17MD010COMPUTATIONAL FLUID DYNAMICS

COURSE CODE	COURSE TITLE	L	P	T	C
17MD010	COMPUTATIONAL FLUID DYNAMICS				

Course Description and Objectives:

This course offers computational methods to solve and analyze problems involving fluid flow and heat transfer. The objective of this course is to enable the students to simulate the interaction of fluids and gases with the surfaces for various initial and boundary conditions.

Course Outcomes:

Upon successful completion of this course student should be able to:

- develop a geometrical model for the fluid flow.
- apply appropriate boundary conditions and visualize the obtained results.
- gain skills in the actual implementation of CFD methods
- formulate finite difference and finite volume methods for various fluid flow problems
- assess stability of a given numerical scheme.

SKILLS ACQUIRED: Students are able to

- Convert partial differential equations to linear algebraic equations.
- Solve linear equations using various numerical techniques.
- Visualize the fluid flow patterns and heat transfer phenomenon using various plots.
- Analyze the results with available experimental results.
- Apply finite difference methods for various fluid flow problems.
- Perform stability and grid-convergence analysis for a given numerical scheme.

UNIT-I **L-13**

Introduction to Numerical Methods - Finite Difference, Finite Element and Finite Volume Methods – Classification of Partial Differential Equations – Solution of Linear Algebraic Equations – Direct and Iterative Approaches

Finite difference methods: Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems – Cartesian, cylindrical and spherical co-ordinate systems – boundary conditions – Un steady state heat conduction – Errors associated with FDE - Explicit Method – Stability criteria – Implicit Method – Crank Nickolson method – 2-D FDE formulation – ADI – ADE

UNIT-II **L-13**

Finite Volume Method: Formation of Basic rules for control volume approach using 1D steady heat conduction equation – Interface Thermal Conductivity - Extension of General Nodal Equation to 2D and 3D Steady heat conduction and Unsteady heat conduction

UNIT-III **L-13**

FVM to Convection and Diffusion: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions

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UNIT-IV **L-13**

Calculation of Flow Field: Vorticity & Stream Function Method - Staggered Grid as Remedy for representation of Flow Field - Pressure and Velocity Corrections – Pressure Velocity Coupling - SIMPLE & SIMPLER (revised algorithm) Algorithm.

UNIT-V **L-12**

Turbulent Flows: Direct Numerical Simulation, Large Eddy Simulation and RANS Models

Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

Activities:

1) **CFD analysis of laminar flow over plate in FLUENT**
2) **CFD analysis of turbulent flow over plate in FLUENT**
3) **CFD analysis of laminar flow over a sphere in FLUENT**
4) **Numerical analysis of convective heat transfer in FLUENT/MATLAB**

TEXTBOOKS:

1. Computational Fluid Flow and Heat Transfer – Muralidharan & Sundarajan (Narosa Pub)
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
4. Computational Fluid Dynamics – Anderson (TMH)
5. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)

REFERENCE BOOKS:

1. Computational Fluid Dynamics, T.J. Chung, Cambridge University
2. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)