

Study Guide for Third Exam
Exam date: December 10, 2015

Chapter 4. Nonlinear Hyperbolic Problems

- Nonlinear advection problem
- Aliasing, nonlinear instability – their origin and effects

Methods for controlling nonlinear instability

Systems of Hyperbolic Equations

- Finite difference schemes and their stability on shallow water equations on staggered and non-staggered grids.
- Accuracy of solutions, in terms of phase speed and group velocities, of inertial gravity waves presented on staggered and non-staggered grids
- Methods for dealing with insignificant fast waves

Boundary conditions for hyperbolic equations

- The concept of well posedness for wave equations based on characteristics
- Wave reflection at computational boundaries (general idea)
- Analysis of reflection with simple advection /wave equation.
- Open/Radiation boundary conditions (general idea)
- Other ways for controlling wave reflection at the lateral and top boundaries

Methods for Elliptic Equations

- Basic methods for solving simple elliptic equations, e.g., SOR and ADI
- Analysis of error reduction with iterative methods
- Rationale for and the general procedure of multi-grid methods for solving elliptic equations
- Costs of different methods

Semi-Lagrangian method for advection

- SL versus Eulerian methods
- Stability of SL methods
- General procedure of the implementation of SL methods
- Non-interpolation SL method
- Attractive aspects of SL methods and their weaknesses

Spectral Methods

- Grid point versus Spectral methods
- General Galerkin procedure
- Application of spectral methods to simple linear and nonlinear equations
- The solution procedure
- Comparison of spectral methods to grid point methods