PHY 604: Computational Methods in Physics and Astrophysics II

Instructor: Cyrus Dreyer, Physics B104, cyrus.dreyer@stonybrook.edu
Web: `https://dreyer-research-group.github.io/phy604_fall2023.html`
Class Meeting: Tuesdays and Thursdays, 2-3:20pm

Course Objectives:
- Learn how to solve problems in physics computationally
- Understand the limitations of numerical methods
- Have the ability to interpret numerical results presented in the literature
- Have exposure to computational tools
- Understand basic idea behind algorithms for performing common computational tasks

Organization:
Course material will be presented through a mix of slides, discussions/derivations on the blackboard, and interactive programming examples. Examples will be provided in Fortran, python, and/or C++.

Office Hours:
By appointment

Texts:
There are no required books. Some recommended texts are

- *Computational Physics*, M. Newman, CreateSpace (primary recommended)
- *An Introduction to Computational Physics*, T. Pang, Cambridge Press
- *Numerical Methods for Physics*, A. Garcia, Prentice Hall

No book covers everything in the way we want for this class. Any text on numerical methods for physics will provide a general introduction, so if you find a good cheap one, go for it. Appropriate papers and links will be posted on the course website.

Preliminary Lecture Schedule:

topic	Newman Ch.	Pang Ch.	Garcia Ch.
overview / basics of computation	4	1	§1.5
good programming practices	2	–	–
differentiation / integration / order-of-accuracy	5	3	§10.2
interpolation / root finding	5, 6	2, 3	–
ODEs	8	4	2, 3
linear algebra	6	5	4
FFTs	7	6	5
fitting	–	2	5
advection / hyperbolic PDEs	9	–	7, 9
Poisson equation / elliptic PDEs	9	7	8
diffusion / parabolic PDEs	–	7	6, 9
Monte Carlo	10	10	11
genetic algorithms	–	–	–
optimization	–	–	–
parallel computing	–	–	–
machine learning	–	–	–

For reference, the appropriate chapters from the 3 suggested books are given.

Programming:
In order to do the assignments and class exercises, you will need to have the ability to write programs in, e.g., Fortran, python, C++, matlab, or a similar language. If you do not have the capabilities to do that, please contact me and we can figure out a plan. Also, if you are planning to do the assignments in a language different from those specified, please discuss it with me first.

Grading:
There will be homework assignments roughly every 2 weeks. You can write code in any language you please (see Programming section)—**each student is expected to do their own work**. There will be a final project at the end of the semester which involves solving a physics problem computationally, writing up a short report, and presenting to the class. The final course grade will consist of 40% homework, 40% final project.

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, Room 128, (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/commcms/academic_integrity/`

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.

Electronic Communication:
Email to your University email account is an important way of communicating with you for this course. For most students the email address is '`firstname.lastname@stonybrook.edu`'. *It is your responsibility to read your email received at this account.* For instructions about how to verify your University email address see this:

`http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo`

You can set up email forwarding using instructions here:

`http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail`

If you choose to forward your University email to another account, we are not responsible for any undeliverable messages.

Religious Observances:
See the policy statement regarding religious holidays at

`http://www.stonybrook.edu/registrar/forms/RelHolPol%20081612%20cr.pdf`

Students are expected to notify the course professors by email of their intention to take time out for religious observance. This should be done as soon as possible but definitely before the end of the 'add/drop' period. At that time they can discuss with the instructor(s) how they will be able to make up the work covered.