NUMERICAL ANALYSIS (DRAFT SYLLABUS)

Published

CLASS SCHEDULE

Section	Location	Time	Instructor(s)
			This table is generated automatically

INSTRUCTOR / TA INFORMATION

Instructor: **Prof. Jeff Orchard**, DC 3615, jorchard@uwaterloo.ca

Teaching Assistant: TBD

COURSE DESCRIPTION

The goal of this course is twofold. You will receive a solid introduction to the theory of several important classes of numerical methods (with derivations of the methods and some proofs), and you will learn to implement the numerical methods efficiently in Python, with some applications to problems in several fields.

The course focuses on numerical methods for solving nonlinear algebraic equations, on ordinary differential equations, on numerical linear algebra, and Fourier theory. This is a graduate-level numerical methods course that will be useful for students from Applied Mathematics, Computer Science, Computational Mathematics, and other programs in Mathematics, Science and Engineering.

Prerequisites: A basic undergraduate course on numerical methods and some experience in Python programming are strongly recommended. Students who have previously taken two or more courses on numerical methods, including a course on numerical linear algebra, are not recommended to take this course.

LEARNING OUTCOMES

No explicit learning outcomes defined for this course.

TENTATIVE COURSE SCHEDULE

1. Floating point number system and error propagation (3 hours)
2. Rootfinding methods (4 hours)
3. Ordinary differential equations (7 hours)
4. LU decomposition for linear systems (5 hours)
5. QR decomposition for linear systems (4 hours)
6. Basic iterative methods for linear systems (3 hours)
7. Fourier transform (6 hours)

8. Eigenvectors and eigenvalues (time permitting)

TEXTS / MATERIALS

Title / Name	Notes / Comments	Required
		No

Numerical Mathematics, by Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, Springer-Verlag, 2007.
available online to U. of Waterloo students at this link (https://ocul-
wtl.primo.exlibrisgroup.com/permalink/01OCUL_WTL/pa2qcq/alma9940348453505162) .

Other references:

- *Introduction To Numerical Computation*, by L. Elden, L. Wittmeyer-Koch, and H.B. Nielsen, Studentlitteratur, 2004.
- *Numerical linear algebra*, by Trefethen and Bau, SIAM, 1997
- *Iterative methods for sparse linear systems* (2nd edition), Yousef Saad, 2003, available free online (https://www-users.cse.umn.edu/~saad/IterMethBook_2ndEd.pdf)

STUDENT ASSESSMENT

Component	Value
Assignments	50%
Final Exam	50%

The final exam will be a closed-book exam, but you will be allowed to bring one sheet of paper on which you can write formulas (two-sided).

Assignments	Due date (tentative)
A1 (floating point)	Sept 22
A2 (rootfinding)	Sept 30
A3 (ODE)	Oct 14
A4 (LU/QR)	Oct 31
A5 (iterative lin alg)	Nov 11
A6 (Fourier)	Nov 25

Late Policy: Your assignment solutions should be submitted online before the deadline. When multiple files are submitted, your official assignment submission time will be determined by your last submission. Also, if you submit

solutions more than once, only your most recent submission will be graded.

If your assignment is late, your assignment grade will be multiplied by a lateness scaling factor, *s*. This factor decays by 20% per hour, and then drops to zero after 12 hours.

$$s = \begin{cases} 0.8^t & \text{for } t \leq 12 \text{ hours} \\ 0 & \text{for } t > 12 \text{ hours} \end{cases}$$

ASSIGNMENT SCREENING

No assignment screening will be used in this course.

NOTICE OF RECORDING

Activities for this course involve recording, in partial fulfillment of the course learning outcomes. You will receive notification of recording via at least one of the following mechanisms: within the Learning Management System (LEARN), a message from your course instructor, course syllabus/website, or other means. Some technologies may also provide a recording indicator. Images, audio, text/chat messaging that have been recorded may be used and/or made available by the University to instructors, TAs, and students of CS 770/CM 770/AMATH 740 for the purpose of materials delivery and review. Recordings will be managed according to the University records classification scheme, WatClass (https://uwaterloo.ca/records-management/records-classification-and-retention-schedules) , and will be securely destroyed when no longer needed by the University. Your personal information is protected in accordance with the Freedom of Information and Protection of Privacy Act (https://www.ontario.ca/laws/statute/90f31) , as well as University policies and guidelines (https://uwaterloo.ca/privacy/) and may be subject to disclosure where required by law.

The University will use reasonable means to protect the security and confidentiality of the recorded information, but cannot provide a guarantee of such due to factors beyond the University's control, such as recordings being forwarded, copied, intercepted, circulated, disclosed, or stored without the University's knowledge or permission or the introduction of malware into computer system which could potentially damage or disrupt the computer, networks, and security settings. The University is not responsible for connectivity/technical difficulties or loss of data associated with your hardware, software or Internet connection.

By engaging in course activities that involve recording, you are consenting to the use of your appearance, image, text/chat messaging, and voice and/or likeness in the manner and under the conditions specified herein. (In the case of a live stream event, if you choose not to have your image or audio recorded, you may disable the audio and video functionality (https://uwaterloo.ca/student-it-services/) . Instructions to participate using a pseudonym instead of your real name are included where the feature exists; however, you must disclose the pseudonym to your instructor in advance in order to facilitate class participation.) If you choose not to be recorded, this notice serves as confirmation of your understanding that you will not ask questions during class, but instead will ask questions before/after class, or in the online discussions.

You are not permitted to disclose the link to/URL of an event or an event session recording or copies of recording to anyone, for any reason. Recordings are available only to authorized individuals who have been directly provided the above instructions/link for their use. Recordings for personal use, required to facilitate your learning and preparation of personal course/lecture notes, should not be shared with others without the permission of the instructor or event coordinator. Review the University's guidelines for faculty, staff and students entering relationships with external organizations offering access to course materials (https://uwaterloo.ca/secretariat/faculty-staff-and-students-entering-relationships-external) for more information on your obligations with respect to keeping copies of course

materials. For more information about accessibility, connect with AccessAbility Services (https://uwaterloo.ca/accessability-services/) .

ADMINISTRATIVE POLICY

Much of the communication in the course will be done on Piazza.

UNIVERSITY POLICY

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity (https://uwaterloo.ca/academic-integrity/) for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4 (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70) . When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity (https://uwaterloo.ca/academic-integrity/) for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71) . For typical penalties, check Guidelines for the Assessment of Penalties (https://uwaterloo.ca/secretariat/guidelines/guidelines-assessment-penalties) .

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70) (other than a petition) or Policy 71, Student Discipline (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71) may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72) .

Note for students with disabilities: AccessAbility Services (https://uwaterloo.ca/disability-services/) , located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.