COURSE CONTENT

ADVANCED FINITE ELEMENT METHODS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEE22	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Mechanics of Solids								

I. COURSE OVERVIEW:

The course covers principles of finite element method as applied to linear and non-linear problems. The course will start by reviewing fundamentals of finite element method including discretization, element formulation, assembling process, boundary conditions, solving system of equations, and post processing. The focus will then shift to non-linear FEM. A brief summary of variational calculus and the classical theory of plasticity will be followed by the theory of non-linear FEM including various numerical integration schemes. This course will also include use of software/programming with available codes/in-house codes in solving nonlinear problems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The theory and characteristics of finite elements that represent engineering structures.
II. The finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.
III. The application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

III. COURSE OUTCOMES:

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

CO 1 Understand the concepts behind the weak formulation methods in FEM.
CO 2 Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.
CO 3 Illustrate the element characteristic equation and generation of global equation.
CO 4 Analyze the solution obtained for various boundary conditions suitable to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axisymmetric and dynamic problems and solve them displacements, stress and strains induced.
CO 5 Apply the numerical methods on heat transfer problems for developing thermal stiffness matrix and thermal load vector.
CO 6 Understand the concepts behind the weak formulation methods in FEM.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (09)
Review of various approximate methods - Rayleigh-Ritz and Galerkin - Stiffness matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

MODULE-II: DISCRETE ELEMENTS (09)
Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying section - Temperature effects in bar elements.

MODULE-III: CONTINUUM ELEMENTS (09)
Plane stress, Plane strain and Axi-symmetric problems - CST Element - LST Element. Consistent and lumped load vectors.

Use of local co-ordinates. Numerical integration. Application to heat transfer problems. Solution for 2-D problems (static analysis and heat transfer).

MODULE-IV: ISOPARAMETRIC ELEMENTS (09)
Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector. Solution for 2-D problems.

MODULE-V: SOLUTION SCHEMES (09)
Virtual work principle, Formulation of governing equation based on virtual work principle for static and dynamic problems.

V. TEXT BOOKS:

1. Segerlind, L.J. "Applied Finite Element Analysis", Second edition, John Wiley and Sons Inc., New York, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
3. S.S.Rao, "Finite Element Method in Engineering", Butterworth, Heinemann Publishing, 3rd edition, 1998
4. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley & Sons, 2002.

VI. REFERENCE BOOKS:

1. K.J. Bathe and E.L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India Ltd., 1983
2. C.S. Krishnamurthy, "Finite Elements Analysis", Tata McGraw-Hill, 1987

VII. ELECTRONICS RESOURCES:

1. www.home.iitk.ac.in/~sbasu/me623_2006/fem_notes_me623.pdf
2. www.nptel.ac.in/courses/112104116/
3. www.me.berkeley.edu/~lwlin/me128/FEMNotes.pdf

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.