Syllabus – PHYS 220 – Spring 2020

Course Information:

PHYS 220:	Introduction to Computational Physics, 4 credits, Spring 2020
Lecture:	MWF, REIC 165, 13:00-14:00
Laboratory:	REIC Noyes Lab, Thurs 8:00-11:00

Instructor Information:

Instructor:	Peter Delamere, Professor of Space Physics
Office:	708E Elvey (Geophysical Institute)
Email:	padelamere@alaska.edu
Phone:	(907) 474-6442
Office Hours:	Tues: 1:00 to 4:00 (Reichardt) or By appointment (Elvey)

Prerequisites: MATH F252X; PHYS F211X; PHYS F212X; PHYS F213X; or permission of instructor.

Scope: This course is intended as an introduction to the art and science of solving physics problems with a computer. The computer will be used as a tool to provide insight into physical systems and their behavior in all areas of physics. It is designed for undergraduate students who have completed their introductory coursework in physics and calculus.

Student learning outcomes: The overarching goal of this course is to teach you how to think critically about using the computer as a tool for understanding the physical world. Specific goals are:

- Learn to develop numerical algorithms and turn them into workable code.
- Learn to solve ordinary differential equations using computational tools. 3) Introduce computational data handling tools, such as the Fast Fourier Transform and simple data fitting.
- Introduce the numerical solution of partial differential equations
- Understand the concept of using random walks to solve physical problems

The course will have succeeded if you will know the necessary tools to address problems in physics that cannot be solved analytically, and if you feel comfortable using these tools.

Textbook: The course curriculum is based on *Computational Physics, 2nd Ed.* by Giordano and Nakanishi. The book is not required, but does provide useful additional information. However, it is Fortran based, and we will program in Python in this class.

A good Python-based book is *Computational Physics* by M. Newman. Much of that material is available online at http://www-personal.umich.edu/ mejn/computational-physics/ Generally, there are many online resources for help with Python, and you're encouraged to spend some effort finding one that suits you well.

Programming language: Python

Laboratory: There is a weekly 3-hour lab session associated with this course. Please note that the first lab session will not take place until Thursday, 23 January 2020. Each week you will have a laboratory session involving problems in computational physics. You should be able to complete the bulk of your lab work and report during the laboratory session. During the lab sessions you should not expect me to provide answers to your every question, as the laboratory is a place of self-discovery.

Project: You will choose a computational physics problem of your own, develop and execute a solution. You are encouraged to develop your own idea, but extensions to lab problems (add more physics) are suitable topics. The textbook, other books, and the internet offer many suggestions for suitable projects. You are encouraged to discuss these with the instructor.

A written project proposal will be submitted not later than the lecture session of 9 March. The project proposal should be no longer than 2 typewritten pages. It includes a fitting title, concise abstract, a description of the physics addressed in the project, a short description of the numerical methods used, and a list of expected results (figures, code, etc). The instructor will provide feedback on the content of this proposal, as well as the writing. The project proposal is part of the final project grade.

You will submit a complete, written solution of the problem, to include working codes, prior to the beginning of the final scheduled lecture. The final report will be an expanded version of the Project Proposal with title, abstract, explanation of the physics investigated, description of the numerical method, presentation of results, a conclusion, and a bibliography. The expected length of the report is about 4 pages. You should also submit all working code as an appendix (in addition to these 4 pages). You will give a 10-minute presentation of your project to the class during the final lab session on April 23. The presentation should be structured similarly to your written report. You will receive some additional guidance for making oral presentations during class, one or two weeks before the end of the semester.

Grading: Grades will be based on the weights given here and ± modifiers will be used. Letter grade ranges will be assigned as follows: A+ [97-100%], A [93-96%], A- [90-92%], B+ [87-89%], B [83-86%], B- [80-82%], C+ %[77-79%], C [73-76%], C- [70-72%], D+ %[67-69%], D [63-66%], D- [60-62%] and F %[<60%].

Homework	15%
Laboratory	20%
Project	15%
Participation	10%
Midterm	20%
Final Exam	20%

Course Policies:

(a) You are expected to fully attend both the laboratory and lecture sessions. Planned absences should be discussed with me in advance. Habitual tardiness or absenteeism affects not only your own performance, but also that of your classmates. Assessment will be based on your contributions to class discussions and laboratory investigations.
(b) Weekly homework assignments are based on the lectures and labs. These assignments will be due one week after they are assigned.
(c) Students are encouraged to work together on homework problems, but the final written solutions must be individual work.
(d) Students must acknowledge all sources of information – included fellow students – used in homework solutions and final projects. The UAF catalog states: "The university may initiate disciplinary action and impose disciplinary sanctions against any student or student organization found responsible for committing, attempting to commit or intentionally assisting in the commission of . . . cheating, plagiarism, or other forms of academic dishonesty. . . "
(e) All UA student academics and regulations are adhered to in this course. You may find these in the UAF catalog (section "Academics and Regulations").

Student protection and services statement:

(a) Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. As required, if I notice or am informed of certain types of misconduct, then I am required to report it to the appropriate authorities. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook/
(b) The University of Alaska Fairbanks is an AA/EO employer and educational institution and prohibits illegaldiscrimination against any individual: https://alaska.edu/nondiscrimination/.
(c) The University of Alaska Fairbanks is committed to equal opportunity for students with disabilities. Students with disabilities are encouraged to contact the coordinator of Disability Services at the Center for Health & Counseling (x7043).
(d) Your instructor follows the University of Alaska Fairbanks Incomplete Grade Policy: "The letter "I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C orbetter) the majority ofwork in a course but for personal reasons beyond the student's control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an "I" grade."
(e) Effective communication: Students who have difficulties with oral presentations and/or writing are strongly encouraged to get help from the UAF Department of Communication's Speaking Center (907-474-5470, speak@uaf.edu) and the UAF English Department's Writing Center (907-474-5314, Gruening 8th floor), and/or CTC's LearningCenter(604 BarnetteStreet,907-455-2860).

Schedule:

Topic	Week	Dates
Introduction to programming	1	
The cooling problem and 1st order Euler scheme	2	
Projectile motion	3	
Oscillatory motion	4	
Higher order methods for ODEs	5	
The Kepler problem	6	
Chaotic motion	7	
Midterm	8	Wednesday, March 4
Wave Phenomena	9	
Spectral analysis	10	
Laplace and Poisson Equations	11	
Currents and Magnetic Fields	12	
Numerical Integration	13	
Random Systems	14	
Quantum Mechanics: The Schoedinger Equation	15	
Final exam	16	1-3 p.m., Wednesday, April 29