

ME 543 Computational Fluid Dynamics (3-0-0-6)

Basic equations of Fluid Dynamics: General form of a conservation law; Equation of mass conservation; Conservation law of momentum; Conservation equation of energy. The dynamic levels of approximation. Mathematical nature of PDEs and flow equations. Basic Discretization techniques: Finite Difference Method (FDM); Analysis and Application of Numerical Schemes: Consistency; Stability; Convergence; Fourier or von Neumann stability analysis; Modified equation; Application of FDM to wave, Heat, Laplace and Burgers equations. Integration methods for systems of ODEs: Linear multi-step methods; Predictor-corrector schemes; ADI methods; The Runge-Kutta schemes. Vorticity-stream function formulation. Solution of Navier-Stokes equations using MAC algorithm. The Finite Volume Method (FVM) and conservative discretization. Numerical solution of the incompressible Navier-Stokes equations: Primitive variable formulation; Pressure correction techniques like SIMPLE, SIMPLER and SIMPLEC; Brief introduction to compressible flows and numerical schemes – quick idea of Euler equations, homogeneity and flux jacobian. Introduction to upwind schemes.

Text/References

1. J. C. Tannehill, D. A. Anderson, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, CRC Press, 2012.
2. J. D. Anderson Jr., Computational Fluid Dynamics, McGraw-Hill International Edition, 2017.
3. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2017.
4. J. H. Ferziger, and M. Peric, Computational Methods for Fluid Dynamics, Springer, 2001.
5. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2010.
6. C. A. J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. 1 and 2, Springer, 1998.
7. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: The finite volume method 3e, Pearson Education, 2007.
8. C. Hirsch, Numerical Computation of Internal and External Flows, Vol.1 and 2, John Wiley & Sons, 2007.