

# Math\*2130 – Numerical Methods

## Winter 2022



(Revision 0: January 5, 2022)

*Disclaimer: Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via Courselink and/or class email.*

*This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.*

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Dr. Matt Demers

[mdemers@uoguelph.ca](mailto:mdemers@uoguelph.ca)

#### Office Hours:

Mondays, 1-2 pm, through Zoom

Wednesdays, 4-5 pm, through Zoom

Otherwise, we could chat after class or set up an appointment. Just contact me!

### 1.2 Teaching Assistants

Courtney Allen

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Michael Dube

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## 2 LEARNING RESOURCES

### 2.1 Course Website

Various resources, solutions, announcements and grades will be regularly posted to the Math\*2130 Courselink page. It is your responsibility to check the page every day, and this is especially important in this time of virtual course delivery.

### 2.2 Required Resources

The primary resource for the course will be the notes that we build together over the semester. These, typically in a “fill-in-the-blank style” will be posted on a regular basis to Courselink in PDF format. You may download them to fill them in during lectures using a tablet, or print them off instead.

### 2.3 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 to apply our methods to throughout the semester, and you will find more in this resource. I will post problem sets from this book regularly through the course.

### 2.4 Additional Resources

#### Lecture Information:

Virtual lectures are prerecorded and provided through Youtube. I will release links to these lectures periodically through the semester (expect 2-5 videos ranging from 15 - 50 minutes apiece) per week. Once campus reopens, lectures will be designed to complement or emphasize certain important topics from those Youtube videos, or to provide extra examples or discussion. Once they begin, these lectures will be available in person; through Zoom; and also will be recorded and posted to Courselink.

#### Lab Information:

Once campus reopens, labs will be dedicated to concepts relating to coding and algorithms to assist in the completion of weekly coding assignments. In the first weeks of the semester, labs will be dedicated to review topics to refresh and to help in completing the warmup assignment. **All labs will be provided through Zoom.** The link will be given in a Courselink announcement.

## Other:

I might post some resources or provide links from time to time if I create something or come across something that I believe might be helpful to you. A “homemade” MATLAB tutorial has already been posted and is available to you from the start to look at or work with, if you already have access to the software. Anything more like this would be posted to the CourseLink site. So again, check CourseLink every day!

## 2.4 Communication & Email Policy

Within the Zoom environment for live labs, please ensure that you are muted at all times unless I invite you to unmute yourself. Please use the chat window to ask any questions during lab or virtual lectures, or stick around just after lab to speak freely with me if possible. Please note that labs will be recorded for the benefit of students who cannot attend. Lectures will be similarly recorded once they begin in person.

You may also:

- Come to my posted 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!
- Post to the discussion board on CourseLink. I do not check these every day, so I encourage you to work with each other and share your insights in case you have a good answer to another student's question!
- Send me an email ([mdemers@uoguelph.ca](mailto:mdemers@uoguelph.ca)). If you do this, 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. I usually try to respond within a few hours. However, I get a lot of email from students and I need to make sure that I have the chance to help as many people as I can in the time I have! So be warned that if you send me *many* emails with various questions, it may take a day or two to get back to you as I may prioritize helping a variety of students first before coming back to you. I appreciate your understanding on this!

## 2.5 Assessment Dates and Grade Distribution

***Note: Any assessments - tests or assignments - that are not completed for ANY reason will have their weight automatically transferred to the final exam. Do not worry about doctor's notes or any other documentation - this is not required (and in fact discouraged. Please do not add unnecessary pressures to our health care system right now.)***

**Warmup Assignment (10%):**  
**Due Monday, January 24 at 8 pm (EST)**

This will be a written assignment available on Courselink starting no later than Tuesday, January 11. Topics will include very basic logical flow in programming (conditionals and loops); some simple concepts in arithmetic, functions, calculus, and linear algebra; intermediate value theorem, mean value theorem, and Taylor's Theorem.

**Lab Assignments (20%):**

*The nature of assignments will depend upon the evolution of the pandemic and whether campus, and thus computer labs, are open to students or not. Pay close attention to Courselink for guidance as we go along!*

Once campus is open, lab assignments involving MATLAB and coding will be given on a weekly basis, assigned on Wednesdays or Thursdays each week and due on Monday evenings at 8 pm. Code should be submitted as a .m file with no spaces in the file name, and your name and/or student number in the file name, to Dropbox on Courselink. You may use the computers in THRN 1319 on a drop-in basis to help complete these. You may also consider obtaining your own license for MATLAB; a free clone, called OCTAVE, may also be used if you wish, though it may lack some functionality in some cases.

Until campus reopens, however, written assignments will be given instead of coding-based assignments. These will be due starting on January 31, and then weekly on Monday evenings, to be submitted by at 8 pm.

**Group Project (10%):**  
**Due Friday, April 8 at noon**

In place of the last two weeks of your lab assignment, you will be working on a project. In a group of up to four people, you will research and write a short paper (no more than 5 pages) to detail a Numerical Method other than any that we have covered in the course. More information will be given on this toward the end of the course.

**Tests 1 and 2 (15% apiece):**

**Friday, February 11**

6:00 - 7:30 pm\* (Virtual)

**Friday, March 18**

6:00 - 7:30 pm\* (Virtual)

**Final Exam (30%):**

**Monday, April 11**

8:30 - 10:30 am\* (Virtual)

\*Additional time will be given to process your work and submit through Crowdmark. More details will be given ahead of each test.

The format for the final exam will be similar to that of tests, and it will be comprehensive, covering material from the whole course. More information on the final exam will be revealed closer to the end of the semester.

### **Best Policies for Writing Virtual Tests and Exams**

#### ***When it comes to communication...***

For each test, the Zoom meeting will be open and you will be welcome to join (camera/microphone off). Be aware that there may be announcements for me to make, especially if I catch a small error or edit on a test, or if I want to clarify a problem. In those cases, I will make the announcement through Zoom, and update Courselink immediately. You are responsible for being aware of any such announcements. I totally welcome you to communicate with each other if these come up, in order to keep one another informed.

At any time, you are welcome to send me an email and I will do my best to *immediately* reply to you during any test or exam.

#### ***When it comes to submitting...***

In an environment of virtual delivery, there is the risk that occasionally, you could run into technical difficulties during submission. I strongly advise you to have a contingency plan for these sorts of situations. For example:

- Have a friend's or family member's backup phone ready to go in case your own phone, camera, or scanner unexpectedly fails.
- Submit your work while you know that your internet, Wi-Fi, etc, are strong. If you are working on solutions to a test, ***submit your solutions as you complete each problem, rather than waiting to submit all solutions at the end of the exam time.*** If your Wi-Fi goes down, that could leave you without enough time at the end to submit.
- If you have continued internet trouble and you are worried that you will not be able to submit your test, contact me through email (using a data plan, etc) at [mdemers@uoguelph.ca](mailto:mdemers@uoguelph.ca) and include pictures of your work. ***I need to be able to see proof that your test is completed ahead, and I must see it ahead of the submission deadline;*** if you contact me after, you have contacted me too late.

Following these pointers will help to mitigate the potential for trouble, and will let me be confident that your issues are valid. It is important that I follow these guidelines strictly, out of fairness to the vast majority of students who will submit correctly and within the allotted time.

Finally, do your best to make sure that ALL of your work is submitted correctly and on time! For example, if you accidentally upload the same solution for multiple questions, there will not be anything that I can do to verify that the unsubmitted question was done within the time limit - and that will be disappointing for both you and myself. *Make sure you leave yourself enough time to double-check your submissions.*

### ***When it comes to cheating...***

There may be times when you feel pressured, stressed, or unprepared. In these cases (or ever), it is not a very good idea to cheat. ***Sites dedicated to quick math help (such as Chegg, CourseHero, Stack Exchange and others) will be monitored - and their use is strictly prohibited for tests and the exam!*** It is never worth risking your academic record and potential credit in the course, just to obtain a couple of extra marks on one test. I strongly advise you not to fall into this trap.

## **2.6 Course Grading Policies**

### **Missed Assessments:**

If you are unable to submit any piece of work over the term (test or assignment), the weight of the missed assessment will be added to the final exam, with no questions asked and no documentation required. There will be no makeup midterm tests. If you know in advance that you have a conflict for a test, provide me with at least two weeks of notice. I will try to schedule an alternative writing time at a time that works for both of us.

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## 3 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

### 3.1 Calendar Description

- 3.2 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.

**Prerequisite Courses:**

(CIS\*1300 or CIS\*1500), (1 of IPS\*1510, MATH\*1090, MATH\*1210, MATH\*2080)

### 3.3 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.

### 3.4 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.

### 3.5 Instructor's Role and Responsibility to Students

As your instructor, I pledge to:

1. Prepare course material, labs and lectures in a way that facilitates learning for a variety of students and learning styles.
2. Respond to you. This includes, as time permits, questions during or after lectures or labs, during office hours, or through email. You are more than welcome to contact me at any time through these means if you have questions or concerns about the course or new concepts.
3. Evaluate you fairly, providing prompt feedback on your performance and justification for any grades you are given. I must provide academic consideration, where appropriate, as described in Section 3.

### 3.6 Students' Learning Responsibilities

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

1. Take advantage of the learning opportunities provided during lectures and assignments, and through Courselink.
2. Treat myself and other students with dignity whenever you address them, in-class or online.
3. Genuinely try all homework in a timely manner and make the effort of attempting optional practice questions, especially if you have faced some trouble with math or programming courses in the past.
4. Seek help if you have tried the homework and are still having difficulty with the course content. This means talking to me! Contact me through email or in office hours (*not* just at the last minute!) and possibly consider other resources as I recommend them to you.
5. Check all of your posted grades with tests that have been returned to you, to verify that the correct mark has been recorded. If not, then for tests, get in touch with me right away in person or through email, and we will figure things out. For lab assignments, contact your TA and they will do the same.
6. Notify me, as described in Section 3, in the case that there are 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.

### 3.7 Relationships with other Courses & Labs

**(CIS\*1300 or CIS\*1500)** These courses provide some fundamental programming skills that will come in handy in this course.

**(IPS\*1510, MATH\*1090, MATH\*1210, MATH\*2080)** These courses provide some fundamental mathematical background in functions and calculus that will prove useful as background knowledge.

### Follow-On Courses

While Math\*2130 is not explicitly a prerequisite for any Mathematics courses at the undergraduate level, it provides an essential set of skills that will be extremely useful to anyone studying math or science in senior or graduate-level courses.

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## 4 TEACHING AND LEARNING ACTIVITIES

### 4.1 Timetable for Lectures and Labs

**Lectures:** Asynchronous to start (through Youtube);  
and then once campus opens,

MW 5:30 - 6:50 pm, ALEX 200 (Section 1)

MWF 11:30 - 12:20 MWF, MACN 105 (Section 2)

**Labs:** (Always through Zoom) Tuesdays 2:30 - 3:20 (Lab Section 1),

Tuesdays 4:30 - 5:20 (Lab Section 2),

Wednesdays 9:30 - 10:20 (Lab Section 3)

### 4.2 Lecture Schedule - (Please note that the timing may vary slightly)

Week(s)	Topic	Text Chapter	Learning Outcomes
1-2	Basics of Programming and Algorithms	1	LO 1,2,10
3-4	Equation-Solving and Root-Finding	2	LO 3,10
5-6	Polynomial Interpolation and Splining	8	LO 4
7-8	Numerical Differentiation and Solution of IVPs	1,11,12	LO 5,6
8-9	BVPs and Finite Difference Schemes	-	LO 7
10	Numerical Integration	11	LO 8,10
11-12	Algorithms for Solving Linear Systems	3,6	LO 9

### 4.3 Other Important Dates

Monday, January 10: First day of classes

February 21 - 25: Reading Week (no classes are scheduled)

Friday, April 8: Last day of classes and last day to drop a course without academic penalty

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## 5 UNIVERSITY STATEMENTS

### 5.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### 5.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars. Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 5.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-regregchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

## 5.4 Copies of Out-of-class Assignments

paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 5.5 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 book their exams at least 14 days in advance and not later than the 40th Class Day. For Guelph students, information can be found on the SAS website <https://www.uoguelph.ca/sas> For Ridgetown students, information can be found on the Ridgetown SAS website <https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 5.6 Academic Integrity

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 encourages academic integrity. 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. Undergraduate Calendar - Academic Misconduct <https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml> Graduate Calendar - Academic Misconduct <https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 5.7 Recording of Materials

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

## 5.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs. Academic Calendars  
<https://www.uoguelph.ca/academics/calendars>

## 5.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email. This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website ( <https://news.uoguelph.ca/2019-novel-coronavirus-information/> ) and circulated by email.

## 5.10 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).

## 5.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

<https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-yoursafe-return/>

<https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces> updated as required in response to evolving University, Public Health or government directives.

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## 6 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact Student Accessibility Services as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208 or email [sas@uoguelph.ca](mailto:sas@uoguelph.ca) or see the website: <https://wellness.uoguelph.ca/accessibility/>

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## 7 RECORDING OF MATERIALS

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## 8 RESOURCES

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