Course Outline

I. Mathematics of the Navier–Stokes equations

- A. Why we should care about the mathematics
- B. Some function spaces
- C. Classical, weak and strong solutions
- D. Mathematical representations of the N.–S. equations
- E. Main theorems on existence, uniqueness and regularity of N.–S. solutions

II. Special Difficulties Arising in Numerical Solution of N.–S. Equations

- A. The problem of pressure-velocity coupling
  1. various forms of N.–S. equations used for numerical computation; their problems associated with well posedness
  2. alternative gridding arrangements—the problem of "checkerboard" solutions, and how to solve it
- B. Cell-Re and high-wavenumber aliasing problems
  1. some standard cell-Re treatments
  2. solution filtering

III. The Main Computational Algorithms

- A. Marker-and-cell (MAC) method
- B. SOLA-VOF
- C. Artificial compressibility
- D. Projection methods
- E. SIMPLE and variants; PISO

Course Requirements

There will be no in-class written examinations in this course. There will be three homework exercises of varying weight (with regard to final course grade) and corresponding varying difficulty. These will basically consist of writing computer codes to implement three different N.–S. equation solution algorithms for 2-D problems posed in rectangular coordinates.
In addition, there will be a term project, the final report and presentation of which will serve as the final examination for the course. This will count for 40% of the total course grade.
The lecture notes will be available over the Internet at the URL

www.engr.uky.edu/∼me691

These notes contain numerous "exercises for the reader." Turning in solutions to a significant number of these can be used for extra credit. If all are handed in, and are substantially correct, a total of 10% of the total course points will be added to your point total.