Astronomy 5900/Physics 6860 Fall 2009 Numerical Methods in Astrophysics and Physics

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Office Hours: W 11:00 – 12:00, drop in, and by appointment
Class Meets: WF 9:00 - 10:15 in Nielsen Hall Room 103
Webpage: http://nhn.ou.edu/∼baron/num_meths/
Required Text: *An Introduction to Computational Physics (2nd Ed.)*, Tao Pang (Cambridge: Cambridge U Press)

Recommended Reading:

An Introduction to Computer Simulation
M. M. Woolfson and G. J. Pert
Numerical Recipes Second Edition
Press et al.
Numerical Methods that Work
Forman S. Acton
Real Computing Made Real
Forman S. Acton
Fortran 95 Language Guide
Wilhelm Gehrke
Fortran 95
Martin Counihan
Mathematical Methods for Digital Computers
Ralston & Wilf
Difference Methods for Initial-Value Problems
R. D. Richtmyer & J. von Neumann
Numerical initial value problems in ordinary differential equations
C. William Gear
Computational Techniques for Fluid Dynamics: Fundamental and General Techniques (Scientific Computation)

C. A. J. Fletcher
Computational Methods for Fluid Dynamics
Joel H. Ferziger & Milovan Peric

This course is an attempt to teach the art of numerical solution of equations that occur in physics and astrophysics problems. While I am most familiar with methods of solving non-linear equations, ordinary differential equations, and partial differential equations, I hope to treat additional topics of interest to the class.

The course is geared for upper division undergraduates and interested graduate students.

I will use astrophysical and physics problems to illustrate computer techniques, but it should be of general interest to all physics and astronomy students.
Topics I hope to cover are:

- Solution of non-linear equations
- Solution of systems of ordinary differential equations
- Finite Difference Methods for partial differential equations
- Message Passing, Asynchronous I/O, OpenMP
- Debuging
- Code Profiling
- Spectral and Finite Element Methods
- Other topics of interest to the class.

Course Prerequisites

You'll need to learn some computer language like: Fortran, C, or IDL, but I will help you and the homeworks should provide a path to learning to use fortran.

I will present examples in Fortran 95/2003 true code, where I will try to develop *good programming practices* and in Meta-code.
Note that the textbook uses Java as its example programing language. We'll see that reading different computer languages is not so difficult; however, writing (speaking) them requires a higher degree of knowledge, but none of us has the proficiency of a "native" speaker. We'll learn how to use the compiler to check our syntax and grammar.

The course requirements consist of class participation, homeworks which will involve writing computer programs and a final project which will be to choose some common problem in physics/astrophysics and present a numerical solution. Final projects will be tailored to your level of expertise. Students working on research problems are encouraged to bring your research into the classroom. That is I encourage you to work on a final project that is directly or indirectly related to your research. For students who have not yet begun research, I will suggest final project topics. You will be expected to present your work to the class. The final paper should be written up like a journal article (for astronomers like an ApJ article, for others like a Phys Rev article). A full list of references is required. If you take a piece of code from someone else you must explicitly refer to that fact in both your presentation, your paper, and your documented code. The final project will count for 35% of the grade, homeworks 50%, and class participation 15%.