# Physics 2820: Computational Mechanics. Fall 2019

Instructor: Dr. James Munroe, jmunroe@mun.ca
Teaching Assistant: Kyle Hall, kpwh23@mun.ca

Synopsis:

The use of computers pervades all fields of science.

Phys 2820 introduces the student to the world of computational physics. From plotting functions and finding roots of algebraic equations, to solving a differential equation, to carrying out operations on sets of data to find relationships between measured variables, the skills learned will be useful anywhere computers are used to solve problems.

In order to make use of a computer, one must be able to precisely translate the method of solving the problem into instructions that the computer can blindly follow. Thus, students will gain hands-on experience in programming (in Python). The students will learn some of the numerical techniques used to differentiate and integrate functions and to solve ordinary differential equations, and gain an appreciation to the limits of numerical solutions.

The context of computation will be primarily classical mechanics, include projectile motion, N-body problems, oscillations, normal modes, as well as examples from geophysics such as gravitational prospecting and determining travel times of seismic waves.

Lectures:

Tuesday and Thursday. Slot 19. 2:00 – 3:15. C-2039
Zoom Video: https://zoom.us/j/434039379

Phys 2820 will be taught in a hybrid format for Fall 2019. The class will regularly meet in C-2039 but most of the lectures will also be delivered over the Internet using Zoom video conferencing. Lectures delivered over Zoom may also be attended remotely. See the schedule below for details on the lecture format.

Labs:

| | | |
|---|---|---|
| Section 001 | Tuesday 3:30-5:00 pm | C-2039 |
| Section 002 | Thursday 3:30-5:00 pm | C-2039 |

Laboratories (7 in total) form a component of the course. Notwithstanding which section for the course you are registered, you may attend either lab session as needed. If you anticipate missing both lab slots on a particular week, please contact Dr. Munroe via email.

Jupyter notebooks from labs will be collected electronically at the end of the Thursday lab sessions.

Software:

The programming language used in this course will be Python 3. A webserver with the required software has been set up for you to use during this course:

https://tinyurl.com/phys2820-F2019

Your user id is the same as your MUN id. e.g. if your email is xyz123@mun.ca then your user id is xyz123. Choose a new password the first time you log on; this sets the password on the server.

This server will be taken down at the end of the course. If you want to use Python and Jupyter for future course work, the Anaconda distribution of Python is recommended.

Textbook:

An Introduction to Computer Simulation Methods 3rd Ed. Gould, Tobochnik, and Christian. (PDF copies of the chapters are available from ComPADRE)

Assignments (7 in total):

To be collected electronically at 10:00 pm on the due date

Evaluation:

| | |
|---|---|
| Assignments | 20% |
| Laboratories | 20% |
| Mid-term tests | 20% |
| Final Exam | 40% |

There is no supplementary exam.

Mid-term tests (in-class, C2039):

| | |
|---|---|
| Midterm Test I | Tuesday, October 8 |
| Midterm Test II | Tuesday, November 12 |

Missed work:

Students who cannot complete assignments, labs, or mid-term tests need to consult the University Calendar, Section 6.7.5 Exemptions from Parts of the Evaluation, and email Dr. Munroe.

Important general information from the University.

It is the student's responsibility to acquaint themselves with these items. Please read.

3. Student Code of Conduct. http://www.mun.ca/student/conduct/

6.8.2 Exemptions From Final Examinations http://www.mun.ca/regoff/calendar/sectionNo=REGS-0628

6.12 Academic Misconduct http://www.mun.ca/regoff/calendar/sectionNo=REGS-0748

Accommodations for Students with Disabilities http://www.mun.ca/blundon/accommodations/

Tentative Schedule

| **Date** | **Format** | **Lecture topic** | **Note** |
|---|---|---|---|
| Thu, Sep 5 | C2039 | 1. Computer Simulations in Physics | |
| Tue, Sep 10 | C2039 | 2. Python Programming | |
| Thu, Sep 12 | Zoom | 3. The Effect of Air Resistance | |
| Tue, Sep 17 | Zoom | 4. The Trajectory of a Cannon Shell | Lab 1 |
| Thu, Sep 19 | Zoom | 5. Sports Balls and the Effects of Spin | Lab 1 |
| Sun, Sep 22 | | | Assignment 1 due |
| Tue, Sep 24 | Zoom | 6. Simple Harmonic Motion | Lab 2 |
| Thu, Sep 26 | Zoom | 7. Damped Pendulums | Lab 2 |
| Sun, Sep 29 | | | Assignment 2 due |
| Tue, Oct 1 | Zoom | 8. Forced Pendulums | Lab 3 |
| Thu, Oct 3 | C2039 | 9. Lorenz Model and the Butterfly Effect | Lab 3 |
| Sun, Oct 6 | | | Assignment 3 due |
| Tue, Oct 8 | C2039 | **Test 1** | |
| Thu, Oct 10 | Zoom | 10. Data Analysis and Curve Fitting | |
| Tue, Oct 15 | | | Fall semester break |
| Thu, Oct 17 | Zoom | 11. Taylor series and Error Estimation | |
| Tue, Oct 22 | Zoom | 12. Numerical Differentiation and Integration | Lab 4 |
| Thu, Oct 24 | Zoom | 13.Higher-Order Methods for Solving DEs | Lab 4 |
| Sun, Oct 27 | | | Assignment 4 due |
| Tue, Oct 29 | Zoom | 14. Travel Time of Seismic Waves | Lab 5 |
| Thu, Oct 31 | Zoom | 15. Wave Motion | Lab 5 |
| Sun, Nov 3 | | | Assignment 5 due |
| Tue, Nov 5 | Zoom | 16. Computer Algebra Systems | Lab 6 |
| Thu, Nov 7 | C2039 | 17. Building on Physics Past | Lab 6 |
| Sun, Nov 10 | | | Assignment 6 due |
| Tue, Nov 12 | C2039 | **Test 2** | |
| Thu, Nov 14 | Zoom | 18. Celestial Mechanics | |
| Tue, Nov 19 | Zoom | 19. Precession of the Perihelion of Mercury | Lab 7 |
| Thu, Nov 21 | Zoom | 20. Three-Body Problem | Lab 7 |
| Sun, Nov 24 | | | Assignment 7 due |
| Tue, Nov 26 | Zoom | 21. Molecular Dynamics | |
| Thu, Nov 28 | Zoom | 22. Course Review | |