COMPUTATIONAL FLUID DYNAMICS

VII Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
A5AE30	PCC	3	1	0	3	30	70	100

COURSE OBJECTIVES:

The course introduces basic aspects of the Computational Fluid Dynamics (CFD) which are involved in solving a Flow Problem using Numerical Methods. The Course shall impart knowledge of following aspects to the students.

1. Understand Basic Philosophy & ideas of CFD
2. Explaining Physics behind the Governing Equation
3. Identify Governing equations of Fluid Dynamics
4. Applications of CFD in various engineering discipline
5. Manipulating Governing Equation based on behavior of different types of PDE's and its impact on CFD
6. Describe Various Methods to discretize partial differential equation
7. List out Types of grids and Needs of Grid generation
8. List out Various techniques employed in CFD to solve Governing equation

UNIT-I INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS

Introduction to computational fluid dynamics, Research tool, Design Tool, Finite control volume, infinitesimal fluid element, substantial derivatives, divergence of Velocity. Governing Equations

UNIT-II GOVERNING EQUATIONS OF FLUID DYNAMICS

Form of Governing equation suited for CFD. Conservation form, Non Conservation forms, shock fitting and shock capturing.
Classification of Quasi-Linear Partial differential equation, The Eigen value method, General behavior of different classes of Partial differential equation, elliptic, parabolic and hyperbolic

UNIT-III DISCRETIZATION AND TRANSFORMATIONS

Introduction, Finite differences and formulas for first and second derivatives, difference equations, Explicit and implicit approaches, multidimensional finite difference formulas, finite difference formulas on non-uniform grids. Problems on 1D , 2D discretization using FDE,BDE,CDE

UNIT-IV GRID GENERATION

Need for grid generation. Structured grids- Cartesian grids, stretched (compressed) grids, body fitted structured grids, Multi-block grids - overset grids with applications.
Unstructured grids- triangular/ tetrahedral cells, hybrid grids, quadrilateral/hexahedra cells. Grid Generation techniques - Delaunay triangulation, Advance font method. Surface and volume estimations, grid quality and best practice guidelines.
Problems on grid transformations

UNIT-V CFD TECHNIQUES

Lax-Wendroff technique, MacCormack's technique, Crank Nicholson technique, Relaxation technique- aspects of numerical dissipation and dispersion, Alternating-Direction-Implicit (ADI) Technique. Pressure correction technique Numerical procedures- SIMPLE, SIMPLER algorithms SIMPLEC and PISO algorithms Boundary conditions for the pressure correction method. Parallel Computing.

Text Books:

1.John .D. Anderson "Computational Fluid Dynamics", McGraw Hill
2.Hoffmann, K.A: Computational Fluid Dynamics for Engineers, Engineering Education System, Austin, Tex., 1989

Reference Books:

1. J Blazek, “Computational Fluid Dynamics: Principles and Applications” Elsevier.
2. Chow CY,” Introduction to Computational Fluid Dynamics”, John Wiley, 1979

COURSE OUTCOMES:

Upon successful completion of this course, the student will have

1. Describe the major theories, approaches and methodologies used in CFD
2. Apply CFD methods (e.g. boundary conditions, turbulence modeling etc.) in commercial cfd codes and describe the limitations on accuracy
3. Apply CFD analysis to real engineering designs
4. Use finite difference and finite volume methods in CFD modeling