AMAEE21 COMPUTATIONAL FLUID DYNAMICS

UNIT-1 FUNDAMENTAL CONCEPTS

1.1 Introduction - Basic Equations of Fluid Dynamics
1.2 Incompressible In viscid flows: Source, vortex and doublet panel, methods - lifting flows over arbitrary bodies.
1.3 Mathematical properties of Fluid Dynamics Equations
1.4 Elliptic, Parabolic and Hyperbolic equations-
1.5 Well posed problems- discretization of partial Differential Equations.
1.6 Explicit finite difference methods of subsonic, supersonic and viscous flows.

UNIT-2 GRID GENERATION

2.1 Structured grids.
2.2 Types and transformations. Generation of structured grids.
2.3 Unstructured grids. Delany triangulation.

UNIT-3 DISCRETIZATION

3.1 Boundary layer Equations and methods of solution
3.2 Implicit time dependent methods for inviscid and viscous compressible flows
3.3 Concept of numerical dissipation
3.4 Stability properties of explicit and implicit methods
3.5 Conservative upwind discretization for Hyperbolic systems
3.6 Further advantages of upwind differencing.

UNIT-4 FINITE ELEMENT TECHNIQUES

4.1 Overview of Finite Element Techniques in Computational Fluid Dynamics.
4.2 Strong and Weak Formulations of a Boundary Value Problem.

UNIT-5 FINITE VOLUME TECHNIQUES

5.1 Finite Volume Techniques- Cell Centered Formulation- Lax- Vendoroff Time Stepping –
5.2 Runge-Kutta Time Stepping- Multi-stage Time Stepping
5.3 Accuracy- Cell Vertex Formulation - Multistage Time Stepping
5.4 FDM -like Finite Volume Techniques - Central and Up-wind Type Discretizations
5.5 Treatment of Derivatives.
5.6 Flux – splitting schemes. Pressure correction solvers- SIMPLE, PESO. Vorticity transport formulation. Implicit/semi-implicit schemes.

Reference Books:

1. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin, 1992
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley & Sons, New York, 1988.