Physics 3800: Computational Physics – Winter 2024

Instructor: Prof. Ivan Saika-Voivod saika@mun.ca.

3800 Computational Physics is a project-based course that trains students to become functional in computational methods by writing and compiling computer code (C/Fortran) in a Unix environment to solve problems from different areas of physics. Students complete one or more projects that introduce students to a particular class of numerical methods. Lectures and tutorials cover the theory that underlies the computational methods and background for code development and the application of the required numerical methods.

Prerequisites COMP1510 or COMP1001 or Engineering 1020 or other programming course; P2820, M2260 (ODE's I) and M3202 (vector calculus)

Lectures: Tuesdays and Thursdays, 9:00 – 10:15am in C3067.

Lab: Fridays, 2:00 pm – 4:00 pm in C3057

Office Hours: To be determined given student preferences.

Course web page: See Brightspace and https://www.physics.mun.ca/courses/p3800/

Textbook:
An Introduction to Computer Simulation Methods 3rd Ed. Gould, Tobochnik, and Christian. (PDF copies of the chapters are available from ComPADRE)
https://www.compadre.org/osp/items/detail.cfm?ID=7375
https://www.compadre.org/osp/document/ServeFile.cfm?ID=7375&DocID=527

Other useful texts:
Computational Physics, Second Edition, by Nicholas J. Giordano and Hisao Nakanishi (Pearson, 2006) [Previous text for this course.]
Introductory Computational Physics, by A. Klein and A. Godunov. (Cambridge University Press, 2006). [A previous text for this course.]

Computational Physics: *An Introduction*. (F. Vesely, Kluwer 2001)
Numerical Recipes – various editions, by Press, Flannery, Teukolsky, and Vetterling.
An Introduction to Computational Physics, T. Pang.
Computational Physics, Landau, Paez and Bordeianu.

Evaluation:

Assignments (4)	20% (5% each)
Lab quizzes	5%
Computer Projects (4)	70% (first 10%, second 15%, third 20%, fourth 25%)
Presentation on Project #4	5%

Note on Computer Projects.
These will involve solving a given physics problem using a particular numerical technique. A written report in Latex with graphs, analysis, discussion of results and your original computer code will be submitted. The submitted software must be self-contained, including all code, input files, make files and scripts required to generate output, along with your generated output files. The instructor should be to run the code himself and reproduce your results.

Outline

I. Review of Unix and Numerical Calculus.
- Basic Unix commands (in lab slot)
- Basic Latex (in lab slot)
- Scripts and Make files (in lab slot)
- Editing and plotting routines (in lab slot)
- Review of numerical differentiation and integration

II. Ordinary Differential Equations (ODEs).
- Euler, Leap Frog
- Runge-Kutta
- Adaptive time steps
- Order, accuracy and stability

III. Monte Carlo Simulations.
- Random number generators
- Random walk
- MC integration
- Metropolis method

IV. Matrices and Eigenvalues.
- Gaussian elimination
- Poisson's equation
- Eigenvalue problems
- Library Subroutines

V. Partial Differential Equations (PDEs).
- Laplace, Wave, Diffusion and Schrodinger equations
- Numerical solutions and stability
- Matrix forms

Communication and Course Continuity
In the case of a class disruptions, cancellations, or method of delivery change due to public health directives, and in the case of revisions to evaluation methods, the instructor or the Head of the department will notify all students registered in the course via the course shell in Brightspace. Any necessary revisions to the evaluation methods will be made in consultation with the students registered in this course. If a student demonstrates that they would be disadvantaged by the change, then, as per Section 6.7.4 of the University Calendar, accommodations will be made.

Wellness and Student Support:
Your wellbeing is important. There are many resources to support student wellness:
Student Life *http://www.mun.ca/student/*
Academic Support *http://www.mun.ca/currentstudents/academic/*
Student Support *http://www.mun.ca/currentstudents/student/*
Wellness and Counselling *http://www.mun.ca/currentstudents/wellness/*

Accommodations: Any student requiring physical or academic accommodations or those with other special needs are encouraged to talk to the instructor as soon as possible. All conversations will remain confidential. The Blundon Centre offers an extensive array of services and has developed a comprehensive policy. See *http://www.mun.ca/blundon*.

Important general information from the University.

- **Missed Work:** Students who cannot complete assignments or midterm tests need to speak to the instructor and consult the University Calendar, University Regulations, Section 6.7.5: Exemptions from Parts of the Evaluation: *http://www.mun.ca/regoff/calendar/sectionNo=REGS-0601#REGS-1949*
- **Student Code of Conduct.** *https://www.mun.ca/student/student-supports-and-services/respectful-campus-community/student-code-of-conduct/*
- **Information Required for Medical Certificates:** *https://www.mun.ca/university-calendar/university-regulations-undergraduate/6/16/#REGS-0888*
- **Exemptions From Final Examinations** *http://www.mun.ca/regoff/calendar/sectionNo=REGS-0628*
- **Academic Misconduct** *http://www.mun.ca/regoff/calendar/sectionNo=REGS-0748*
- **Accommodations for Students with Disabilities (***https://www.mun.ca/student/about-us/units-and-contacts/accessibility-services---the-blundon-centre/***).**
- **Last day to drop a course** without academic prejudice is Feb. 29, 2024. See University Diary (*https://www.mun.ca/university-calendar/general-information/4/*).
- **Winter Break** is Feb. 19 to Feb. 23; **Good Friday** is March 29; **Lectures end** Friday April 5, 2024.

Confidentiality: The University respects the confidentiality of all material contained in medical notes. Physicians are strongly advised to retain a copy of the medical note in case the medical note needs to be verified or reissued at a later date.

Use of Recording Devices in Classrooms The lectures and displays (and all material) delivered or provided in this course, including any visual or audio recording thereof, are subject to copyright owned by the instructor. It is prohibited to record or copy by any means, in any format, openly or surreptitiously, in whole or in part, in the absence of express written permission from the instructor any of the lectures or materials provided or published in any form during or from the course.