BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
First Semester 2015-2016
Course Handout (Part II)

Date: 03/08/2015

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further details regarding the course.

Course No.	**:**	**CE G619**
Course Title	**:**	**Finite Element Analysis**
Instructor-in-charge	**:**	**SHAMSHER BAHADUR SINGH**

1. **Course Description:**

Fundamentals of the finite element method (FEM); basic formulations of FEM; steps in FEM; 1-D, 2-D and 3-D elements; axi-symmetric elements, isoparametric elements; programming aspects in FEM; plate bending elements; shell elements; review of newly developed elements; material and geometric nonlinearity; Buckling and Vibration problems, application of FEM to civil engineering problems.

2**. Scope and Objective of the Course**:

Finite element method is the most powerful numerical method widely used for solving problems in different branches of engineering specially Civil Engineering. This method is usually used to solve complex problems with regard to complexity in material, geometry, boundary, and loading conditions, such as non-homogeneous material, irregular geometry, boundary conditions, and static & dynamic loading conditions. The course is aimed to enable students to understand the advanced concept of finite element method and its application to Civil Engineering.

3. Text Book

R. D. Cook, D. Malkus, M. E. Plesha, and R. J. Witt, Concepts and Applications of Finite Element Analysis, Wiley India, Fourth Edition, 2003.

4. Reference Books

1. O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu, The Finite Element Method: Its Basis & Fundamentals, Butterworth-Heinemann, 6th edition, Elsevier India, New Delhi, 2005.
2. Huebner and Thornton, The Finite Element Methods for Engineers, 2nd Edition, Mc-Graw-Hill.
3. Chandrupatla and Belegundu, Introduction to Finite Elements in Engineering, 2nd Edition, Prentice-Hall
4. C.S. Krishnamurthy, Finite Element Analysis: Theory and programming, Second Edition, 1994.
5. C. S. Desai and J.F. Abel, Introduction to Finite Element Method, CBS Publishers & Distributors, New Delhi, 1972.
6. Reddy, J.N., "An Introduction to Finite Element Method, 2nd Edition McGraw-Hill.

Sl No	Learning Objectives	Topics To be Covered	No. of Lects.	Chap./Art. Nos. of TB
1.	Introduction	Need of FEM in solids and structures, basic concept of FEM, advantages of FEM, Steps in FEM, derivation of force – displacement relation using virtual work method, Concepts of compatibility and completeness. Functionals and Governing Differential Equation, Strong and Weak form of Differential Equations, Natural and Essential Boundary Conditions.	5	1, RB6
2.	Variational Formulation an Approximation	Quadratic Functional, Rayleigh-Ritz Method, Finite Element Formulation using Variational Method	5	4
3.	Weighted Residual Methods	Galerkin Method for Finite Element Formulation	2	5
4.	Interpolation function	Interpolation function for basic and higher order elements, criterion for selecting the interpolation function	2	3
5.	Generalized Force – Displacement Relationship	Principle of virtual work, Derivation of generalized Force-displacement relationship using principal of virtual work, expressions for stiffness matrix and load vectors	2	3
6.	One-dimensional Elements	Development of Shape functions for one-dimensional elements, Development of stiffness matrix for Bar Element, Assembly of Elements, properties of structural stiffness matrix, application of boundary conditions, development of load vector, solution to equations, determination of strains, stresses and reactions, analysis of truss structures, Lagrangian and Serendipity shape functions for higher order 1-D elements, development of stiffness matrix and load vector for Higher order one-dimensional	4	3
7.	Two-dimensional Elements	Displacement functions for 2-D elements, Stress-strain relation for plane stress and plane strain problems, stiffness matrix for constant strain triangular (CST) element and linear strain triangular (LST) element, Shape functions for higher order Triangular elements, Lagrangian and Serendipity shape functions for rectangular elements, stiffness matrix for Lagrangian and Serendipity rectangular elements, defects in rectangular elements	6	3
8.	Axi-symmetric elements	Formulation of axi-symmetric elements and its application	3	14
9.	Beam elements	Stiffness matrix for beam elements in 2-D and 3-D, shear deformation in beams, analysis of 2-D and 3-D framed structures	2	15
10.	3-D elements	Review of various 3-D elements, Lagrangian and Serendipity Shape functions for 3-D elements, constitutive matrix for 3-D elasticity	2	3
11.	Isoparametric Elements	Introduction to isoparametric elements, Bi-linear quadrilateral elements, Quadratic quadrilateral elements, Hexahedral elements, Incompatible modes, static condensation, choice of numerical integration, consideration to various types of loads, stress calculation, effect of element geometry, validity of iso-parametric elements, Patch Test	4	6

12.	Triangular and tetrahedron Iso-parametric elements	Reference coordinates and shape functions, Element characteristic Matrix, Analytical Integration, Numerical Integration	3	7
13.	Plate Bending Elements	Plate Behaviour, Kirchhoff Plate Elements, Mindlin Plate Elements, shear locking	4	15
14.	Shells elements	Shell theory, Arch Elements, Shells of revolution, general three and four node shell elements, curved isoparametric shell elements, shear and membrane locking	4	16

6. **Evaluation Scheme**:

SN. No.	Evaluation Component	Duration	Weightage	Time	Venue	Nature of Component
1.	Mid Term Test	90 min	25	9/10 10:00 - 11:30 AM		CB
2.	Take Home Assignment	24 Hrs	10			OB
3.	Viva-Voce	30 min	10			-
3.	Assignments/ Computer Program/ Computer Based Take Home Assignments and Projects	—	20			-
4.	Compre Exam.	3 Hrs	35	10/12 AN		OB

7**. Chamber Consultation Hour**: To be announced in the class

8. **Notices**: All notices concerning the course will be displayed on Notice Board of Civil Engineering Group. Notices will also be sent through Course Management Tools (CMT) of BITS Pilani.

Instructor-In-Charge
CE G619