Course Outline

Scientific Computing with Python

Cross-listed as PHYS-2112 and ACS-2112

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1 Course Sections

There are three course sections:

- One section PHYS/ACS-2112-758 in-person on Wednesday's from 6:00 to 9:00 p.m. on the U of W Campus, Lockhart Hall, Room 1L10, aka 1L10 Studio, see https://www.uwinnipeg.ca/tech-sector/software-and-services/1110-studio-support-services.html
- Two sections PHYS/ACS-2112-750 and -751 online asychronous with video recordings of the Wednesday lecture available via Nexus/Panopto by Thursday of each week.
- For all sections for tests and exams, and for the in-person section in case in-person is not possible, we will use live online delivery with Zoom using the meeting below. Students must be available during the posted test/exam times for live streaming. High speed internet and access to an electronic device with a webcam (e.g., smart phone, laptop) is mandatory.

  06:00PM - 09:00PM
  https://us06web.zoom.us/j/82677100353
  Meeting ID: 826 7710 0353
  Passcode: monty

  For Live Online delivery:

  - Students are expected to have their video enabled. This helps everyone (you, other

students, and the instructor) engage with the subject and others. If you have a concern with this, talk with the instructor. Recorded lectures will not include video of students, only audio of questions and maybe chat text.
    - To minimize noise, students should stay muted except when asking or answering questions. You may also use the meeting chat function, but the instructor may not notice new questions for a few minutes when focused on the shared screen. Feel free to attract their attention via the meeting software's raise-hand function, or raise your hand or otherwise get their attention via video, or unmute.

- Students are expected to attend all classes for lectures, class activities, and tests and exams. Please disable notifications on your devices.
- Students are expected to be on time, come prepared to ask questions, and abide by the UW Respectful Working and Learning Environment Policy at http://www.uwinnipeg.ca/respect/

2 Course Information

- 2022 Fall Term
- Instructor: Stuart Williams
- Email address for all class questions is the TA/Lab Assistant/Marker/Instructor Email: phys-2112-ta@googlegroups.com

  This email is monitored by the instructor (although less on weekends), but the TA(s) who usally respond.

  When sending email, please try to avoid screen shots because they can't be searched, easily saved, may be hard to read, etc. Instead copy/paste text.

  Email is an asynchronous form of commuication. Do not expect immediate replies to email. Plan ahead.

  Note that in the first few weeks of class, 95% of the questions that are asked via email are answered in this course outline (aka syllabus), the schedule, or other course documents on Nexus. I instruct the TA(s) to not answer those questions, but rather send students back to the documents they are expected to read and understand. If you don't read these documents you will likely lose marks or worse. If you need clarification on something in the documents, please cite the document and explain what is unclear, so we can fix the document.

  You should not need the instructor's direct email address (st.williams@uwinnipeg.ca). As explained above you should use phys-2112-ta@googlegroups.com instead.
- Course webpage on Nexus: https://nexus.uwinnipeg.ca/d2l/home/48276
- Students will need to install Python and Jupyterlab on their personal computer to follow along with lectures and to complete assignments. This will be covered in the first lecture and in Lab sessions run by the TA(s).
- Office Hours

The TA has time allocated for answering lecture and homework questions. Office hours for the TA(s) will be announced when available.

You can start by asking questions via e-mail to the phys-2112-ta@googlegroups.com address (which the instructor also reads). Often a TA can meet with you virtually.

- Here is the calendar Course Description from https://www.uwinnipeg.ca/academics/calendar/docs/all-course-descriptions.pdf

  PHYS-2112/ACS-2112 Scientific Computing with Python (3 hrs Lecture)

  This Python language course shows students how to create basic programming structures in Python including decisions, loops and more advanced topics such as object-oriented programming with classes and exceptions. Unique Python data structures such as tuples and dictionaries are introduced. Students learn how to create Python programs with graphic elements as well as data visualization and publication quality figures. Applications from a variety of scientific fields are discussed when appropriate.

  Note: This course is appropriate for all students with an interest in scientific computing, and experience with elementary computer programming is recommended.

- Prerequisites: None. However, beware that programming is hard to learn for many people. It requires attention to detail and precise logical thinking. It's sort of like writing recipes, but to a very naive and literal child. For some, having some math background helps. For others, interest in word problems or puzzles helps.

  If you're not sure, consider watching an hour or so of https://www.youtube.com/watch?v=F6yLRM3b0q8 to see how quickly you catch on.

  If you're new to programming, expect to spend more time than others in the first half of the course than those who have programming experience.

3 Topics and Learning Outcomes

Upon the successful completion of this course, the student will have most of the following:

- Basic understanding of some basic computer science and programming concepts:
  - How variables are used in software, and two models of implementing them
  - Basic data types and more interesting complex data types (usually implemented as classes)
  - Character encoding
  - Functions
  - Boolean expressions and if statements
  - Loops
- Basic ability to code in Python: - Names, namespaces, scopes and name search order - Built-in data types and their most important operators and methods - Built-in functions - String formatting and f-strings - Sequence indexing and slicing - List comprehensions, generator expressions, and generators - Simple classes - Exceptions - Function locals, non-locals, globals - Writing unit tests with pytest
- If time permits, introduction for awareness to a subset (TDB) of the following advanced Python features
  - Class internals

    - Bound methods
    - Metaclasses
    - Decorators
    - Special methods of classes
    - Iterables, iterators, and the iterator protocol
- Basic ability to handle large amounts of data in Python efficiently with NumPy and Pandas
- Basic ability to visualize data with Pandas and awareness of other visualization packages
- Familiarity with techniques to measure and increase the performance of Python code
- Brief introduction to Machine Learning

Note that the details of the topics and learning outcomes above are tentative and some of them may not be achieved.

4 Course Text Books and Material

The following free online books will be used in the course. Only parts of each book will be used.

- Think Python - How to Think Like a Computer Scientist 2nd Edition, Version 2.4.0 by Allen B. Downey (Green Tea Press). Copyright 2015 Allen Downey.

  This book teaches programming, using Python as the example language.

  Available free in PDF format at https://greenteapress.com/wp/think-python-2e/, HTML format at http://greenteapress.com/thinkpython2/html/index.html, and Jupyter notebooks adapted from it at several locations.

  Other editions will be similar but don't have identical assignment problems, so be sure you have the correct version.

- The Python Data Science Handbook by Jake VanderPlas (O'Reilly). Copyright 2016 Jake VanderPlas, 978-1-491-91205-8.

  Available free in PDF or Jupyter Notebooks at https://jakevdp.github.io/PythonDataScienceHandbook/

  This books teaches NumPy and Pandas, assuming you already know some Python.

  Most "pages" in this book have lots of small code samples so the number of words per page will be about half that of a typical textbook.

  This book will be used both as a textbook and a reference. In its role as a textbook it presents concepts you should understand and on which you will be tested. In its role as a reference it may help you complete assignments.

- A Whirlwind Tour of Python by Jake VanderPlas (O'Reilly). Copyright 2016 O'Reilly Media Inc, 978-1-491-96465-1.

  Available free in PDF or Jupyter Notebooks at https://github.com/jakevdp/WhirlwindTourOfPython

  This book teaches programming with Python and can be used as an alternative or supplement to the Think Python book.

5 Important Dates

- Sep 7 to Nov 30, 2022: - course lectures
- Sep 6 - 19 Period when 2022-2023 Fall and Fall/Winter Term course registration, course adds/drops and section changes occur. Subsequent changes will be permitted only under the most exceptional circumstances and only when authorized by an Academic Advisor in the Student Services Office. Registration in all courses will be subject to space availability. Any courses dropped after this period will not be subject to refund.
- Oct 9 - 15 Mid-term reading week. No classes, except Education students taking 4000 level certification courses are required to attend class and practicum during this period. Please consult your course outline for more information.
- Wednesday Oct 19 6:30 to 7:30 p.m. Mid-term test (online, see above). If you can't make that date/time, drop the course, or accept the zero score.
- Nov 16 FINAL DATE to withdraw without academic penalty from courses which begin in Septem Mar 2- Mar 16 FINAL DATE to withdraw without academic penalty from courses which begin in January 2022 and end in April 2022 of the 2022 Winter Term. (Also called Voluntary Withdrawal or "VW")
- TBD (likely Wednesday) Final Exam from 6 to 9 p.m. on Zoom (see above)
- Dec 9 - 22 The Fall Term evaluation period for final items of work for this term which can include scheduled tests, exams, or the submission of papers or projects. for this term which can include scheduled tests, exams, or the submission of papers or projects.

For all other important dates, see https://www.uwinnipeg.ca/academics/calendar/docs/dates.pdf

6 Grade Distribution

- 45% Assignments
  - One each week, most worth about 100 points, except the first two.
  - See the section "Instructions for Weekly Assignments", below, for more details.
- 20% Mid-term Test
  - Covers mostly core Python
  - Wednesday Oct 19 6:30 to 7:30 p.m. - no alternate dates
- 35% Final exam - cumulative
  - Date and time TBD

7 Important Notes

- Assistance: Students are encouraged to consult with the TA when experiencing difficulties in the course, including assignments.

- Tests/Exams:

  - Tests and Exams are administered and/or submitted online. The format and specific instructions will be communicated prior to the test/exam date.
  - Authorized course materials and devices will be communicated prior to each test/exam.
  - Please note that student's activities will be monitored during online quizzes/tests/exams, including via video, which is why a webcam is required.

- Grading System: Below are the guidelines for conversion from numerical (percentage) grades to letter grades. The final grades are approved by the Physics Department Review Committee.

  Letter Grade - Percentage:

  ```
  A+   95-100
  A    87-94
  A-   80-86
  B+   74-79
  B    67-73
  C+   61-66
  C    53-60
  D    50-52
  F    0-49
  ```

- See Assignments for details on assignments.

8 Course Information and Policies

- The University's regulations on wearing masks is "Highly Recommended". Please be considerate and be prepared to wear a mask, if social distancing in the classroom is not possible.
- Attendance at lectures (in-person) or their recordings (asynchronous online) is expected. Students cannot be admitted to this course if they can't attend regularly or keep up with video recordings.
- If you feel ill or have new or worsening symptoms of COVID-19, please do not attend in-person lecture. Stay home. The lecture notes and video recording are available on Nexus, so you would be able to catch up on your studies. I will not repeat the topics, nor will hold separate class for those who miss the lectures.
- The schedule of assigned readings, lectures, assignments and their' due dates will be posted on Nexus in the Schedule file.
- All course materials, including lecture slides, assignments, and tests/exams are only for the students registered in this course, PHYS-2112, and must not be shared with any other students or individuals outside this course.
- You must not share your Nexus ID and password with anybody to access your courses on your behalf. It is in violation of the University policies (see University Academic Calendar for more information)

9 Assessments

Please note that there are no options for additional grades. Only the assessments listed on this Course Outline count toward the final grade. No extra homework, test rewrites, or extra credits will be given for this course.

9.1 Assignments

- The assignments for each week use material covered in readings and lecture. Each week's assignment is usually due at 1:00 p.m. on the Tuesday before the following week's lecture, and the due date of the assignments after the last lecture will be announced.

- There are two kinds of assignments:

  1. Python coding assignments, #1 through about #11, should be submmited in files with file extension ".py", archived in a zip archive file. Many of these let you choose a subset of the

assignment to complete.

However, if you complete more than required, the problems with lower marks will be dropped, likely increasing your overall mark on the assignment.

Also note that test/exam questions are often based on assignment questions, so ideally you should know how to solve even the problems you don't complete.

2. Pandas data analysis and machine learning assignments, in the last few weeks of the course, should be submitted as Jupyter Notebook(s) with file extension ".ipynb", archived in a zip archive file.

- All assignments are usually due at 1 p.m. on a Tuesday. If you turn them in after 1 p.m. they receive no credit, in part because solutions to most assignments are presented in lecture starting at 6 p.m. Wednesdays. No due date extensions will be granted.

  However, the lowest 3 assignment marks (weighted) will be dropped in grade calculations, which is the rationale for no extensions being granted for assignment due dates.

  You may be tempted to skip 3 assignments early in the term, but then something out of your control (such as getting sick) might hit later in the term when you have none left from the 3 assignments you could skip. To be clear, any assignment not turned in on time gets zero credit.

- See the schedule file for details of each assignment.

  - There are about 13 assignments planned. Most assignments after the first two are worth about 100 points.
  - The points weighting for each problem in an assignment is indicated in square brackets ([]).
  - The file name you should use for you solution is in parentheses (round brackets).

- Assignments must be submitted online via Nexus as a zip file of Python code files and/or Jupyter notebook files, depending on the assignment. See below for more details.

- Assignments submitted after the due date/timeLate assignments will not be accepted without prior permission from the instructor, and credit may be limited to exercises for which solutions are not yet presented in lecture.

- You should try first to complete your assignments without any assistance. If you succeed, you'll learn the most. However, if you are stuck, you are allowed to receive help with assignments, but you are not allowed to copy code from a helper, the internet, or anywhere, to complete an assignment. A good rule of thumb is you can talk with others about how you might approach a solution, but you can't take any notes; then you have to do a different activity for at least an hour, for example studying for a different class, and then after that you should try to complete your assignment.

- The required format for submitting each assignment is a single zip file with .py and/or .ipynb files included, depending on the specific assignment.

- There is no need to include you name or student id in the assignment submission, Nexus records that already.

- Do not add any comments in the Nexus submission form - they will be ignored. Instead you may include a README.txt file if you have a message for the marker you'd like them to read before marking the other files.

- There are many resources online on how to create a zip archive file, e.g. https://edu.gcfglobal.org/en/techsavvy/working-with-zip-files/1/

- The zip file should have a file extension ".zip", not ".7z" or other archive formats (it needs to be unpackable by Python's zip library). Only contents of files with the ".zip" extension will be marked.

- The zip file should have only files, no subfolders, so create the zip file from the folder in which you completed the assignment, not from the parent folder.

- Don't include other files, not even files that are usually hidden by your operating system (e.g. `.DS_Store` on MacOS). Don't include any other files such as folders or files created by editors/IDEs (e.g. `.idea/`), or Python (`__pycache__/`) or pytest (`.pytest_cache/`),. or Git (`.git/`), or virtual environments, or Jupyter checkpoints (`.ipynb_checkpoints/`). Before submitting your .zip file, look at its contents to be sure no extra files are included.

  In short, only include the files the marker needs to mark the assignment. Double-check your zip file contents before uploading it.

  Historically Mac OS X users have had trouble with this. See https://apple.stackexchange.com/questions/239578/compress-without-ds-store-and-macosx

- Writing code is similar to writing an essay where you follow style guides, check for spelling mistakes, footnote correctly, etc. Code is a form of writing, communicating mostly to other programmers, but also telling the Python interpreter what to do. Review your own code to be sure it is clear and easy to read. Note that code is read far more than it is written.

- A solution that that produces the correct answer will get partial credit (perhaps as low as 30%), but for full credit it needs to be easy to read, easy to understand, easy to maintain (fix bugs), and easy to change (add enhancements).

  For full credit, in addition to a correct solution, also include:

  - Module and function docstrings that are "accurate, brief, and clear" (ABC)
  - ABC names for functions and variables
  - Code that is not redundant (in general less code is better, as long as its still easy to read, understand, and modify). Don't Repeat Yourself (DRY). If you find yourself copying and pasting your own code to complete a solution, you should refactor using functions or constants.
  - Code comments only where they add value. Don't write comments that explain what code does if it would be obvious to a competent Python developer. Do add comments when what the code does would not be obvious, or is unusual or surprising, to a competent Python developer.
  - Tests that can be run with `pytest` to show that you confirmed the code is correct, and which also serves as documentation of what the code does. Reduce your effort by writing those tests first.
  - Code formatted following "PEP 8 -- Style Guide for Python Code" as follows:
    - Read PEP 8 https://www.python.org/dev/peps/pep-0008/
    - At least skim these:
      - https://github.com/google/styleguide/blob/gh-pages/pyguide.md
      - https://github.com/amontalenti/elements-of-python-style
    - Install the "black" formatting tool https://github.com/psf/black and run it on your code with arguments `--line-length=79 --skip-string-normalization` (which you can configure in a file). For Jupyter notebooks there are several options: https://www.reddit.com/r/Python/comments/ixbibn/black_for_jupyter_notebook_and_jupyterlab/

        - Install and run flake8 and pylint on your code, and correct as many errors as you can.
    - To get even better at coding, read the Coding-Advice.html file.

- In the second half of the course when working with data sources you should include code that downloads them, as opposed to including the data source itself.

- Submit assignments via Nexus. If you want to make changes after submitting, submit another zip file. Only the last zip file will be marked, so be sure it contains all of the assignment, even if you submitted parts of it in a previous zip file.

- Assignment submissions are NOT accepted via e-mail.

- Your Assignments will be marked in a timely manner by a Marker. The feedback will be available to you through Nexus, within 2 weeks after the submission.

- Academic misconduct will be taken seriously. For more information, please see the notes below.

9.2 Tests/Exams

- Identifications may be asked for the tests/exams.
- Tests and Exams are administered in class for in-person and over Zoom for Online Asyncronous. The format and specific instructions will be communicated prior to the test/exam.
- Only authorized course materials or devices will be allowed in test/exam, which will be communicated prior to each test/exam.
- Usually the tests and exams in this course ask you to choose a subset of problems in each section to answer, to help alleviate cases where a gap in your knowledge hurts your score.

10 Academic Integrity

You are expected to take academic integrity very seriously and be mindful of your own activities and the requests/offers you may receive from others.

In addition to the guidelines in the Academic Calendar (Regulations and Policies, Subsection 8a), for all assessment items in this course, the following are considered cheating, plagiarism, or academic misconduct:

- Copying from another student's work and submitting it as your own (group or collaborative work approved by the instructor is not considered cheating).
- Consulting or copying from any unauthorized sources, including, but not limited to: the Internet; online calculators and graphing tools; assignments or tests/exams from previous years or from other courses; solutions provided by a third party (purchased or otherwise).
- Asking questions from another student or any unauthorized person during the exams and tests.
- Using any unauthorized sources during the tests and exams.
- Soliciting and obtaining solutions to the assignments, tests, and exams via any means of communication (e.g., e-mail, text, phone call, social media chats, etc.).
- Providing test or exam questions and/or solutions to another student, uploading them to a filesharing websites, including Chegg, CourseHero, Quizlit, etc, or otherwise sharing them outside the course.

It is your responsibility to know the policies and guidelines, and to be aware of the academic misconduct procedures, and your rights and responsibilities. Anybody involved in the process could be charged with academic misconduct. For more information, please see the Academic Calendar, Regulations and Policies,

Subsection 8a. https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf

11 Important Information

1. A permitted or necessary change in mode of delivery may require adjustments to important aspects of this course outline, like class schedule and the number, nature, and weighting of assignments and/or exams.

2. Students can find answers to frequently ask questions (FAQ) related to remote learning here: https://www.uwinnipeg.ca/covid-19/remote-learning-faq.html.

3. When it is necessary to cancel a class due to exceptional circumstances, every effort will be made to inform students via UWinnipeg email, or on Nexus, via Course News.

4. When it is necessary to cancel a class due to exceptional circumstances, every effort will be made to inform students via UWinnipeg email.

5. Students have the responsibility to regularly check their UWinnipeg e-mail addresses to ensure timely receipt of correspondence from the University and/or their course instructors. Only your University of Winnipeg email address (Name@webmail.uwinnipeg.ca) will be used for course related correspondence.

   Emails sent through Nexus will not be checked.

6. Please note that withdrawing before the VW date (Nov. 16, 2022) does not necessarily result in a fee refund. A minimum of 20% of the work on which the final grade is based will be evaluated and available to the student before the voluntary withdrawal date. I encourage you to contact the instructor before withdrawing.

7. Regulations, Policies, and Academic Integrity. Students are encouraged to familiarize themselves with the "Regulations and Policies" found in the University Academic Calendar at: https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf. Particular attention should be given to subsections 8 ("Student Discipline"), 9 ("Senate Appeals"), and 10 ("Grade Appeals").

   Please note the importance of maintaining academic integrity, and the potential consequences of engaging in plagiarism, cheating, and other forms of academic misconduct. Even "unintentional" plagiarism, as described in the UW Library video tutorial "Avoiding Plagiarism" (https://www.youtube.com/watch?v=UvFdxRU9a8g) is a form of academic misconduct.

   Similarly, uploading essays and other assignments to essay vendor or trader sites (filesharing sites that are known providers of essays for use by others who submit them to instructors as their own work) is a form of misconduct, as it involves "aiding and abetting" plagiarism. More detailed information can be found here: Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-procedures.pdf.

8. Respectful Learning Environment. Students are expected to conduct themselves in a respectful manner on campus and in the learning environment irrespective of platform being used. Behaviour, communication, or acts that are inconsistent with a number of UW policies (e.g. Respectful Working and Learning Environment Policy https://www.uwinnipeg.ca/respect/respect-policy.html, Acceptable Use of Information Technology Policy https://www.uwinnipeg.ca/institutional-analysis/docs/policies

/acceptable-use-of-information-technology-policy.pdf) could be considered "non-academic" misconduct. More detailed information can be found here: Non-Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-procedures.pdf.

9. Copyright and Intellectual Property. Course materials are the property of the instructor who developed them. Examples of such materials are course outlines, assignment descriptions, lecture notes, test questions, and presentation slides - irrespective of format. Students who upload these materials to filesharing sites, or in any other way share these materials with others outside the class without prior permission of the instructor/presenter, are in violation of copyright law and University policy.

   Students must also seek prior permission of the instructor/presenter before, for example, photographing, recording, or taking screenshots of slides, presentations, lectures, and notes on the board (or computer). Students found to be in violation of an instructor's intellectual property rights could face serious consequences pursuant to the Academic Misconduct or Non-Academic Misconduct Policy.

10. Privacy. Students are reminded to know their rights in relation to the collecting of personal data by the University (https://www.uwinnipeg.ca/privacy/admissions-privacy-notice.html), especially if Zoom is being used for remote teaching (https://www.uwinnipeg.ca/privacy/zoom-privacy-notice.html) and testing/proctoring (https://www.uwinnipeg.ca/privacy/zoom-test-and-exam-proctoring.html).

11. Research Ethics. Students conducting research interviews, focus groups, surveys, or any other method of collecting data from any person, including a family member, must obtain research ethics approval before commencing data collection. Exceptions are research activities done in class as a learning exercise. For submission requirements and deadlines, see https://www.uwinnipeg.ca/research/ethics/apply-for-human-ethics.html

12. Religious Holidays: Students may choose not to attend classes or write examinations on holy days of their religion, but they must notify their instructors at least two weeks in advance. Instructors will then provide opportunity for students to make up work or examinations without penalty. A list of religious holidays can be found in the 2020-21 Undergraduate Academic Calendar.

13. Service for Students with Disabilities: Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams or during lectures/laboratories are encouraged to contact Accessibility Services (AS) at 204.786.9771 or https://www.uwinnipeg.ca/accessibility-services/ to discuss appropriate options. All information about a student's disability or medical condition remains confidential.

14. The dates the University is closed for holidays, irrespective of campus closure related to COVID19: September 5 (Labour Day), September 30 (Truth and Reconciliation Day), October 10 (Thanksgiving Day), November 11 (Remembrance Day), December 23 through January 2, February 20 (Louis Riel Day), April 07 (Good Friday). Fall mid-term reading week is October 9-15; Winter mid-term reading week is February 19-25