Phys 370 (3 credits) **Fall 2008**

Introduction to Computational Physics

Instructor: Dr. Alan R. Denton
South Engineering 214
alan.denton@ndsu.edu
Tel: 231-7036

Assistant: Goetz Kaehler
South Engineering 310
goetz.kaehler@ndsu.edu
Tel: 231-8977

Lectures: TTh 9:30-10:45
South Engineering 221

Office/Lab Hours: W 1:30-3:30 p.m.
Th 10:45-12:00

Bulletin Description: Introduction to computational methods, with applications involving planetary motion, numerical integration, chaotic oscillations, percolation, random walks, diffusion limited aggregation, and Fourier transforms.

Goals: Learn basic concepts and practical methods of computational physics; develop scientific programming skills through numerically solving a variety of physics problems.

Preparation: Programming experience is not required. Prereq: PHYS 251, MATH 166.

Classes: Interactive meetings, emphasizing discussion and hands-on problem solving.

Student Responsibilities: Attend all classes. Read assigned material in advance. Come prepared for discussion. Be curious; ask questions. Complete assignments on time.

Required Text: H. Gould, J. Tobochnik, and W. Christian,
Introduction to Computer Simulation Methods,
3rd edition (Pearson, 2007).

Evaluation: Homework assignments (70%); final project and presentation (30%).
Project topics, on various aspects of computational physics, will be assigned mid-semester.
Written project reports (including programs) are due: **Friday, December 5, 5:00 p.m.**
Oral presentations will be scheduled during the final two weeks of semester: **Dec. 8-19**.
Note: 10% of the project grade will be based on attending and evaluating presentations.

Homework: Teamwork is encouraged, but write your own report and list collaborators. Identical or near-identical programs will receive no points. Since solutions will be discussed on the due date, late assignments cannot be accepted. However, partial credit will be given to incomplete work, so be sure to submit whatever you have finished by the deadline.
In preparing laboratory reports, follow the guidelines in the Appendix of Chapter 1.
Submit homework via the Blackboard course homepage (`https://bb.ndsu.nodak.edu`).

Grading: A: 90-100%, B: 80-89.9%, C: 70-79.9%, D: 60-69.9%, F: $< 60\%$

Tentative List of Topics

- Computers in Physics: importance of computer simulation
- Introduction to Programming: Java, basic Unix commands, visualization
- Particle Motion: modified Euler algorithms, solving ODEs, trajectories
- Oscillatory Systems: simple harmonic motion
- Planetary Motion: equations of motion, circular and elliptical orbits
- Chaos and Dynamical Systems: period doubling, universality
- Random Processes: random walks, nuclear decay, polymers
- Dynamics of Many-Particle Systems: molecular dynamics
- Normal Modes and Waves: coupled oscillators, Fourier series, wave motion
- Electrodynamics: electric charges, fields, and potentials
- Monte Carlo Methods: integration, importance sampling, Metropolis algorithm
- Fractals and Kinetic Growth: fractal dimension
- Complex Systems: cellular automata, neural networks, genetic algorithms

Rules of the Road

- *No food or drinks are allowed in the computer lab (we love our computers)!*
- *If a program hangs the computer, do not reboot. Rather, contact an instructor.*
- *All access to NDSU computers must respect NDSU Senate Policy, section 158: Acceptable use of Electronic Communication Devices*
  `http://www.ndsu.nodak.edu/policy/158.htm`
- *All work done in this course must be completed in a manner consistent with NDSU Senate Policy, section 355: Code of Academic Responsibility and Conduct*
  `http://www.ndsu.nodak.edu/policy/355.htm`
- *Plagiarism or inappropriate use of computers will result in failure of the course.*
- *Any students with disabilities who need accommodation in this course are encouraged to speak with the instructor as soon as possible to make appropriate arrangements.*