| COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|
| 1151AE218 | COMPUTATIONAL METHODS FOR AERONAUTICAL ENGINEERING | 2 | 2 | 2 | 4 |

**Course Category:**

Programme core

**a. Preamble:**

The course introduces to theoretical basics and practical application of the finite element method as well as to related numerical modeling techniques. It is designed to solve practical engineering problems related to solid mechanics, heat transfer. It provides necessary tool for the analysis and solution of practical structures and processes.

**b. Prerequisite Courses:**

- Numerical Methods using MATLAB
- Compressible flow Aerodynamics
- Aircraft structural Mechanics

**c. Related Courses:**

- Nil

**d. Course Educational Objectives:**

- To equip the students with basic methodology of Finite Element Method.
- To formulate the structural analysis using FEM.
- To perform engineering simulations using Finite Element Method software packages

**e. Course Outcomes:**

Upon the successful completion of the course, students will be able to:

| CO Nos. | Course Outcomes | Knowledge Level (Based on revised Bloom's Taxonomy) |
|---|---|---|
| CO1 | Describe different types of computational methods | K2 |
| CO2 | Describe computational procedures | K2, S3 |
| CO3 | Solve one dimensional problems using numerical techniques | K4, S3 |
| CO4 | Solve the problems on plane elasticity | K4, S3 |
| CO5 | Solve heat transfer and torsion problems by application of FEM and compare with theoretical solutions | K4, S3 |

**f. Correlation of COs with POs:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | **H** | | | **H** | | | **H** | **H** | **H** | **H** | | |
| CO2 | **H** | **H** | | **H** | | | **H** | **H** | **H** | **H** | | |
| CO3 | **H** | | | **H** | | | **H** | **H** | **H** | **H** | | |
| CO4 | **H** | | | **H** | | | **H** | **H** | **H** | **H** | | |
| CO5 | **H** | **H** | | **H** | | | **H** | **H** | **H** | **H** | | |

H- High; M-Medium; L-Low

**g. Course Content:**

**UNIT-I INTRODUCTION TO COMPUTATIONAL METHODS 12**

Review of fluid mechanics, Types of fluid flow, governing equations of fluid flow- Continuity, Momentum, energy equations, Boundary conditions, Governing equations for incompressible and compressible flows- Introduction to FEA- Classical Techniques in FEA -Finite Element Method-Finite Volume Method-Finite difference method.

**UNIT-II COMPUTATIONAL PROCEDURES 12**

Process in CFD and FEA- preprocessing- mathematical modeling, Geometry and mesh creation, solver- Discretization method (Basics) and post processing- Contours, vectors, plots, streamlines, Residuals

**UNIT III APPLICATIONS OF 1D ELEMENT 12**

Stiffness matrix formulation of 1D element - Bar, Truss and Beam-Numerical applications of 1D element.

**UNIT IV PLANE ELASTICITY PROBLEMS 12**

Various types of 2-D-elements Application to plane stress, plane strain and Axisymmetric analysis**.**

**UNIT V FIELD PROBLEMS 12**

Applications to other field problems like heat transfer and fluid flow.

**List of Experiments 30**

1. Flow analysis over a flat plate
2. Flow analysis over a cylinder
3. Fluid flow over typical airfoil
4. Structural analysis using 1D element
5. Structural analysis using 2D plane elasticity element
6. Stress analysis of plate with hole using 3D element
7. Thermal analysis of a rod using 1D heat conduction element
8. Thermal analysis of a plate using 2D heat transfer element

**Total Periods: 90**

**h. Learning Resources**

**i. Text Books:**


1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, Third Edition,Prentice Hall India, 2003
2. Rao. S.S., " The Finite Element Methods in Engineering," 5th edition, Butterworth and Heinemann, 2010
3. Reddy J.N., "An Introduction to Finite Element Method", 3rdedition, McGraw Hill, 2005


**ii. Reference:**


1. Daryl L. Logan, “A First Course in the Finite Element Method”, 5th edition, Cengage Learning, 2012
2. Krishnamurthy, C.S., "Finite Element Analysis", 2nd edition, Tata McGraw Hill, 2001.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
4. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003.
5. Larry J Segerlind, "Applied Finite Element Analysis", Second Edition, John Wiley and Sons, Inc.1984.