Course syllabus: PHY 277 Computational Physics and Astronomy Spring 2024

An introduction to computing on UN*X/Linux computers. Fundamentals of using UN*X/Linux to write computer programs for numerical algorithms to solve computational physics and astronomy problems. Assignments are carried out in a high-level compiler programming language such as Fortran 90 or C++ and require extensive use of SINC site computers outside the classroom. *Prerequisite:* PHY 125, 126, 127; or PHY 131, 132, 133, 134; or PHY 141, 142; AMS 151 or MAT 126 or 131 or 141. *Advisory Prerequisite:* AMS 161 or MAT 127 or 132 or 142 or 171. *3 credits.*

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Meeting: MWF 10:00 – 10:53 AM, Mathematics S235.

Office Hours Calder: Tues. 10:00–11:30 AM, Wed. 1:00–2:00 PM. Other times by appointment.
Office Hours Lloyd: Tues. 2:45–4:15 PM, Wed. 12:00–1:30 PM. Other times by appointment.

Texts: *Fortran 95/2003 for Scientists and Engineers* (4th edition) by Chapman.
Absolute C++ (6th edition) by Savitch.

Evaluation: There will be 2 mid-term exams, homework assignments, and a final exam. The course score will be weighted as follows: 25% for the homework assignments, 20% for each midterm exam, and 35% for the final. Homework assignments will be graded on a point scale but each assignment will count roughly the same amount.

Homework: Homework will be assigned most weeks and will be due the following week. Late homework will not be accepted without prior permission. Homework should be uploaded to Brightspace for grading. See the grading rubric for details of how the programming assignments will be graded.

Exams: Two hour exams and one final exam. The two midterms are scheduled as "common exams " outside of the normal class meeting time. The final will be held as scheduled by the Registrar. Dates for these are listed in the outline of lectures below. Missed exams may not be made up! With advance notice and/or careful documentation of extenuating circumstances, an exam may be excused or accommodations made.

Purpose: This course is designed to prepare sophomore Physics and Astronomy majors for the realities of modern scientific computing. The desktop computer running Linux (or some form of Un*x operating system) has become ubiquitous in the fields of physics and astronomy for a variety of purposes: numerically solving problems that cannot be easily solved analytically, analyzing or acquiring data from experiments and observations, writing papers or reports, or presenting results on the WWW. This course will help you to attain a minimal level of scientific computing literacy that you need to function on a daily basis in this field. The course will focus on developing the skills needed carry out core tasks on modern computers running Linux (or Un*x) operating systems. This course will cover the following core topics:

- Using Linux (or Un*x) computer systems running X-windows.
- Most of the modern FORTRAN programming language.
- A subset of the C++ programming language

The course will also briefly introduce

- Some elementary numerical methods
- A short introduction to the LaTeX typesetting system, the Gnuplot plotting software, and other topics.

What To Expect: This course will require you to carry out numerous programming or other computing tasks on the MATHLAB Linux machines located in S235 of the Math Tower. It is likely you will have to spend a substantial amount of time writing and debugging programs in this laboratory setting. It may be possible in some cases for you to carry out some assignments on other computers however the instructor and T. A. for this course will not offer any formal support for such efforts. The bottom line is that you should plan to carry out your work on the MATHLAB machines or other machines specified by the instructor. The instructor may require you to turn in your assignments electronically, via web pages that you develop, or in the form of hard copy. The course T.A. will hold office hours in the MATHLAB in order to assist you with problems that you may encounter in carrying out your assignments. Lecture notes will be provided via Brightspace.

Americans with Disabilities Act: If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

SPECIAL NOTE REGARDING PLAGIARISM AND DISHONESTY: All instances of plagiarized work or academic dishonesty will be brought before the Academic Judiciary Committee. All parties involved (both the copier and the person who produced the original work) will be held accountable for any instance of plagiarism or dishonesty. You are responsible for protecting the security of your programming assignments by making sure that your directories are not world readable. If you are unsure how to secure your home directory see the instructor immediately.

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Additional Class Policies

- Student Responsibilities: You will be expected to abide by by all University regulations, procedures, requirements, and deadlines as described in the Undergraduate Student Bulletin.
- Attendance: As per the University policy outlined in the Undergraduate Student Bulletin, students are expected to regularly attend all classes and to participate in the classroom experience.
- Assignments: All work on class assignments is to be carried out independently. There will be no collaborative assignments. Computer programs developed for this course should be developed exclusively by you alone. Late assignments will not be accepted.
- Computer Use: All use of University owned computers and networks must be in accordance with the University Information Technology Policy.
- Passwords: You are responsible for maintaining your computer account password. Lost or forgotten passwords will under no circumstances be accepted as an excuse for turning in homework assignments. If you lose or forget your password your password the instructor is unable to reset it for you. Your only recourse for a lost or forgotten password is to appeal for help from the administrator, and the instructor will provide you with contact information for a particular machine.
- Classroom Behavior and Conduct: You are expected to conduct yourself in accordance with the minimal undergraduate student responsibilities described in the Undergraduate Student Bulletin including:
  - You are expected to arrive for class promptly.

  - Avoid behavior that is disruptive to the classroom especially the use of cell phones. Disruptive behavior will not be tolerated.
  - Avoid web surfing during class.
  - Be familiar with material presented in previous lectures.

- Reporting of Grades: Grades will be posted on Brightspace. The instructor will discuss grades during office hours but out of privacy and other concerns will not report or discuss grades via email.

Outline of Lectures Spring 2024

Note that the lecture topics are subject to change depending on progress of the class. Exam dates will not change.

class	date	topic
1	Jan. 22	Course and University Policies. Introduction to Linux. Machines and accounts.
2	Jan. 24	Linux Operating System, Shells, and Linux filesystem. Connecting remotely
3	Jan.26	Linux file manipulation, editing files, "Hello, World!" program.
4	Jan. 29	Transferring files, binary data, data types, floating point numbers.
5	Jan. 31	Fortran character set and statements, structure of Fortran programs, Fortran variables.
6	Feb. 2	Variables, declaration and assignment statements, parameters, list-directed I/O.
7	Feb. 5	The Linux/Un*x file system, root directory, absolute and relative paths, making direcories.
8	Feb. 7	Intrinsic functions, relational and logical operators, if constructs.
9	Feb. 9	Linux shell variables, the PATH, making changes permanent.
10	Feb. 12	Shell aliases, STDIN and STDOUT, permissions, ASCII vs. binary files.
11	Feb. 14	IF constructs, naming and nesting, top-down design, globbing and wildcards. Running on SeaWulf.
12	Feb. 16	Loops, exit and cycle statements, using loops.
13	Feb. 19	Floating point equality, safe operations, obsolete constructs, Gnuplot.
	Feb. 19	Mid-term Exam 1 8:30 - 9:50 PM
14	Feb. 21	Numerical integration II, Convergence testing.
15	Feb. 23	Root finding examples.
16	Feb. 26	Plotting data with Gnuplot. Basic formatted I/O concepts.
17	Feb. 28	Formatted I/O. Format descriptors.
18	Mar. 1	Basic file I/O, OPEN and CLOSE statements, IOSTAT= clause in READ statements.
19	Mar. 4	Arrays I
20	Mar. 6	Arrays II
21	Mar. 8	Subroutines
	Mar. 11	
	Mar. 13	Spring Break
	Mar. 15	
22	Mar. 18	Fortran modules and functions.
23	Mar. 20	Real types, precision, and makefiles.
24	Mar. 22	TBA
25	Mar. 25	Introduction to C++ I.
26	Mar. 27	Introduction to C++ II.
	Mar. 28	Mid-term Exam II 8:30 - 9:50 PM
27	Mar. 29	Integrating the equations of motion. Euler's method for ODE's.
28	Apr. 1	Runge-Kutta methods for ODE's.
29	Apr. 3	C++ relational and Boolean operators, precedence rules, conditional and loop structures
30	Apr. 5	C++ functions, local and global variables.
31	Apr. 8	Astronomy Lab
32	Apr. 10	C++ argument-passing mechanism, C++ arrays, C++ arrays in functions.
33	Apr. 12	C++ multi-d arrays, C++ pointers, C++ dynamic arrays.
34	Apr. 15	File I/O in C++, function parameters
35	Apr. 17	Brief intro to LaTeX.
36	Apr. 19	More LaTeX, creating a basic web page.
37	Apr. 22	More I/O, least-squares fitting.
38	Apr. 24	Structures and classes in C++, derived types and modules in Fortran 90.
39	Apr. 26	Structures and Classes continued, encapsulation.
40	Apr. 29	Introduction to parallel computing.
41	May 1	Fortran pointers, linked lists, object oriented programming.
42	May 3	Object oriented programming, advanced topics/F2k
Final	May 19	**Final exam** (Comprehensive) 11:15 AM – 1:45 PM[a]

[a]Nota Bene: The ultimate authority on the date and time of the final is the Registrar. Students should monitor the exam schedule on the Registrar's web page (http://www.stonybrook.edu/registrar/finals.shtml) during the semester as changes have happened in past semesters. Please also note the student responsibility statement on the Registrar's exam schedule page.

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