AS5460: FINITE VOLUME METHODS FOR HYPERBOLIC PDES

Course Content:

Classification of PDEs – elliptic, hyperbolic and parabolic; discrete representation of PDE using Finite difference Method: accuracy, consistency and stability of discretized PDE; dissipation and dispersion errors, stability analysis using von Neumann and matrix methods; finite volume method: basic concept; Linear model equation: 1-D (wave) advection equation – exact solution, notion of wave speed and characteristic, numerical solution using FDM and FVM; upwinding methods Non-linear model equation: Burgers' equation – numerical solution to Burgers' equation; Godunov's scheme; shocks and centered expansions; shock speed System of linear equations: linear acoustics equations (1D), wave speeds / Eigen values and Eigen vectors, characteristic variables, Riemann problem and its solution, upwinding methods for system of equations; System of non-linear equations: Euler equations, conservation and quasi-linear form, flux Jacobian matrix, Eigen values and Eigen vectors, characteristic variables; Flux reconstruction methods for the Euler equation: flux- vector splitting schemes – van Leer, AUSM and LDFSS schemes; flux difference splitting scheme: Roe's method; Higher order interface state reconstruction: MUSCL scheme with limiters; Higher order time integration: Runge-Kutta methods;

TextBooks:

None.

ReferenceBooks:

1. **LeVeque, Randall J.** Finite volume methods for hyperbolic problems. Vol. 31. Cambridge university press, 2002.
2. **Pletcher, Richard H., John C. Tannehill,** and Dale Anderson. Computational fluid mechanics and heat transfer. CRC Press, 2012.
3. **Hirsch, Charles**. Numerical computation of internal and external flows: The fundamentals of computational fluid dynamics. Butterworth-Heinemann, 2007.
4. **Laney, Culbert B**. Computational gas dynamics. Cambridge university press, 1998.

Prerequisite: