

# **AMMR-26 FINITE ELEMENTS METHODS IN ENGINEERING**

## **UNIT-1 INTRODUCTION**

- 1.1 Introduction. Historical Background. Design Considerations. Need of Finite Element Method.
- 1.2 The Process Of Finite Element Method, Field And Boundary Conditions, Steps Involved In Fem, The Standard Discrete System, Transformation Of Co-Ordinates.

## **UNIT-2 FINITE ELEMENTS OF ELASTIC CONTINUUM DISPLACEMENT APPROACH**

- 2.1 Introduction, Direct Formulation Of Finite Element Characteristic, Generalized Nature Of Displacements, Strains, And Stresses, Generalization To The Whole Region--Internal Nodal Force Concept Abandoned,
- 2.2 Displacement Approach As A Minimization Of Total Potential Energy, Convergence Criteria, Discretization Error And Convergence Rate,
- 2.3 Displacement Functions With Discontinuity Between Elements--Non-Conforming Elements And The Patch Test,
- 2.4 Bound On Strain Energy In A Displacement Formulation, Direct Minimization.

## **UNIT-3 GENERALIZATION OF THE FINITE ELEMENT CONCEPTS WEIGHTED RESIDUAL AND VARIATIONAL APPROACHES**

- 1.1 Introduction, Weighted Residual Methods, Approximation To Integral Formulations: The Weighted Residual Method,
- 1.2 Virtual Work As The 'Weak Form' Of Equilibrium Equations For Analysis Of Solids Or Fluids, Variation Principles,
- 1.3 Establishment Of Natural Variation Principles For Linear, Self-Adjoin Differential Equations, Maximum, Minimum, Or A Saddle Point,
- 1.4 Constrained Variation Principles, Lagrange Multipliers And Adjoin Functions.

## **UNIT-4 STRAIN PLANE STRESS AND PLANE**

- 4.1 Introduction, Element Characteristics, Some Practical Applications, Special Treatment of Plane Strain With An Incompressible Material.

## **UNIT-5 AXI-SYMMETRIC STRESS ANALYSIS**

- 5.1 Introduction, Element Characteristics, Some Illustrative Examples.

## **UNIT-6 THREE-DIMENSIONAL STRESS ANALYSIS**

- 6.1 Introduction, Tetrahedral Element Characteristics.

## **UNIT-7 ELEMENT SHAPE FUNCTIONS SOME GENERAL FAMILIES OF CONTINUITY**

- 7.1 Introduction, Two-Dimensional Elements, Completeness Of Polynomials, Rectangular Elements – Lagrange Family,

7.2 Rectangular Elements—‘Serendipity’ Family, Triangular Element Family, One-dimensional Elements, Three-Dimensional Elements, Other Simple Three-Dimensional Elements.

### **UNIT-8 CURVED, ISOPARAMETRIC ELEMENTS AND NUMERICAL INTEGRATION**

8.1 Introduction, Parametric Curvilinear Co-Ordinates, Geometrical Conformability Of Elements, Variation Of The Unknown Function With In Distorted, Curvilinear, Elements, Continuity Requirements,

8.2 Transformations, Element Matrices, Area and Volume Co-Ordinates, Convergence of Elements in Curvilinear Co-Ordinates, Numerical Integration.

### **UNIT-9 SOME APPLICATIONS OF ISOPARAMETRIC ELEMENTS IN TWO- AND THREE-DIMENSIONAL STRESS ANALYSIS**

4.1 Introduction, a Computational Advantage of Numerically Integrated Finite Elements.

#### **Reference Books:**

1. Introduction to Finite Elements in Engineering by T R Chandrupatla and A D Belegundu.
2. Introduction to the Finite Element Method by J N Reddy
3. Finite Element Analysis: Theory and Programming by C S Krishnamoorthy

