FEM IN STRUCTURAL ENGINEERING

Paper Code: ETCE-418	**L**	**T/P**	**C**
Paper: FEM in Structural Engineering	**3**	**1**	**4**

INSTRUCTIONS TO PAPER SETTERS: **MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

Objective*: To introduce the concept of the FEM for obtaining solution of ordinary and partial differential equation. The course deals with numerical discretisation as a finite element approach and deals with various methods/problems such as Continuum problems, weighted residual methods, higher order finite element approximation, variational methods, partial discretisation and time-dependent problems and generalized finite elements and error estimates.*

UNIT-I

Boundary Value Problems and the Need for Numerical Discretisation: Introduction, examples of Continuum problems, history of finite element method.

Weighted residual methods: Approximation by trial functions, weighted residual forms, piecewise trial functions, weak formulation, Galerkin method, examples of One-, two- and three -dimensional problems.

[T1,T2][No. of Hours: 11]

UNIT-II

Higher order finite element approximation: Degree of polynomial in trial functions and rate of convergence, the patch test, shape functions for C0 and C1 continuity, one-, two-and three-dimensional shape functions.

Isoperimetric formulation: The concept of mapping, isoperimetric formulation, numerical integration, mapping and its use in mesh generation.

[T1,T2][No. of Hours: 10]

UNIT-III

Variational Methods: Variational principles, establishment of natural Variational principles, approximate solution of differential equations by Rayleigh-Ritz method, the use of Lagrange multipliers, general Variational principles, penalty functions, least-square method.

Partial discretisation and time-dependent problems: Partial discretisation applied to boundary value problems, time-dependent problems via partial discretisation, analytical solution procedures, finite element solution procedures in time domain.

[T1,T2][No. of Hours: 12]

UNIT-IV

Generalized finite elements and error estimates: The generalized finite element method, the discretisation error in a numerical solution, measure of discretisation error, estimate of discretisation error

Coordinate Transformation: Transformation of vectors and tensors, transformation of stiffness matrices, degree of freedom within elements, condensation, condensation and recovery algorithm, sub structuring, structural symmetry.

[T1,T2][No. of Hours: 12]

Text Books:

[T1] Zienkiewicz, O.C., and Morgan, K., Finite Element Approximation, John Wiley and Sons.

[T2] Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill.

References:

[R1] Huebner, K.H., Thornton, E.A., and Byrom, T.G., The Finite Element Method for Engineers, John Wiley

[R2] Hutton, D.V., Fundamentals of Finite Element Analysis, McGraw Hill.

[R3] Kikuchi, N., Finite Element Methods in Mechanics, Cambridge University Press.

[R4] Cook, R.D., Malkus, D.S., Plesha, M.E., and Witt, R.J., Concepts and Applications of Finite Element Analysis, John Wiley and Sons.

[R5] Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, McGraw Hill.