Finite Element Analysis

B.E. Sem. VIII [MECH/AUTO]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	–	–
Oral Exam	–	25
Term Work	–	25

SYLLABUS

1. **Introductory Concepts**
   Introduction to FEM. Brief History. General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM.
   Differential Equations in different fields: Types of Differential Equations. Primary and Secondary Variables and types of Boundary Conditions.
   Matrix Algebra: Matrix operations, Gauss Elimination Method to get inverse of a Matrix. Partitioning of Matrix.
   Numerical Integration: Trapezoidal rule, simpson's $1/3^{rd}$ rule, Newton cotes formula, Gauss quadranture formula, Gauss quadranture in two dimensions.

2. **Approximate solution of differential equations**
   Weightaed residual techniques, collocation, Least squares and Galerkin methods.
   FEM Procedure : Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, essential boundary conditions, natural boundary conditions, homogeneous and non-homogeneous boundary conditions.

3. **Minimization of a functional**
   Principle of minimum total potential. Piecewise Rayleigh-Ritz method. Comparison with weighted residual method.
   Piecewise approximations: Basis of Finite Element Methods. Formulation of matrix method--"stiffness matrix"; transformation and assembly concepts.

4. Example problems in one dimensional structural analysis, heat transfer and fluid flow (Stepped and Taper Bars, Fins, Fluid Network, Spring-Cart systems, Plane Trusses, Beams).
   Elements of variational calculus. Band-width, aspect ratio, coarse and fine meshing, etc.

5. **Two dimensional finite element formulations**
   Introduction, Three nodded triangular element, four nodded rectangular element, six nodded triangular element, compatibility, four nodded quadrilateral element, eight nodded quadrilateral element, nine nodded quadrilateral element.
   Natural coordinates and coordinate transformations: Alternate methods for deriving shape functions, Natural coordinates – quadrilateral elements, Natural coordinates – triangular elements.
   Isoperimetric. Algorithms for solution of equations. Convergence criterion, patch test and errors in finite element analysis. Method of Elimination. Sources of error

6. **Finite element formulation of dynamics**
   Applications to free vibration problems. Lumped and consistent mass matrices. Algorithms for solution of Eigen value problems. Transient dynamics problems in heat transfer and solid mechanics.

References Books :

1. The Finite Element Method its Basis & Fundamentals (*O.C.Zienkiewicz, R.L.Taylor & J.Z.Zhu*) Butterworth-Heinemann, Elsevier
2. Finite Element Method, (*Reddy J. N.*) McGrawHill
3. The Finite Element Method in Engineering , 4th Edition (*S.S.Rao*) Academic Press, Elsevier
4. Finite Element Methods for Engineers (*U.S.Dixit*) Cengage Learning
5. Textbook of FE Analysis (*P.Seshu*) Prentice Hall
6. Introduction to Finite Elements Methods (*Desai and Abel*) CBS Publication.
7. Introduction to Finite Elements in Engineering (*Tirupati R. Chandrupatla & Ashok D.Belegundu*)
8. Introduction to Finite Element Methods (*Erik Thompson*) Wiley India.
9. Finite Elements Hand Book (*H. Kardestuneer*).
10. Concepts & Applications of Finite Element Analysis (*R.D.Cook*).
11. Finite Element Procedures in Engineering Analysis (*Bathe, K.J.*) Prentice Hall of India.
12. The Finite Element Method for Engineers (*Huebener K.H., Dewhirst D.D., Smith D.E. and Byrom T.G.*) John Wiley, New York.
13. Finite Element Methods (*Logan*) Cengage Learning
14. Finite Elements Analysis (*George Buchanan*) McGrawHill
15. Finite Elements Analysis (*C.S.Krishnamoorthy*) Tata McGrawHill
16. Concept and Application of Finite Element Methods (*Robert Cook*) Wiley India.

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