I YEAR M. TECH (MACHINE DESIGN) FIRST SEMESTER

17MEMD1T5D COMPUTATIONAL FLUID DYNAMICS Credits 4

Lecture: 4 periods/week **Internal assessment: 40 marks**

Tutorial: - - **Semester end examination: 60 marks**

COURSE OBJECTIVES:

- Demonstrate the governing flow equations for a fluid dynamics problem.
- Outline the Partial Differential Equations (PDEs) and various discretization techniques.
- Apply the basic knowledge of Computational Fluid Dynamics (CFD) to Nozzle flow problems and Incompressible flow problems.
- Apply the basic knowledge of CFD to Heat Transfer problems.

COURSE OUTCOMES:
After completion of the course, student should be able to

1. Describe governing flow equations for a fluid dynamics problem.
2. Classify the Partial Differential Equations (PDEs) and various Discretization techniques.
3. Apply the basic knowledge of Computational Fluid Dynamics (CFD) to Nozzle flow problems and Incompressible flow problems.
4. Apply the basic knowledge of CFD to Heat Transfer problems.

UNIT-I
INTRODUCTION
Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics,
GOVERNING EQUATIONS OF FLUID DYNAMICS:
Introduction, Models of the Flow, Substantial Derivative, Divergence of Velocity, Continuity Equation, Momentum Equation and Energy Equation, Conservation and Non-conservation forms of Governing Flow Equations.

UNIT-II
PARTIAL DIFFERENTIAL EQUATIONS – ITS MATHEMATICAL BEHAVIOR
Introduction, Classification of Quasi-Linear Partial Differential Equations, Eigen Value Method, Hyperbolic Equations, Parabolic Equations, Elliptic Equations.
DISCRETIZATION
Introduction, Finite Differences, Difference Equations, Explicit and Implicit Approaches, Errors and Stability Analysis, Grid Generation.
TRANSFORMATION OF GRIDS
Transformation of Equations, Metrics and Jacobians, Transformed version of Governing Flow Equations.

UNIT-III

CFD TECHNIQUES

Introduction, The Lax Wendroff Technique, MacCormack's Technique, The Alternation-Direction Implicit (ADI) Technique, Pressure Correction Technique.

CFD Application to Nozzle Flow Solution to Subsonic-Supersonic Isentropic flow using MacCormack's Technique

CFD Application to Incompressible Couette Flow Solution by using Pressure Correction method.

UNIT-IV

NUMERICAL METHODS IN HEAT CONDUCTION

One-Dimensional Steady Heat Conduction in a plane wall and boundary conditions; Two-Dimensional Steady Heat Conduction and boundary conditions; Transient Heat Conduction in a plane wall; Two-Dimensional Transient Heat Conduction in a rectangular coordinates.

Learning Resources

Text Books

1. John. D. Anderson, Computational fluid dynamics - Basics with applications, McGraw Hill
2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher. Computational Fluid Mechanics and Heat Transfer. NewYork: Hemisphere, 1984.

REFERENCES

1. Suhas V. Patankar, Numerical heat transfer and fluid flow, Butter-worth Publishers.
2. T. K Sengupta, Fundamentals of Computational Fluid Dynamics, University Press