-pdf
6. https://themechangers.blogspot.in/2013/08/ebook-finite-element-method-in.html