PHYS474:
“Computational Physics”
Spring 2018

- Description: This course provides an overview of some of the most widely used methods of computational physics, including numerical integration, numerical solutions of differential equations, molecular dynamics simulations, and Monte Carlo simulations. In addition to giving the students a basic working knowledge of these particular techniques, *the goal is to make them proficient in scientific computing and programming in general, so that they will be prepared to tackle also other computational problems that they may encounter in the future.* (3 credits).

- Prerequisites: ~~PHYS404 (Stat. Mech.)~~; and PHYS373 (Math. Methods II); and (PHYS165, CMSC106, or CMSC131). Matlab will be used throughout this course; you must be familiar with its basic use (or a scientific programming language such as FORTRAN or C). I also strongly recommend first taking PHYS401/2.

- Instructor: Prof. Ian Appelbaum, Physical Sciences Complex, Rm. 2154.

  Phone: x5-0890 / e-mail: appelbaum@physics.umd.edu

  Please arrange a meeting time via email to discuss grades or other personal situations including absences. Questions about the course material should be directed to the asynchronous Q&A board on the course webpage at https://piazza.com/umd/spring2018/phys474.

- TA: TBA

- Course Web Site: All course materials, including this syllabus, homework assignments, solutions, lecture notes, etc. will be posted to the Piazza page.

- Schedule: 3:00pm–4:15am, Monday and Wednesday in AJC 2134.

- Homework: Homework is assigned approximately every other week via the Piazza page. Late homework will not be accepted and will receive a grade of 0.

- Grading: Your course (letter) grade is determined - at the END of the semester - by your numerical scores on homeworks (60%) and a final project (40%).

- Dropping the Course: The last day to drop the course is April 11.

- UMD course policy

Tentative and incomplete list of possible topics:

- Mechanics
  - Equations of motion: Verlet algorithm
  - Distributed systems: partial-differential equations, finite differences, and the Crank-Nicholson method, basis vectors and eigenproblems, boundary conditions
- E & M
  - Electrostatics: Laplace and Poisson equation
  - Dynamics: Wave propagation, resonance, transfer matrix method, diffraction and interference
- Statistical Mechanics
  - Random thermal motion: Metropolis-Hastings, Drift-diffusion
  - Phase transitions: Ising model of ferromagnetism
- Quantum Mechanics
  - Bound states: finite-differences and variational method, perturbation theory
  - Self-consistent Schrödinger-Poisson solution
  - scattering: transfer matrix, Green's functions and self-energy
  - periodic potentials and bandstructure

Also:
signal processing (FFT, polynomial interpolation, etc.), error analysis, computational complexity, root finding, Monte-Carlo, sparse matrix methods, Hopfield networks, quadrature …