*We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the “Dish With One Spoon” wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.*

**PHYSICS 2G03 – SCIENTIFIC COMPUTING**

**2020 Fall Term**

Instructor: James Wadsley **| E-mail:** [wadsley@mcmaster.ca](mailto:wadsley@mcmaster.ca) **|**  Office Hours: TBA

Teaching Assistants **| E-mail:** [phys2g03.mcmaster@gmail.c](mailto:phys2g03.mcmaster@gmail.c)om

COURSE DESCRIPTION

Physics 2G03 is a hands-on introduction to modern scientific programming using standard C/C++ under Linux. It assumes no prior programming experience. We teach you the basic things you need to know about programming as it is used in research, development and high performance computing in academia and industry. The course culminates in an individual research project for each student to model a real world system such as orbits, populations, diseases, economics or particles.

The course introduces how computers work and do math, Linux/UNIX, algorithms, numerical methods, program development and programming in a modern high-level language. We have selected C++ for this purpose because C/C++ are popular and widely used languages and also similar to many other languages you may use in your career in research or industry (including Graphics: CUDA and Web development: Java, C#, PHP). We will focus on programming fundamentals, the components that are common to C, C++ and other languages. We will provide C/C++ and scripting (e.g. Python) examples to help you understand variations between languages and their limitations.

Additional topics such as scripting, web content, objects/classes, graphics and parallel programming will be included according to student interest.

*Prerequisites*

One of ARTSSCI 1D06 A/B, ISCI 1A24 A/B, MATH 1A03, 1LS3, 1X03, 1ZA3

*Course Expectations*

For Fall 2020 the course will be online. Students are required to have a laptop (or desktop if working at home) for in-class work. For Fall 2020 you can work exclusively at home on a desktop but you must have regular access to it (including every class-time). In addition, for Fall 2020 Lecture material will be available in advance (slides and video lectures). A detailed schedule will be provided and indicated material is expected to be studied prior to class time. Quizzes and small programming tasks will be used to assess understanding.

The primary activity in this course is working under Linux and writing programs. We assume no prior knowledge. Activities will build up from simple commands (e.g. look at files), to running a simple program and then developing your own programs. Class time will most often be spent working on your laptop/desktop writing programs and interacting with the TAs and the lecturer to get them working (via Zoom or similar, TBA). Later in the term, class time will mostly be devoted to working on your project.

Projects are developed individually by each student according to their scientific interests. Popular choices include orbital dynamics (planets, asteroids, galaxies), animal populations, SIR disease models, stellar structure, particle dynamics, economics and other simple models that use a small set of ODEs (ordinary differential equations) to evolve the system. Student are encouraged to talk to other professors and draw on outside material for project ideas. Students work with the TAs and instructor to refine the idea, develop a model and the program. The program should produce figures and be demonstrated to classmates and TAs. Students hand in a write-up the project and critique the model for its realism and limitations.

*Class Schedule*

Day(s): Monday 12:30 - 1:20PM, Tuesday 1:30 - 2:20PM, Thursday 12:30 - 1:20PM

Location: Online via Zoom or similar (TBA)

***Course Website***

<http://avenue.mcmaster.ca/>

COURSE AND LEARNING OBJECTIVES

Learning Objectives

By the end of this course, students should have a good understanding of how computers work and how to express mathematical models as programs. You will understand how to work in a typical scientific computing set-up (e.g. Linux workstation) with compiled languages like C/C++ and the relative efficiency, uses and limitations of compiled versus scripted programs (e.g. python). Students will have experience developing a numerical model of a real scientific problem and see how this can lead to a career in research in academia or industry. This experience is excellent preparation for summer research, co-op or industry work such as data science.

**MATERIALS & FEES**

**REQUIRED MATERIALS/ RESOURCES**

Materials are on Avenue to Learn: <http://avenue.mcmaster.ca>

This includes lectures (video for Fall 2020), notes and assignments.

You will need to have a laptop in class for every class (regardless of whether it is designated Lab or Lecture on the timetable). For Fall 2020 you may also work at home at a desktop if necessary. The key requirement is that the computer you use is available to you every class and for most of each week.

Physics 2G03 is a hands-on course. You will regularly try things on computers during class and develop a number of programs from the ground up. For your laptop or desktop, Windows, Linux or MacOS are all fine. We will help you install the minimal software needed in class time. Your computer will be used to connect to phys-ugrad where all programming work will occur.

The homework assignments are an integral part of the course. The standard programming language for the course is C++. Programs must be compiled using the C++ compilers on the phys-ugrad system. Only C++ will be accepted. Solutions in other programming languages, such as Matlab, Maple, Python, etc will NOT be accepted. Solutions compiled on other computers will not be accepted.

You will find getting a basic reference book on C++ to be useful.

A good introductory book, especially for those with limited programming background, (but expensive for new copies) is:

"C++ for Engineers and Scientists" Gary J. Bronson (This book mostly targets traditional, procedural programming as this course does)

If you are quite interested in programming and want a comprehensive C++ text (also not too expensive), we recommend:

“The C++ Primer” Lippman, Lajoie, Moo (This covers modern C++ features and object oriented programming. It is a large book to carry around though)

A good book on just C (which means only basic C++) is: “Programming in C” Stephen G. Kochan

The lecture notes (all available on avenue) are fairly comprehensive but you'll probably need a reference of some kind. Googling is an option. There are also many on-line references, such as <https://en.cppreference.com> but you may find it a bit technical.

**VIRTUAL COURSE DELIVERY**

**To follow and participate in virtual classes it is expected that you have reliable access to the following:**

* A computer that meets performance requirements [found here](https://cto.mcmaster.ca/technology-resources-for-mcmaster-students/#tab-content-device-recommendations).
* An internet connection that is fast enough to stream video.
* Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contract [uts@mcmaster.ca](mailto:uts@mcmaster.ca) as soon as you can. Please visit the [Technology Resources for Students page](https://cto.mcmaster.ca/technology-resources-for-mcmaster-students/#tab-content-device-recommendations) for detailed requirements. If you use assistive technology or believe that our platforms might be a barrier to participating, please contact [Student Accessibility Services](https://sas.mcmaster.ca/), [sas@mcmaster.ca](mailto:sas@mcmaster.ca), for support.

**COURSE OVERVIEW AND ASSESSMENT**

*Course Schedule* – This schedule is a draft and may be revised. Note that the ordering of the topics is set and unlikely to change.

*Course Outline*

* Using the Labs (your laptop), Unix, Algorithms, C/C++ Code, Hardware, Compiling, Debugging (First 3-4 weeks)
* Variables, Programs, Functions, Program Flow, Arrays, I/O, Files (Next 4-5 weeks)
* Advanced Topics: Program Development, Object Oriented Programming, C vs C++, Fortran + other languages, Shell Scripts, Graphics, Parallel Programming (Final 4 weeks)

EVALUATION

|  |  |
| --- | --- |
| **Assessment** | **Weight** |
| Assignments/Classwork | 50% |
| Project | 30% |
| Weekly quizzes | 20% |
|  | 100% |

There will be in-class work designed to build skills and conceptual understanding as well as large assignments. Major assignments will be spaced through the term and due dates will be set in consultation with the class to allow for other deadlines.

Quizzes will occur regularly every week. No exams are planned for this course.

Projects deadlines begin mid-term and the final write-up is due at the end of the course.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

[McMaster Student Absence Form (MSAF):](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/msaf-mcmaster-student-absence-form/) In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

For the Faculty of Science, please follow the guidelines located [here](https://science.mcmaster.ca/associatedean/images/Forms/MSAF-Information.pdf).

*Policy Regarding Missed Work*

Extensions are available if discussed with the lecturer or teaching assistants. Otherwise, late penalties will be assessed. Work extended with MSAF is due immediately after the MSAF period ends. Any exceptions will have late penalties assessed. This deadline policy applies automatically and does not have to be confirmed by the instructor. If you have special circumstances, we advise contacting the instructor prior to the deadline and prior to using MSAF.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services (SAS](https://sas.mcmaster.ca/)) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [*Academic Accommodation of Students with Disabilities*](https://secretariat.mcmaster.ca/app/uploads/Academic-Accommodations-Policy.pdf) policy.

*Physical and Mental Health*

For a list of McMaster University’s resources, please refer to the [Student Wellness Centre](https://wellness.mcmaster.ca/).

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](https://secretariat.mcmaster.ca/app/uploads/2019/02/Academic-Accommodation-for-Religious-Indigenous-and-Spiritual-Observances-Policy-on.pdf) policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

*Equity, Diversity, and Inclusion*

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Physics & Astronomy is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexualities, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Chair of Undergrad Studies, Undergraduate Advisor (Level I), and/or Undergraduate Advisor (Levels II to IV) (contact details listed [here](https://www.physics.mcmaster.ca/contact/contact-us.html)) or to contact the [Equity and Inclusion Office](https://equity.mcmaster.ca/).

**COURSES WITH AN ON-LINE ELEMENT**

*Online Statement*

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

***Some courses may*** use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

*McMaster University Statement on Inclusivity*

The University values integrity, inclusiveness and teamwork, and strives to support the personal and collective growth of the McMaster student community.

These values are foundational to ensuring campus environments – both in-person and virtual –are conducive to personal wellbeing and academic success.

**ONLINE PROCTORING**

**Some courses may** use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins. If you have questions about whether this software will be used, or concerns about the use of this software, please contact the course instructor.

**ACADEMIC INTEGRITY**

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

**It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [*Academic Integrity Policy*](https://secretariat.mcmaster.ca/app/uploads/Academic-Integrity-Policy-1-1.pdf)*,* located at [https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/](https://secretariat.mcmaster.ca/university-policies-procedures-%20guidelines/)

**The following illustrates only three forms of academic dishonesty:**

* plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
* improper collaboration in group work.
* copying or using unauthorized aids in tests and examinations.

Some helpful information can be found [here](https://sscm.mcmaster.ca/).

**AUTHENTICITY / PLAGIARISM DETECTION**

In this course, we will be using a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster’s use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity.](http://www.mcmaster.ca/academicintegrity)

**CONDUCT EXPECTATIONS**

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the [*Code of Student Rights & Responsibilities* (the “Code”).](https://secretariat.mcmaster.ca/app/uploads/Code-of-Student-Rights-and-Responsibilities.pdf) All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

Additional information about the Code and netiquette can be found [here](https://sscm.mcmaster.ca/the-code/the-code-virtual-communities/).

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

RESEARCH ETHICS – NA

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.