FINITE ELEMENT METHODS

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEC27	Core	3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Mechanics of Solid, Heat Transfer

I. COURSE OVERVIEW:

The finite element analysis (FEA) is a numerical method widely used for modeling and analyzing structures. This course introduces the mathematical modeling concepts of the Finite Element Method forsolving structural, thermal and dynamics problems that are too complicated to be solved by analytical methods.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic concepts of Finite Element methods and its applications to complex engineering problems.
II. The characteristics and selection of different finite elements used in finite element methods.
III. The equilibrium equations and stress-strain relations for different boundary conditions encountered in structural and heat transfer continuum problems.
IV. The application of the FEM technique to dynamic problems and validate the solutions through simulation software for real time applications.

III. COURSE OUTCOMES:

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

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

IV. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO FEM (10)

Introduction to FEM, FEA software's, 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.

MODULE –II: ANALYSIS OF TRUSSES AND BEAMS (08)

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.

MODULE –III: 2-D & 3-D ANALYSIS(10)

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 nodded isoparametric elements.

MODULE –IV: STEADY STATE HEAT TRANSFER ANALYSIS (08)
Steady state Heat Transfer Analysis - 1D Heat conduction of slab and fin elements, 2D heat conduction - analysis of thin plates, Analysis of a uniform shaft subjected to torsion.

MODULE –V: DYNAMIC ANALYSIS (09)
Dynamic Analysis - Dynamic equations, formulation of lumped and consistent mass matrices, Eigen Values and Eigen Vectors for a stepped bar, beam; Finite element formulation to 3D problems in stress analysis.

V.TEXT BOOKS:

1. Tirupathi K. Chandrupatla and Ashok D. Belagundu, "Introduction to Finite Elements in Engineering", Pearson, 4th Edition, 2011.
2. S.S. Rao, "The Finite Element Methods in Engineering", Elsevier, 4th Edition 2009.

VI.REFERENCE BOOKS:

1. O.C. Zienkowitz, "The Finite Element Method in Engineering Science", McGraw Hill. 4th Edition, 2009.
2. Robert Cook, "Concepts and Applications of Finite Element Analysis", Wiley, 4th Edition, 2010.
3. S.Md.Jalaludeen, "Introduction of Finite Element Analysis" Anuradha publications, 4th Edition, 2010.
4. J. N. Reddy, "An Introduction to Finite Element Methods", McGraw Hill, 4th Edition 2009.

VII.WEB REFERENCES:

1. https://www.google.co.in/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#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=0ahUKEwj8l5D3hqDQAhUJMI8KHVt1DDsQFggpMAI&url=http%3A%2F%2Ffaculty.ksu.edu.sa%2Frizwanbutt%2Fdocuments%2Ffem_lecture_notes.pdf&usg=AFQjCNEN0EUu9fHFOCd0vbEFwn0_sQxjsw&sig2=vrVKeosgduzEv22yxKaC3A&bvm=bv.138493631,d.c2I
3. https://www.kth.se/social/upload/5261b9c6f276543474835292/main.pdf.