## PAE5J003 COMPUTATIONAL FLUID DYNAMICS (4-0-0)

**OBJECTIVE**

To study the flow of dynamic fluids by computational methods

**Module-I**

FUNDAMENTAL CONCEPTS

Introduction - Basic Equations of Fluid Dynamics - Incompressible In viscid Flows: Mathematical properties of Fluid Dynamics Equations -_ Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations. Explicit finite difference methods of subsonic, supersonic and viscous flows.

**Module-II**

DISCRETIZATION

Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation –Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing.

**Module-III**

GRID GENERATION

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

**Module-IV**

FINITE VOLUME TECHNIQUES

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

**TEXT BOOK**

1. Fletcher, C.A.J., “Computational Techniques for Fluid Dynamics”, Vols. I and II,

Springer - Verlag, Berlin, 1988.

**REFERENCES**

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.

3. Klaus A Hoffmann and Steve T. Chiang. “Computational Fluid Dynamics for Engineers”, Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.

4. Anderson, Jr.D., “Fundamentals of Aerodynamics”, McGraw-Hill, 2000.