# 17MD007ADVANCED FINITE ELEMENT ANALYSIS

| COURSE CODE | COURSE TITLE | L | P | T | C |
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| 17MD007 | ADVANCED FINITE ELEMENT ANALYSIS | | | | |

**Course Description and Objectives:**

This course explores the fundamental concepts of finite element methods, a numerical method to find the approximate solutions of various field problems. The objective of this course is to emphasize analysis and provide solutions using FEM for thermal and structural problems.

***Course Outcomes:***

Upon successful completion of this course student should be able to:

- understand the concept of plane stress and plane strain.
- recognize the behavior and usage of each type of elements covered
- perform numerical integrations in FE methodologies
- analyze and solve field problems using appropriate packages

**SKILLS ACQUIRED: Students are able to**

- Convert partial differential equations to linear algebraic equations.
- Implement energy method concepts to solve beam problems.
- Identify displacements, stresses of 1D structural problems
- Formulate iso-parametric elements.
- Provide solutions for thermal and structural problems.

**UNIT-I** **L-13**

Introduction- comparison of various FEA methods (Weight Residual, Displacement approach, Potential Energy approach, Galerkin approach, Virtual work approach, Rayliegh Ritz approach), Mathematical preliminaries of variational formulations and integral formulations.

**UNIT-II** **L-13**

Second – order differential equation in 1-D: Finite element models Basic steps of FEA for a boundary value problem, Applications in solid mechanics, heat transfer and fluid mechanics.

**UNIT-III** **L-13**

FEA applications: Plane trusses, Euler – Bernoulli Beam Elements, Application problems.

**UNIT-IV** **L-13**

Dynamic considerations : Formulation for point mass and distributed masses, element mass matrix ofone dimensional Bar element. Eigen vectors, Applications to Bars, Stepped Bars. Natural Frequencies, mode shapes

**UNIT-V** **L-12**

Single variable problems in 2-D: Introduction to Boundary Value Problems (BVP). Solution of plane stress and plane strain problems, Conductive and convective heat transfer using triangular elements.

**Activities:**

1. Solve 1D problems in bars
2. Solve 2D problems in structures visualized as assembly of springs
3. Solve beam problems
4. Solve vibration problems
5. Solve fluid flow problems
6. Solve heat transfer in fins problems

**TEXTBOOKS:**

[1] J N Reddy, An Introduction To The Finite Element Method, Mcgraw-Hill, New York, 1993.

**REFERENCE BOOKS:**

[2] R D Cook, D S Malkus and M E Plesha, Concepts And Applications Of Finite Element Analysis, 3d Ed., John Wiley, New York, 1989.
[3] K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, Nj, 1982.
[4] T J T Hughes, the Finite Element Method, Prentice-Hall, Englewood Cliffs, Nj, 1986[5] O C Zienkiewicz And R L Taylor, The Finite Element Method, 3d Ed. Mcgraw-Hill, 1989