Physics 333: Computational Physics Spring 2017

Course Information

- Instructor Name: Andrew Ware
- Office: CHCB 130 MTWF and SS 412 R
- Email: andrew.ware@umontana.edu
- Lectures: M@ 11:10 am – 12:30 pm and W 3:10 – 5:00 pm in CHCB 227
- Text: *Computational Physics,* 2nd Edition, Giordano and Nakanishi (required)
  A Primer on Scientific Programming with Python, Langtangen (recommended)
- Office Hours: MW 11 am – 12 pm & TR 10 – 11 AM & by appointment
- Website: umonline.umt.edu

Overview

The goal of this class is to learn some of the fundamental tools of computational physics. We will discuss both the power and the limitations of numerical methods. Part of this course will also be an introduction to Python programming.

Homework

I'll assign reading, which is **strongly** recommended to be read **before** you come to class. The work for this class will come in the form of Python exercises (not required!), about 6 homework assignments and 3 longer projects. All will involve some programming. For each homework assignment prepare a LaTeX, Word, OpenOffice, or equivalent document with your work including the discussion on your answers to the questions and include any figures that you produce. Create a pdf from this and send me the pdf file along with all the Python scripts created for that homework assignment. Send this in an email with subject as 'phsx 333 – hw 1' (or 2, 3, etc.). I'll include comments on your pdf files and send them back to you.

Projects

There will be 3 longer projects and these longer assignments consist of writing, evaluating, and documenting a code that solves an interesting physics problem. For the projects, you will be expected to write a report that includes an introduction that describes the physics of the problem, the numerical methods used, and your results including any figures that you produce. You can send these to me as a pdf file along with all the Python scripts created for that project in an email with the subject as 'phsx 333 – project 1' (or 2 or 3). Your final project includes a presentation (see below).

Exams

There will be no exams for this class. For the final, however, each student will present a brief talk discussing his or her final project. This will include a movie that you have made from your data.

Grading

Python Exercises	Optional – up to 5 % extra credit
Homework	45 %
Projects	45 %
Final presentation	10 %

Learning Objectives

After completing this course, you should:

Preliminaries

- Recognize and execute basic Python commands
- Run the iPython interpreter
- Execute a Python script in a UNIX terminal
- Produce a plot of your data with Python
- Understand the basic data types of Python and Numpy
- Recognize and use basic programming structures

Discretizing Differential Equations

- Analyze the truncation error of numerical integration schemes
- Perform numerical integration of ordinary differential equations
- Apply these skills to solving physics problems
- Present project results in a coherent report

Evolution of Fields

- Recognize and execute a discrete Fourier transform
- Apply this skill to solve a one-dimensional wave problem
- Analyze different time stepping techniques for PDEs

Random Distributions and Monte Carlo Methods

- Understand the basics of a numerical random number generator
- Understand and apply Monte Carlo integration
- Apply Monte Carlo techniques to model stochastic processes

Class Topics

Preliminaries

- The choice of programming language
- Scientific programming with Python (Numpy!)
- Analyzing and plotting data

Discretizing Differential Equations

- Numerical integration of an ordinary differential equation
- Implicit versus explicit methods and stability
- Numerical integration of a system of ODEs

Evolution of Fields

- Coupled oscillators and normal modes
- Numerical integration of partial differential equations
- Finite difference and spectral methods

Random Distributions and Monte Carlo Methods

- Random walks
- Monte Carlo methods
- Stochastic systems

Course Guidelines and Policies

Student Conduct Code

The Student Conduct Code at the University of Montana embodies and promotes honesty, integrity, accountability, rights, and responsibilities associated with constructive citizenship in our academic community. This Code describes expected standards of behavior for all students, including academic conduct and general conduct, and it outlines students' rights, responsibilities, and the campus processes for adjudicating alleged violations. Full student conduct code: http://www.umt.edu/vpsa/policies/student_conduct.php

Course Withdrawal

Students may use Cyberbear to drop courses through the first 15 instructional days of the semester. Beginng the 16th instructional day of the semester through the 45th instructional day, students use paper forms to drop, add and make changes of section, grading option or credit. PHSX 101 can only be taken as credit/no-credit.

Disability Modifications

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or call 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

[This course can be taken for a traditional letter-grade only]