Department of Mathematics and Statistics
University of Guelph

MATH*2130: Numerical Methods - Course Syllabus **Winter 2024**

For information on current COVID-19 safety protocols, follow these links: `https://news.uoguelph.ca/covid-19/safety-practices/`.

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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1. <u>**Learning Resources:**</u>

   1.1. **Course Website:**

   Course material, news, announcements, and grades will be regularly posted to the MATH*2130 Courselink website. You are responsible for keeping up-to-date on this site.

   1.2. **Required Resources:**

   The primary resource for the course will be "fill-in-the-blank" style notes. I will provide the notes (with empty "blanks") for free via download from CourseLink. We will proceed to fill in the blanks during lecture as we work through the course content. Completed lecture notes will be posted to CourseLink throughout the semester.

   1.3. **Recommended Resources:**

   Numerical Analysis (Third Edition) by Timothy Sauer. Pearson Education, 2018. This textbook may provide an important source of exercises and background reading through the semester! While there is a small "For You to Try" section created for each chapter in our notes, it is useful to have many different examples throughout the semester, and you will find more in this resource.

   1.4. **Additional Resources:**

   Lecture Information: All lectures will be delivered face-to-face, in person, though lectures will also be broadcast over zoom. Lecture recordings and completed lecture notes will be uploaded to the course website at the end of every week. However, attendance of class is strongly encouraged, and in particular there is an in-class component to assessments that could potentially improve your grade (see Section 3 below).

   Lab Information and Computer Resources: This section is organized in bullets to communicate some important points:

   - **During this course we will learn the basics of coding in MATLAB, though I will assume you have some had experience with computer programming** (i.e. some experience writing code in some programming language). In other words, this is not a course on programming in MATLAB, and class time will be more focused on math than on coding, but we will not assume any knowledge of MATLAB, and will walk you through the basics through a combination of lecture time, weekly labs, and handouts.
   - **There will be 3 Assignments involving theoretical math and coding in MATLAB due on specified dates** (see Section 3 below). The format required of your assignment submission will be clarified in the assignment handouts.
   - **The weekly labs (starting in week 2) will be held in THRN 1319, where students have access to MATLAB and can collaborate with each other on completing the assignments (and preparing for tests) with support from course TAs.** You are welcome to use the computers in THRN 1319 on a drop-in basis to help complete the assignments (or study), and have been granted card access to THRN 1319 by being enrolled in this course.

- For working from home (not just in lab) **you may consider obtaining your own license for MATLAB** ($100 USD). Here is a link to the website where you can purchase MATLAB:

    https://www.mathworks.com/store/link/products/student/SV?s_tid=ac_buy_sv_but1

    Alternatively, you can use the free basic version of MATLAB online, which is adequate for our purposes, but which, among other restrictions, limits your use to 20 hours per month. **In order to activate the basic version of MATLAB online, you will need to create an account at mathworks.com using your ⟨uoguelph.ca⟩ email account.** Here is a page that outlines the difference between basic and licensed MATLAB versions, and provides a link to activating MATLAB online:

    https://www.mathworks.com/products/matlab-online/matlab-online-versions.html

    A free clone of MATLAB, called OCTAVE, may be used instead (see `https://octave-online.net/`), though OCTAVE may lack functionality in some cases for our class, so please be careful when choosing this option.

Other: Past tests, supplementary questions, and other resources may be posted to the Course website as needed. Again, it is important that you check regularly to keep up-to-date.

1.5. **Communication & Email Policy:** Major announcements will be posted to the CourseLink page. It is your responsibility to check the CourseLink page regularly. As per university regulations, all students are required to check their ⟨uoguelph.ca⟩ e-mail account regularly: e-mail is the official route of communication between the University and its student.

Disclaimer: Student Identity Disclosure in Recordings

The university has requested that I include the following disclaimer regarding recorded materials. While I don't anticipate the use of any videos or recordings as our class will be run entirely face-to-face, I want to ensure that we are prepared in the case that the pandemic pushes us in this direction.

By enrolling in a course, unless explicitly stated and brought forward to their instructor, it is assumed that students agree to the possibility of being recorded during lecture, seminar or other "live" course activities, whether delivery is in-class or online/remote.

If a student prefers not to be distinguishable during a recording, they may

1. turn off their camera
2. mute their microphone
3. edit their name (e.g., initials only) upon entry to each session
4. use the chat function to pose questions.

Students who express to their instructor that they, or a reference to their name or person, do not wish to be recorded may discuss possible alternatives or accommodations with their instructor.

1.6. **Getting Help:**

My number one priority is to ensure that you are supported and have lots of opportunities to ask questions and get help! Here are some options for getting help in this course:

- Please feel encouraged to ask questions during lecture.
- Attend your lab and ask your TA for help.
- Come to office hours. Don't ever hesitate to drop in, even if you think you are behind in your studying. Getting you caught up is **exactly** what those opportunities are there for!
- Send me an email (grichards@uoguelph.ca). Since there are over 100 of you and only one of me, I would prefer to answer questions in a group forum during office hours (so that I can help more of you at once), but certainly for more personal queries, this is a great option. If you ask questions by email, it would be extremely helpful for you to attach a picture of your work, so I can easily see where you might be stuck and be able to help you more quickly.

2. <u>**Assessment:**</u>

   2.1. **Dates and Distribution**

   You grade will be determined as the maximum of the following two schemes:

	Scheme 1
11 In-class Quizzes (1% each for top 9 only)	9%
3 Assignments (7% each)	21%
2 Midterm Tests (17% each)	34%
Final Exam	36%

	Scheme 2
3 Assignments (7% each)	21%
2 Midterm Tests (20% each)	40%
Final Exam	39%

In-class Quizzes: **There will be 11 in-class single-question multiple choice Quizzes completed using `www.mathmatize.com`.** You will need to create an account using your ⟨@uoguelph.ca⟩ email address (or use an existing account under this email), and it will cost you $7 for the semester to create a new account (links and instructions will be provided on CourseLink). We will have exactly one multiple choice quiz every week starting in week 2 (the week of January 15-19), but each multiple choice quiz may take place on either Tuesday OR Thursday (but never both) depending on how the material is presented. Students will be allowed to submit the multiple choice quiz responses remotely using `www.mathmatize.com`, but the window for multiple choice quiz submission will open and close during class, so only students who are attending in person or over zoom will be able to participate. Each multiple choice quiz will be graded out of 2 points: 1 point for submitting the quiz, and 1 point for selecting the correct response. There will NOT be any quiz held during the first week of classes. **Only the top 9 of your 11 multiple choice quiz scores will count toward the 9% component of your multiple choice quiz grade in Scheme 1.** The multiple choice quizzes will be open book, they will be similar to examples recently completed in class, and you will be encouraged to collaborate with other students. It is my intention that you will be able to complete the multiple choice quizzes (with correct responses) by attending class regularly, paying attention, and following the gist of the material. In other words, I will design the multiple choice quizzes to keep you engaged with the material, but not to be particularly difficult.

Assignments: **There will be 3 written assignments due throughout the term** (see schedule below). Most assignment problems will involve a mix of theoretical and MATLAB/coding challenges. Assignments will cover 2-3 weeks worth of course content. You may use your course notes and work together with your peers to figure things out, but **you must write and execute your own code, and complete your own written solutions when preparing your submission. Copying another person's (or chatbot's) code or answers (or obtaining your answer from another source) is academic misconduct and will not be tolerated.**

- Assignment 1: Thursday, January 25, 2023 (Week 3) Upload by 11:59PM to Gradescope.
- Assignment 2: Thursday, March 7, 2023 (Week 8) Upload by 4:59PM to Gradescope
- Assignment 3: Thursday April 7, 2023 (Week 12) Upload by 11:59PM to Gradescope

Midterm Tests: **There will be 2 Midterm Tests** (see schedule below).
The Midterm Tests will involve a mix of theoretical mathematical questions and MATLAB code related questions. Coding problems will be graded for structure, not for finer points of MATLAB syntax. This will be discussed more via posts on CourseLink.

- Midterm Test 1: Week 6 (Feb 12-18). Exact Time and Location: TBA. Closed-book, closed resource, independent. Exact topics TBA.
- Midterm Test 2: Week 10 (March 18-24) or Week 11 (March 25-31) Exact Time and Location: TBA. Closed-book, closed resource, independent. Exact topics TBA.

Final Exam: Friday April 12th, 2023 8:30-10:30am (120 minutes to write). Location: TBA. Closed-book, closed resource, independent. Cumulative.

*Should face-to-face instruction be shut down at any point by the administration, any assessments completed during such a shutdown will be proctored via Zoom according to the schedule above. Please ensure that you have a working web camera should we need to run assessments in this way.

2.2. **Course Grading Policies**

Academic Consideration: When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor in writing, with your name, ID number, and e-mail contact. See the academic calendar for information on regulations and procedures for Academic Consideration: `http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml`

Illness: Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g. final exam or major assignment).

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: `http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml`

Missed term tests, assignments, or quizzes: For missed quizzes note that only the top 15 out of 21 quizzes will count toward your final grade in Scheme 1, which gives room for missed quizzes due to the reasons listed above without notifying me about it. Missed tests or assignments will receive a grade of 0%, unless you miss the assessment due to any of the above reasons and bring it to the attention of the course instructor within 1 week of the assessment date in a written email, in which case the weight of the missed assessment will be added to the final exam. There will be no makeup tests or quizzes.

Group Work: You are encouraged to work together to learn the course material and complete For You to Try and textbook exercises. All term tests and the final exam are individual assessments and must be completed independently.

Copies of out-of-class assignments: Keep paper and/or other reliable back-up copies of assignments, homework, and your midterms. You may be asked to submit this work at any time.

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3. **Aims, Objectives & Graduate Attributes:**

3.1. **Calendar Description**
This course provides a theoretical and practical introduction to numerical methods for approximating the solution(s) of linear and nonlinear problems in the applied sciences. The topics covered include: solution of a single nonlinear equation; polynomial interpolation; numerical differentiation and integration; solution of initial value and boundary value problems; and the solution of systems of linear and nonlinear algebraic equations.
Credit Weight: 0.5, **Department:** Mathematics & Statistics, **College:** CEPS, **Campus:** Guelph
Prerequisites: (CIS*1300 or CIS*1500), (1 of IPS*1510, MATH*1090, MATH*1210, MATH*2080)

3.2. **Course Aims**
This course is taught with the goal of putting into practice some of the concepts and intuition that students have developed with so far in other math courses. This means being able to develop computer programs that can run simple mathematical algorithms, and gaining an understanding of how continuous mathematical objects such as derivatives or solutions to differential equations might be approximated using a discrete numerical approach instead – as well as the error involved in doing so.

3.3. Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Explain the general concepts of algorithms, limiting behaviour and asymptotic notation.
2. Gain an understanding of how computers handle numerical data, including floating-point operations, rounding, truncation, iteration, and error.
3. Find roots to single nonlinear equations through the use of various numerical algorithms.
4. Calculate a polynomial interpolant or cubic spline given a set of points.
5. Utilize difference approximations for various derivative operators.
6. Numerically approximate the solutions to initial value problems through a series of increasingly sophisticated approaches.
7. Understand the nature of a Boundary Value Problem and an introduction to numerical techniques for their solution.
8. Numerically approximate the results of definite integrals.
9. Create algorithms for solving linear systems of equations.
10. Use Taylor's Theorem to produce error bounds for numerical techniques.

3.4. Instructor's Role and Responsibility to Students

As your instructor, I must:

1. Develop and deliver course material in a professional way that facilitates learning for a variety of students and learning styles.
2. Attend all lectures, filling in the Course Manual as we proceed in each lecture. I will provide completed course notes online regularly, but I strongly urge you to come to class. Bear in mind that most Labs will not use the Course Manual and these completed notes might not be provided to you.
3. Respond to you. This includes, as time permits, questions in lectures and lab tutorials, after classes, during office hours, or through email (where I reserve the right to reply within a timeframe of 1-2 days). You are more than welcome to contact me at any time through these means if you have questions or concerns about the course or the course material.
4. Evaluate you fairly, and fairly as compared to your peers, providing prompt feedback on your performance and justification for your grade. I must provide academic consideration, where appropriate, as described in Section 3.

3.5. Students' Learning Responsibilities

As a member of this class, you are expected to:

1. Take advantage of the learning opportunities provided during lectures.
2. Treat others with respect and dignity whenever you address them, in-class or online.
3. Genuinely try "For You To Try" problems in a timely manner, on your own time.
4. Seek help if you have tried the homework and are still having difficulty with the course content. This means contacting me (not just at the last minute!) and possibly considering other resources as I recommend them to you.
5. Check all grades against tests that have been returned to you, once they are posted to the Course website, to verify that the correct mark has been recorded.
6. Notify me, as described in Section 3, in the case that there are missed tests/quizzes or academic conflicts that are known in advance. If illness, work, or extra-curricular activities are causing you to struggle, you are advised to keep me up-to-date on your progress, so that I can be more helpful to you.

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4. Teaching and Learning Activities:

4.1. Timetable for Lectures and Labs

Lectures: See webadvisor for details.

Labs: See webadvisor for details.

4.2. Lecture Schedule

(schedule is approximate and subject to change depending on time constraints)

Week(s)	Topics	Chapter(s) from Sauer	Learning Outcomes
1-2	Programming and Algorithms	1	LO 1, 2, 10
3-4	Root Finding	2	LO 3, 10
5-6	Interpolation and Splines	8	LO 4
7-8	Numerical Differentiation and IVPs	1, 11, 12	LO 5, 6
8-9	BVPs and Finite Difference	-	LO 7
10	Numerical Integration	11	LO 8, 10
11-12	Linear Systems	3, 6	LO 9

4.3. Other Important Dates

First day of lecture: Tuesday, January 9.

First day of labs: Monday, January 15.

NOTE: There will be NO LABS in Week 1 (January 8-12).

Winter Break (no classes): Monday, February 19 - Sunday, February 25.

Last day of lecture: Thursday, April 4.

Note: Labs will not be held on Monday, April 8 (it is following a Friday schedule).

Drop Date: Courses that are one semester long must be dropped by the end of the last day of classes (**Monday, April 18, 2024**). The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar. `https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml`

Course Evaluation Information: Near the end of the term, you will be given the opportunity to evaluate your instructor and provide comments regarding your experience. The evaluations for this class will be done online, and time will be provided to complete the evaluations in-class. Your instructor will inform you of when these are to take place.

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5. <u>ACADEMIC MISCONDUCT:</u>

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it.

Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

5.1. Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar: `http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml`

More information regarding academic integrity can be found at: `https://guides.lib.uoguelph.ca/AcademicIntegrity`

6. **Accessibility:**

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

More information: `www.uoguelph.ca/sas`

7. **Recording of Materials :**

Presentations which are made in relation of course work – including lectures – cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Posted online videos and course notes are the property of the instructor and are not to be otherwise disseminated beyond this course.

8. **Resources:**

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

`http://www.uoguelph.ca/registrar/calendars/index.cfm?index`

9. **Mental Health Resources:**

One out of every five students in Canada experiences some sort of mental health issue at some point in their academic career. If you find yourself facing a mental health crisis, or just need to talk to someone, please consider taking advantage of one of the following resources available to University of Guelph students:

Counselling Services: Visit the Counselling Services website (`https://wellness.uoguelph.ca/counselling`) to get information on resources available to you, both online and in-person. You can also visit them at Health Services (J.T. Powell Building, ext 53244) where they offer individual and group counselling sessions by appointment or walk-in.

Student Support Network: is located in the Wellness & Education Promotion Centre in the J.T. Powell Building and offers confidential, peer-based, drop-in support.

Good2Talk: (1-866-925-5454) is a free, 24/7 student hotline that provides professional counselling and referrals for mental health, addictions and well-being.

Here 24/7: (1-844-437-3247) specializes in assessment, referral and appointment booking and is available 24/7 for crisis support.

You are not alone and you will not be judged for asking for help.