

1. Introduction (1.5 weeks)

- A. Notational Issues
- B. Order notation
- C. Discretization of derivatives
- D. Operator notation
- E. Explicit and implicit schemes, computational molecules
- F. Measuring errors
- G. Ideas of consistency, stability and convergence
- H. Methods of discretization: direct discretization, control volumes
- I. Coding issues

2. Parabolic PDEs (6 weeks)

- A. Properties of solutions, boundary conditions, physical meaning
- B. One Dimensional Problems
  - a. Standard 2nd order schemes
  - b. Higher order schemes
  - c. Nonlinear equations
  - d. Systems of parabolic pdes
  - e. Summary of results
- C. Higher Dimensional Problems
  - a. Elementary methods
  - b. Iterative matrix methods
  - c. ADI methods
  - d. Implementation issues
  - e. 3d schemes
  - f. Polar coordinates
  - g. Summary of results

3. Hyperbolic PDEs (6.5 weeks)

- A. Properties of solutions, boundary conditions, physical meaning
  - a. Characteristics
  - b. Factorization
  - c. Discontinuities
  - d. Well-posed problems
- B. One dimensional problems
  - a. Advection equation
    - 1. Stability
    - 2. Upwinding and other standard schemes

3. Dissipation and dispersion
    4. Curved characteristics, travel time coordinates
  - b. Nonlinear conservation laws
    1. Introduction
    2. Standard schemes
    3. Godunov method
    4. MUSCL scheme
  - c. Second order equations
    1. Explicit schemes
    2. Implicit schemes
    3. Conversion to first order systems
  - d. Systems of advection equations
    1. Introduction and standard schemes
    2. Flux vector splitting
    3. Isothermal equations of gas dynamics
- C. Higher Dimensional Problems
  - a. Advection equation
  - b. Wave equation
4. Case Studies  
(supplied by students)