20MD001 Computer Aided Simulation

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Course Description and Objectives:
This course explores the fundamental concepts of finite element 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 will 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.
- Evaluate the stresses and strains for one dimensional and two dimensional mechanical elements.

UNIT – I **L-12**
Introduction- comparison of various FEA methods (Weight Residual, Displacement approach, Potential Energy approach, Galerkin approach, Virtual work approach, Rayleigh Ritz approach), Mathematical preliminaries of variational formulations and integral formulations.

UNIT – II **L-12**
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-12**
FEA applications: Plane trusses, Euler – Bernoulli Beam Elements, Application problems.

UNIT – IV **L-12**
Dynamic considerations: Formulation for point mass and distributed masses, element mass matrix of one-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.

LAB EXPERIMENTS

1. To solve the given GDE of a boundary value problem using Rayleigh-Ritz method in excel

2. To solve the given GDE of a boundary value problem using Galerkin method in excel

3. To simulate 1D structural problems using ANSYS and compare with analytical solution

4. To simulate 1D thermal problems using ANSYS and compare with analytical solution

5. To simulate applications of plane truss using ANSYS

6. To analyze beams for various boundary conditions using ANSYS

7. To find natural frequency and mode shape of a plane bar using ANSYS

8. To find natural frequency and mode shape of a stepped bar using ANSYS

9. To simulate 1D structural problems using ANSYS and compare with analytical solution

10. To simulate 1D thermal problems using ANSYS and compare with analytical solution

TEXT BOOKS:

1. J N Reddy, An Introduction To The Finite Element Method, Mcgraw-Hill, New York, 2013

REFERENCE BOOKS:

1. R D Cook, D S Malkus and M E Plesha, Concepts And Applications Of Finite Element Analysis, 3d Ed., John Wiley, New York, 2009.

2. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, Nj, 2012.

3. T J T Hughes, the Finite Element Method, Prentice-Hall, Englewood Cliffs, Nj, 1986

4. O C Zienkiewicz And R L Taylor, The Finite Element Method, 3d Ed. Mcgraw-Hill, 2011