Syllabus PHYS 3210 --- Introduction to Computational Physics

Instructor: Dr. Hui Wang
Office: Bioinformatics 224
Email: H.Wang@uncc.edu

Lecture room: Bioinformatics 104
Prerequisites: PHYS 2102 and MATH 2171.

Course objectives: The use of computers for computation and simulation is an integral part of the physics discipline. Moreover, computational physics has become as important as theoretical and experimental physics. Students will learn basic skills in programming in the context of solving physics problems. It is assumed that the student has no computer programming experience, and only modest understanding of physics at an elementary level. Through a variety of projects, the students are to obtain a deeper understanding of physical principles they already learned by solving physics problems and implementing computer simulations. This project-oriented, active learning approach allows students to work more comfortably at their own pace, where the student is engaged in solving problems in exploratory mode to gain better physical insight, similar to what is done in the context of research. In short, the objective of this class is to introduce you to how computers are used in physics, and for you to develop the basic skills that will be immediately useful in future classes, and in your career as your skills develop further.

Assignments and Projects: Assigned projects will require an informal documentation of implementation and the corresponding source codes, together with the outputs electronically. Two projects selected by the student (and approved by the instructor) will require a formal written report. Furthermore, each student will make a short presentation of one of these reports for the class. As such, additional computer/software skills are developed to make reports and presentations in a professional manner expected of a scientist.

Grading:
10% Random in-class quiz
40% Assigned projects (approximately 5)
20% Formal report for selected project I
20% Formal report for selected project II
10% Short class presentation (based on project II)

Grade scale: 0-59% F, 60-69% D, 70-79% C, 80-89% B, 90-100% A

Topics to be covered:
Basics of linear algebra, matrices and vectors
Interpolation and integration methods
Solving ODEs and PDEs
Optimization techniques
Simulating single particle motion and visualizing trajectories in 2D and 3D
Planetary motion and other few body problems
Oscillatory Systems
Numerical problems in electrodynamics
Monte Carlo simulation methods, random processes, Brownian motion and diffusion
Dynamics of many particle systems, simulations of thermal systems

Additional Topics for Formal Projects (to be selected by the student in consultation with the instructor)
Chaotic motion of dynamical systems
Normal modes and waves
Kinetic growth processes, percolation, fractals and thermal systems
Additional methods and models for simulating time evolution of complex systems
Quantum systems


Computer resources: The department of Physics and Optical Science has computer stations for students to use (Room 278). Personal computers (desktop or laptop) are also welcome.

Computer software: There is no requirement to use a specific programming language in this course. The Java computer language and Open Source Physics library are used extensively throughout the class textbook. The source code for programs discussed in the book and the Open Source Physics library can be downloaded freely from [www.opensourcephysics.org/sip](http://www.opensourcephysics.org/sip). The Open Source Physics library provides for easy graphical input of parameters, tabular output of data, plots, visualizations and animations, numerical solution of ordinary differential equations, and useful data structures. Combined with the author’s starter Java programs, it becomes easy for a novice to write powerful programs that are platform independent, simpler and more graphically oriented than other programming languages. The Open Source Physics library was developed by Wolfgang Christian, and his book: *Open Source Physics: A User's Guide with Examples* is an optional textbook for this class that discusses the Open Source Physics library in much more detail.

It would not be difficult to learn Java programming at an introductory level in this course, because the focus is not in teaching you a specific programming language. Rather you will learn general programming principles at an elementary level. If your interest is in computational physics, you should consider taking computer courses in the computer science department.

Other Computational Physics Books of interest:

More advanced texts:

Integrity: Students are required to read and abide by the Code of Student Academic Integrity. Violations of the Code of Student Academic Integrity, including plagiarism, will result in disciplinary action as provided in the Code. Definitions and examples of plagiarism are set forth in the Code. The Code is available from the Dean of Students Office or online at: [http://www.legal.uncc.edu/policies/ps-105.html](http://www.legal.uncc.edu/policies/ps-105.html)

* Note: I reserve the right to change class policy to serve the best interest of the class.