

IV B.Tech I Semester

15AME58-COMPUTATIONAL FLUID DYNAMICS

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Course Objective:

This course covers topics related to Computational Fluid Dynamics (CFD). CFD is an important tool in engineering analysis and design of fluid systems. In this course Students will develop the equations describing fluid flow and numerical solutions to these equations. Emphasis will be placed on understanding different approaches employed for both time and spatial discretization and how to evaluate these approaches. Students will look at time accurate and steady-state methods, explicit and implicit techniques, laminar and turbulent flow, compressible and incompressible approaches, stability considerations, etc. These techniques will be applied to applications of mixing and heat transfer.

UNIT I

Introduction: Methods to solve a physical problem, numerical methods, brief comparison between FDM, FEM & FVM, applied numerical methods. Solution of a system of simultaneous linear algebraic equations, Iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices. Finite difference applications in heat conduction and convection, heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer.

Learning outcome & Suggested Student Activities:

This chapter gives the overall view of the various kinds of numerical methods adopted. It also discusses about various solutions for the numerical methods adopted in CFD. The applications of finite difference methods with examples in conduction and convective heat transfer are introduced.

UNIT II

Finite Differences: Discretization, consistency, stability, and fundamentals of fluid flow modeling. Introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

Learning outcome & Suggested Student Activities:

This chapter gives how to discretize partial differential equations, including the governing flow equations which is the foundation for the finite difference method. Explicit and implicit approaches represent the fundamental distinction between various numerical techniques.

UNIT III

Errors and Stability Analysis: introduction, first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modeling, conservative property, the upwind scheme.

Review Of Equations Governing Fluid Flow And Heat Transfer:

Introduction, Conservation of mass Newton's second law of motion, expanded forms of Navier-stokes equations, conservation of energy principle, special forms of the Navier stokes equations.

Learning outcome & Suggested Student Activities:

This chapter focuses on numerical errors that are generated and how the numerical calculations become unstable and also entails the conservations of mass, momentum and energy equations to the fluid flow along with Navier stokes equation.

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UNIT IV

Steady Flow: Dimensions form of momentum and energy equations, navier stokes equation, and conservative body force fields, stream function, vorticity formulation, boundary, layer theory, buoyancy, driven convection and stability.

Learning outcome & Suggested Student Activities:

This unit gives the fundamental principles of fluid mechanics, its governing differential equations and boundary conditions.

UNIT V

Simple Cfd Techniques: Viscous flows conservation form space marching, relocation techniques, viscous flows, conservation from space marching relocation techniques, artificial viscosity, the alternating direction implicit techniques, pressure correction technique, computer graphic techniques used in CFD. Quasi one dimensional flow through a nozzle, turbulence models, standard and high reynolds number models and their applications.

Learning outcome & Suggested Student Activities:

This unit gives the information about some techniques for numerical solutions for flow problems. These equations are applicable to time and space marching solutions especially parabolic hyperbolic and elliptic equations.

TEXT BOOKS:

1. Computational Fluid Dynamics, J Chung (2010), 2nd edition, Cambridge University Press
2. Computational Fluid Dynamics, John .D. Anderson (2010), 3rd edition, McGraw- Hill International Edition, India.

REFERENCE BOOKS:

1. Computational Fluid Dynamics for Engineers, Ronnie Anderson (2012), 2nd edition, Cambridge University Press, India.
2. Computational aerodynamics and fluid dynamics an introduction, Jean-Jacques Chattot(2010),3rd edition, Springer, Germany.
3. Essential computational fluid Dynamics - olegzikanov, wiley India.
4. Introduction to computational fluid dynamics - pradip, Niyogi S.K. Chakrabary, M.K. Laha - pearson.

