Numerical Methods in Fluid Dynamics
Math 6890, Fall 2006

Instructor: Prof. D.W. Schwendeman (schwed@rpi.edu, 276-2647)

Office Hrs.: to be announced (422 Amos Eaton)

Ref. Texts:

1. Anderson, Tannehill and Pletcher, *Computational Fluid Mechanics and Heat Transfer*, Hemisphere, New York, 1984.
2. Hirsch, *Numerical Computation of Internal and External Flows*, Wiley-Interscience, 1988.
3. LeVeque, *Finite Volume Methods for Hyperbolic Problems*, Cambridge University Press, 2002.

Outline:

1. Preliminaries (ATP, chaps 2, 5; Hirsch, chaps 1, 3)

   Topics: derivation of the equations of fluid flow, classification of PDEs, canonical forms and well-posed problems, behavior of solutions, characteristics.

2. Basic numerical methods (ATP, chaps 3, 4; Hirsch, chaps 4, 6–9)

   Topics: finite-difference and finite-volume methods, numerical methods for model equations, consistency and truncation error, stability analysis, convergence and order of accuracy, Lax theorem.

3. Inviscid flow problems (ATP, chap 6; Hirsch, part VI; LeVeque, chaps 11–15, 17)

   Topics: Euler equations (and reduced forms), quasi-linear and conservation forms, characteristics, shock waves and contact discontinuities, Riemann problems, shock-capturing methods, Godunov methods and approximate Riemann solvers, high resolution schemes, multidimensional problems, grid generation and adaptive mesh refinement, stiff source terms.

4. Viscous flow problems (ATP, chaps 7–9; Hirsch, part VII)

   Topics: Navier-Stokes equations, boundary-layer flows and numerical methods, steady and unsteady incompressible flows, primative variable and stream function-vorticity formulations.

Grading Policy:

Course grades will be based on Exams (midterm and final), a Term Computing Project, and problem sets/computing assignments. The weights for these are 50%, 20%, and 30% approximately.