

# AMAE-25 FINITE ELEMENT ANALYSIS

## UNIT-1 INTRODUCTION

- 1.1 Historical Background
- 1.2 Mathematical Modeling of field problems in Engineering
- 1.3 Governing Equations- Discrete and continuous models
- 1.4 Boundary, Initial and Eigen Value problems- Weighted Residual Methods
- 1.5 Variational Formulation of Boundary Value Problems- Ritz Technique
- 1.6 Basic concepts of the Finite Element Method.

## UNIT-2 ONE-DIMENSIONAL PROBLEMS

- 2.1 One Dimensional Second Order Equations
- 2.2 Discretization- Element types- Linear and Higher order Elements
- 2.3 Derivation of Shape functions and Stiffness matrices and force vectors
- 2.4 Assembly of Matrices- Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.
- 2.5 Fourth Order Beam Equation- Transverse deflections and Natural frequencies of beams.

## UNIT-3 TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

- 3.1 Second Order 2D Equations involving Scalar Variable Functions
- 3.2 Variational formulation- Finite Element formulation- Triangular elements
- 3.3 Shape functions and element matrices and vectors.
- 3.4 Application to Field Problems-
- 3.5 Thermal problems- Torsion of Non-circular shafts-
- 3.6 Quadrilateral elements- Higher Order Elements.

## UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

- 4.1 Equations of elasticity- Plane stress, plane strain and axisymmetric problems
- 4.2 Body forces and temperature effects- Stress calculations, Plate and shell elements.

## UNIT V ISOPARAMETRIC FORMULATION

- 5.1 Natural co-ordinate systems- Isoperimetric elements- Shape functions for iso parametric elements-
- 5.2 One and two dimensions- Serendipity elements- Numerical integration and application to plane stress problems - Matrix solution techniques-
- 5.3 Solutions Techniques to Dynamic problems- Introduction to Analysis Software.

### References Books:

1. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004.
2. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.