III Year B.Tech. Mechanical Engg. II-Semester

L	T	P	To	C
3	1	-	4	4

ME326 COMPUTATIONAL FLUID DYNAMICS

(Dept. Elective - II)

Course Description & Objective:

Students will be taught to appreciate how computers are used to perform millions of calculations required to simulate the interaction of fluids and gases with the complex surfaces used in engineering.

Course Outcomes:

1. *Understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing and analyzing the results.*
2. *Become conscious of the limitations of CFD and develop an appreciation for the factors limiting the accuracy of CFD solutions.*
3. *To develop an understanding for the major theories, approaches and methodologies used in CFD and apply it to numerically solve the governing equations for fluid flow*
4. *To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.)*
5. *Understand and apply finite difference methods to fluid flow problems*
6. *Understand how to assess stability and conduct a grid-convergence assessment.*

UNIT - I Governing Equations and Boundary Conditions:

Basics of computational fluid dynamics – Definition and overview of CFD, need, advantages, problem areas, Governing equations of fluid dynamics – Continuity, Momentum and Energy equations — Physical boundary conditions.

UNIT - II Partial Differential Equations:

Mathematical behavior of PDEs in CFD: Elliptic, Parabolic and Hyperbolic equations. Methods of Deriving the Discretization Equations - Taylor Series formulation – Introduction to Finite difference method – Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis.

UNIT - III Solution methodologies: The Lax-Wendroff Technique, MacCormack’s Technique, Space marching, Direct and iterative methods, Thomas algorithm, Alternating Direction Implicit method.

UNIT - IV Heat Conduction:

Finite difference formulation of steady and transient for one-dimensional and two-dimensional conduction equation, incorporating boundary conditions.

UNIT - V Incompressible Navier Stokes equation

Finite-Difference Methods : Choice of Governing Equations, one-directional Flow; Velocity/Pressure Formulation, Velocity/Vorticity Formulation, Stream Function/Vorticity Formulation, Two-Dimensional Flow; Stream Function/Vorticity Formulation, Velocity/Pressure Formulation, Boundary conditions, staggered grid, Marker and Cell Method.

TEXT BOOKS :

1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd ed., Longman Publication, 2004.
2. John D. Anderson Jr, "Computational Fluid Dynamics-The Basics withApplications", 6th ed., Mcgraw Hill, 2009.

REFERENCE BOOKS:

1. C. Hirsch, "Numerical Computation of Internal and External Flows", Volumes I and II, 2nd ed., John Wiley & Sons, 2007.
2. Subas, V.Patankar "Numerical heat transfer fluid flow", 2nd ed., Hemisphere Publishing Corporation, 2004.
3. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", 2nd ed., Narosa Publishing House New Delhi, 2011.
4. Fletcher C.A.J. "Computational Techniques for Fluid Dynamics", Volumes I and II, 2nd ed., Springer, 2000.
5. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Hemishphere Publishing Corporation, 1997.