MAE 223, Spring 2009
Computational Fluid Dynamics

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- **Course description:** Numerical methods for the solution of a variety of fluid flow problems will be presented. Finite difference, finite volume and spectral methods will be discussed.

- **Prerequisites:** MAE 290A, 290B or equivalent. MAE 210A, 210B or equivalent. Introduction to linear algebra, ordinary differential equations and partial differential equations.

- **Textbooks:** The following books can be used as reference: *Computational Techniques for Fluid Dynamics*, by C.A. J. Fletcher. The MAE 290B text, *Numerical Computation in Science and Engineering* by C. Pozrikidis. The MAE 290A text, Part II of the book by T. Bewley, draft copy downloadable from http://numerical-renaissance.com/Numerical_Renaissance.html

  A reading list is provided with the books in that list on reserve in the S&E library.

- **Course work:** There will be 2 hws (60 %) and a final project due on **Friday, June 5.** (40 %).

- **Programming:** The homeworks will involve a blend of numerical analysis and programming. You can start with Matlab for programming but will need to transition to Fortran by HW 2 and the final project. You can choose the assigned project or you can choose a project (after discussion with me) based on your research topic.

- **Lectures:** The times and location are: Tu, Th 2:00p - 3:20p HSS 2152

- **TA information:** A TA will be available for weeks 5-10.

- **Prof. Office hours:** Monday, 2:00-2:55

MAE 223
Reading list
(These books are on S&E library reserve)

C.A.J. Fletcher, Computational Techniques for Fluid Dynamics, 2nd edn, vols. 1 and 2, 1991

Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric, Springer-Verlag, 3rd edn. 2002

C Pozrikidis, Numerical Computation in Science and Engineering, 2008

MAE 223
Course Outline

Weeks 1-2	*Brief* review of the finite-difference method: discretization, accuracy, stability, convergence; 1- and 2-D unsteady convection-diffusion equation; Poisson equation.
Week 3,4	Finite difference method for the incompressible Navier-Stokes equations: Marker and Cell (MAC) method. Fractional step method. A RK3/finite difference method for the N.S. equations.
Week 5	Spectral methods for periodic problems: Discrete Fourier representation, Aliasing, Fast Fourier Transform (FFT), 1-D convection diffusion equation.
Week 6-8	A mixed spectral/finite difference method for the N.S. equations. Applications: Box turbulence, shear layer, channel flow.
Week 9-10	Large eddy simulation. Turbulence Models.