COURSE CONTENT

ADVANCED FINITE ELEMENT METHOD								
II Semester: CAD / CAM								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BCCD13	**Core**	L	T	P	C	CIA	SEE	Total
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Pre requisites: Finite Element Methods								

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 for solving 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 Properties of Stiffness Matrix derived for various types of loads applied on bars, trusses and beams.
II. The finite element formulations and solve 2-D CST, Iso parametric Elements and, Stress-Strain Analysis for 3D Elements.
III. The Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity.
IV. The 2D and 3D finite element plates behavior and Boundary Element Formulation of Electrostatic Problems through Numerical implementation.

III. COURSE OUTCOMES:

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

CO1 Explain the energy principles and weighted residual methods to develop the finite element method governing equation for solving bar and trusses.
CO2 Develop 2D problems using CST elements and 3D problems with tetrahedron elements for analyzing the Plates and shells.
CO3 Evaluate the natural frequencies and thermal stresses for 2-D problems
CO4 Apply theory of plate bending for non-linear and anisotropic materials using C^0 and C^1 continuity elements.
CO5 Apply finite element method for solving electrostatic problems using boundary value methods.
CO6 Apply the boundary elemental method for formulation of electrostatic problems in three dimensional analysis.

IV. COURSE CONTENT:

MODULE -I: Finite Element Methods-A Review (10)

One Dimensional Problems: Formulation of Stiffness Matrix for a Bar Element by the Principle of Minimum Potential Energy, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic shape functions. Analysis of Trusses: Derivation of Stiffness Matrix for Trusses, Stress and strain Calculations, Calculation of reaction forces and displacements. Analysis of Beams: Derivation of Stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection, Stresses, Shear force and Bending moment, Problems on uniform and stepped beams for different types of loads applied on beams.

MODULE -II: Bending of Plates and Shells (10)
Finite element – formulation of 2D Problems: Derivation of Element stiffness matrix for two-dimensional CST Element, Derivation of shape functions for CST Element, Elasticity Equations, constitutive matrix formulation, Formulation of Gradient matrix. Two dimensional Isoparametric Elements and Numerical integration. Finite element: formulation of 3D problems: Derivation of Element stiffness matrix for Tetrahedron Element, Properties of Shape functions for 3D Tetrahedral Element, Stress-Strain Analysis for 3D Element, Strain Displacement for Relationship Formulation.

MODULE -III: Steady State Heat Transfer Analysis (09)
Steady state heat transfer analysis: One Dimensional Finite Element analysis of fin and composite slabs. Two-dimensional steady state heat transfer problems: Derivation of Thermal Stiffness matrix for 2D heat transfer problems-CST, Derivation of thermal force vector for 2D heat transfer problems.

Dynamic Analysis: Formulation of mass matrices for uniform bar and beam Elements using lumped and consistent mass methods, Evaluation of Eigen values and Eigen vectors for a stepped bar and beam Problems.

MODULE -IV: Plate Bending (10)
Plate Bending: Introduction, Plate behavior, C1 (Kirchoff) Plate elements, C0 (Mindlin) Plate elements, Mindlin beam, More devices for C0 Plate elements, Boundary conditions, Analytical problems Nonlinear finite element of solids: Material Nonlinearities, objective rates, nonlinear elasticity, Plasticity, visco-plasticity, viscoelasticity.

MODULE -V: Boundary Element Method (09)
Boundary Element Method: Potential Problems: Introduction, boundary Element Approach Fundamental solution. Numerical Implementation, Determination of Ci, Final Relation, three-dimensional analysis, tackling kernel singularity. Boundary Element Formulation for Electrostatic Problems: Introduction, Basic Relation Boundary condition, other relations. Discretization and Matrix Formulation, Determination of term C(p)m.

V. TEXT BOOKS:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, John Wiley & Sons, Incl., 4th edition, 2017.
2. O. C. Zienkiewicz, R. L. Taylor, J. Z. Zhu, “Finite Element Method: Its Basic and fundamentals”, Butterworth Heinemann, 6th edition, 2018.

VI. REFERENCE BOOKS:

1. K. J. Bathe, “Finite Element Procedures”, Prentice Hall, 3rd edition, 2018.
2. S. S. Rao, “Finite element method in Engineering”, Butterworth Heinemann, 12th edition, 2018.
3. J. N. Reddy, “An introduction to nonlinear finite element analysis”, Oxford University Press, 4th edition, 2018.

VII. ELECTRONICS RESOURCES:

1. http:// nptel.ac.in/courses/112/106/112106130/

VIII. MATERIALS ONLINE:

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