

# Math\*2130 – Numerical Methods

## Winter 2021



(Revision 0: January 7, 2021)

**Disclaimer:** Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website <https://news.uoguelph.ca/2019-novel-coronavirus-information/>. The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

**Dr. Matt Demers**

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

#### **Office Hours:**

Tuesdays, 3 - 4:30 pm through Zoom

Wednesdays, 3 - 4:30 pm through Zoom

Individual, by appointment through Microsoft Teams

### 1.2 Teaching Assistants

**Courtney Allen**

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**Daiana Spataru**

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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:

Lectures will be 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, though this will vary widely depending on the material. The best time to watch each video will be shortly after each is released; in other words, stay on top of things.

#### 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 work with. 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 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.

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

### Lab Assignments

**These are due each Tuesday at noon throughout the semester except during the last two weeks of class.** The first one will be given out on Wednesday, January 13 and due Tuesday, January 19 at noon.

**Worth 30% of your overall mark** (your lowest assignment will be automatically dropped; this includes if you are sick).

Each week, you will be given a small assignment for marks, usually involving a (typically simple) numerical algorithm in MATLAB. Lab Assignments will be released through Courselink on Wednesday evenings. Each lab will be due on each following Tuesday at noon. Any code must be submitted as a MATLAB script file through Dropbox on Courselink. Written solutions, if any, will be submitted through Crowdmark. Read the instructions carefully for each assignment for more details as we go along. Collaboration is welcome on assignments; however for your own benefit, you should submit your own work as a final product.

To access MATLAB, you will have access to a virtual CEPS lab (instructions for access will be revealed early in the semester). ***There are only 50 stations to go around, even though there are over 450 people in the class. Thus, it is imperative that you do not leave your work until the last minute; and when you are finished, log off right away to make space for other users.*** As a guideline, try your best to access these virtual spaces only according to your last name as follows:

**Last names A-F: Access the virtual labs on Thursdays.**

**Last names G-M: Access the virtual lab on Fridays.**

**Last names N-Z: Access the virtual lab on Mondays.**

**Anyone: Access the virtual lab anytime over the weekends, Tuesdays, and Wednesdays.**

As you have nearly one week to complete each assignment, there will be no exceptions if you cannot submit your work on time.

(Note that you may also complete assignments on your own if you otherwise have access to MATLAB. Free software, Octave, also provides an alternative that you are welcome to use, though it may lack some functionality in some cases.)

**Warmup Assignment:**

Due Monday, January 25 at noon.

**Worth 10% of your grade (or 0% if your Final Exam Grade > your Warmup Grade)**

This will be a written assignment available on Courselink starting no later than Tuesday, January 12. 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.

**Group Project**

Due Friday, April 9 at noon

**Worth 10% of your grade**

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:**

**Thursday, February 25**

6:00 - 7:00 pm + 30 minutes to submit\*

**Worth 15% of your grade**

**Thursday, March 18**

6:00 - 7:00 pm + 30 minutes to submit\*

**Worth 15% of your grade**

\*If you have accommodations in the form of extra time through SAS, the standard test time is considered to be 60 minutes. Any extended amount of time you receive is based only upon this period of time, and you will receive 30 minutes of additional time to process and submit.

Tests will be provided in advance of 6:00 pm through Courselink; you will submit your written solutions through Crowdmark. Further instructions will be given on Courselink as we get closer. Be forewarned that late grades will be strictly enforced if your work is submitted beyond the extra 30 minutes that are provided for processing and submission.

**Final Exam:**

Friday, April 23

11:30 am - 1:30 pm

**Worth 20% of your grade (or 30% if your Warmup mark < Final Exam mark)**

The format for the final exam will be similar to that of tests. 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...***

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 update Courselink immediately. Therefore, you should absolutely keep Courselink open while you are writing your test in case I do make an announcement; *I am assuming that you are reading these announcements as I make them, as though I made them in person, and you are responsible for observing any edits that I point out!* 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.
- From a practical standpoint, it should be clear that there is no way for me to verify that any claim a student may make about a test submission issue is valid and true. Following the above 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. This is especially true when that test is only worth 20% of your mark in the first place. I strongly advise you not to fall into this trap.

## **2.6 Course Grading Policies**

### **Missed Assessments:**

If you are unable to attend any tests due to medical, psychological, or compassionate reasons, please email me. See below for details and consult the undergraduate calendar for information on regulations and procedures for Academic Consideration:

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

### **Accommodation of Religious Obligations:**

If you are unable to meet an in-course requirement due to religious obligations, please email me within two weeks of 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:

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

### **Passing grade:**

You must receive a final grade of 50% or greater in order to pass this course.

### **Missed Tests:**

If you miss a test due to acceptable grounds for granting accommodation, the weight of the missed assessment will be added to the final exam. 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 *ahead* of the scheduled assessment (but for clarity, I cannot guarantee that such an arrangement will be possible). Only in very exceptional circumstances will I allow for an alternative time that is afterward.

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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 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

Asynchronous (through Youtube); Labs are 6-6:50 pm on Thursday evenings through Zoom.

### 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

### 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-reg-regchg.shtml>

#### Associate Diploma Calendar - **Dropping Courses**

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

## 5.4 Other Important Dates

Monday, January 11: First day of classes

February 15 - 19: Reading Week (no classes are scheduled)

Friday, April 2: Good Friday (no classes are scheduled)

Friday, April 12: Last day of classes and last day to drop a course without academic penalty

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## 5 ACADEMIC MISCONDUCT

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.

### 5.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

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

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

<https://academicintegrity.uoguelph.ca/>

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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

Presentations which are made in relation to 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.

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## 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: <https://www.uoguelph.ca/registrar/calendars>