

## FINITE ELEMENT METHODS

<b>V Semester: AE</b>								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAE009	Core	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
<b>Contact Classes: 45</b>		<b>Tutorial Classes: 15</b>		<b>Practical Classes: Nil</b>			<b>Total Classes: 60</b>	
<b>I. COURSE OVERVIEW:</b>								
<p>The finite element methods (FEM) are a numerical method widely used for modeling and analyzing structures. This course introduces the mathematical modeling concepts of the Finite Element Method for solving structural, thermal and dynamics problems that are too complicated to be solved by analytical methods.</p>								
<b>II. OBJECTIVES:</b>								
<b>The course should enable the students to:</b>								
<p>I The basic concepts of Finite Element methods and its applications to complex engineering problems.</p> <p>II The characteristics and selection of different finite elements used in finite element methods.</p> <p>III The equilibrium equations and stress-strain relations for different boundary conditions encountered in structural and heat transfer continuum problems.</p> <p>IV The application of the FEM technique to dynamic problems and validate the solutions through simulation software for real time applications.</p>								
<b>III. COURSE OUTCOMES:</b>								
<b>After successful completion of the course, students should be able to:</b>								
CO 1		Choose discretization concepts and shape functions of structural members for computing displacements and stresses of the aircraft components.					Apply	
CO 2		Utilize the shape functions of truss and beam elements for obtaining stiffness matrix and load vector to compute nodal displacement, stresses.					Apply	
CO 3		Identify the required discrete models of constant strain triangle element for estimating displacement and stress under load conditions.					Apply	
CO 4		Make use of axi-symmetric modeling concepts to solids of revolution for stress approximation					Apply	
CO 5		Apply numerical techniques of heat transfer problems to compute the temperature gradients under various thermal boundary conditions					Apply	
CO 6		Develop the governing equations for the dynamic systems to estimate circular frequency and mode shapes, in correlation with modern tools					Apply	
<b>IV. SYLLABUS:</b>								
<b>UNIT-I</b>	<b>INTRODUCTION</b>						<b>Classes: 10</b>	
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. One Dimensional Problems: 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.								
<b>UNIT-II</b>	<b>ANALYSIS OF TRUSSES AND BEAMS</b>						<b>Classes: 10</b>	
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.								
<b>UNIT-III</b>	<b>CONTINUUM ELEMENTS</b>						<b>Classes: 09</b>	
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 isoperimetric elements and problems.								

<b>UNIT-IV</b>	<b>STEADY STATE HEAT TRANSFER ANALYSIS</b>	<b>Classes: 09</b>
Steady state Heat Transfer Analysis: one dimensional analysis of slab, fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.		
<b>UNIT-V</b>	<b>DYNAMIC ANALYSIS</b>	<b>Classes: 07</b>
Dynamic Analysis: Formulation of finite element model, element –Mass matrices, evaluation of Eigen values and Eigen Vectors for a stepped bar, truss. 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 etc.		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. Tirupathi. R. Chandrapatla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, 3<sup>rd</sup> Edition, 2003.</li> <li>2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001.</li> <li>3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.</li> <li>2. K. J. Bathe, E. L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.</li> <li>3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4<sup>th</sup> edition, John Wiley and Sons, Inc., 2003.</li> <li>4. Larry J Segerlind, "Applied Finite Element Analysis", 2<sup>nd</sup> Edition, John Wiley and Sons, Inc. 1984.</li> </ol>		
<b>Web References:</b>		
<ol style="list-style-type: none"> <li>1. <a href="http://www.home.iitk.ac.in/~sbasu/me623_2006/fem_notes_me623.pdf">www.home.iitk.ac.in/~sbasu/me623_2006/fem_notes_me623.pdf</a></li> <li>2. <a href="http://www.nptel.ac.in/courses/112104116/">www.nptel.ac.in/courses/112104116/</a></li> <li>3. <a href="http://www.me.berkeley.edu/~lwlw/me128/FEMNotes.pdf">www.me.berkeley.edu/~lwlw/me128/FEMNotes.pdf</a></li> </ol>		
<b>E-Text Books:</b>		
<ol style="list-style-type: none"> <li>1. <a href="http://www.civilenggforall.com/2015/09/finite-element-analysis-by-ss-bhavikatti-free-download-pdf-civilenggforall.com.html">www.civilenggforall.com/2015/09/finite-element-analysis-by-ss-bhavikatti-free-download-pdf-civilenggforall.com.html</a></li> <li>2. <a href="http://www.books.google.co.in/books/about/Finite_Element_Analysis_For_Engineering.html">www.books.google.co.in/books/about/Finite_Element_Analysis_For_Engineering.html</a></li> </ol>		
<b>Course Home Page:</b>		