Math 320: Linear Algebra and Differential Equations (002) FA21

General Course Information

Generic Math 320 Course Description

Introduction to linear algebra, including matrices, linear transformations, eigenvalues and eigenvectors. Linear systems of differential equations. Numerical aspects of linear problems.

Prerequisites: MATH 222, 276 or graduate/professional standing

Course website: https://canvas.wisc.edu/courses/261842

Course Designations and Attributes

Breadth – Natural Science
Level – Advanced
L&S Credit – Counts as Liberal Arts and Science credit in L&S
Honors – Honors level (!) course

Credit Hours

This *3-credit class* meets for *three 50-minute class periods* and *one 50-minute discussion* each week over the fall semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc.) for about *2 hours* out of the classroom *for every class period*. This syllabus includes additional information about meeting times and expectations for student work.

Class Instructional Mode, Time, and Location

Class	Date & Time	Location
320-002	MWF 11:00 AM – 11:50 AM	Van Vleck B239 (in person)

There will be a total of 42 classes (40 lectures + 2 midterms) with no class on the 25th Nov due to the Thanksgiving-break.

Discussion Sessions

Section	Date & Time	Location
321-DIS	T 8:50 AM – 9:40 AM	Van Vleck B129 (in person)
322-DIS	T 9:55 AM – 10:45 AM	Van Vleck B203 (in person)
323-DIS	T 11:00 AM – 11:50 AM	Birge 350 (in person)

There will be a total of 11 discussion sessions per section.

Instructor

Dr Thomas Chandler (he/him), tgchandler@wisc.edu

Availability: The instructor will be available at the following:

- Office Hours: MW 1:30 PM – 2:30 PM on Zoom (virtual, link found on canvas and will be emailed)
- Extra (in-person or virtual) instructor office hours can be arranged on request. Please contact the instructor via canvas or email.
- Contributing to Q&A on Piazza predominantly on Monday and Wednesday evenings.

Teaching Assistant

Yunfan He, yhe233@wisc.edu

Availability: The TA will be available at the following times:

- Office Hours: R 9:00 AM – 11:00 AM on Zoom (virtual, link found on canvas and will be emailed)
- Extra (in-person or virtual) TA office hours can be arranged on request. Please contact the TA via canvas or email.
- Contributing to Q&A on Piazza predominantly on Tuesday and Thursday evenings.

Other Course Information

Required Textbook, Software, & Other Course Materials

Campus provides students with technology guidelines and recommendations for instruction. Students should consult these resources prior to the start of the semester.

Textbook: Differential Equations and Linear Algebra, by Gilbert Strang, Wellesley-Cambridge Press 2014. ISBN: 978-0980232790. Book website: http://math.mit.edu/~gs/dela/ which includes video lectures by Gil Strang.

Software: MATLAB (MATrix LABoratory) will be used by the instructor for several demonstrations. UW students have institutional access to MATLAB, see https://software.wisc.edu/cgi-bin/ssl/csl.cgi (UW login required). Learning and using MATLAB is recommended, but is not required for this course; however, assessed homework may require reading, understanding, and writing algorithms in MATLAB-like syntax. Alternatives to MATLAB (e.g. Python and Mathematica) may also be useful to the students

Other: Supplementary notes and MATLAB code samples may be posted on canvas.

Course Website, Learning Management System & Digital Instructional Tools

- All course material, homework, announcements, and grades will be uploaded onto Canvas (https://canvas.wisc.edu/courses/261842)
- All virtual contact (e.g. virtual office hours) shall be via Zoom, with link found on the Canvas website (https://canvas.wisc.edu/courses/261842/external_tools/14065)
- Questions of general interest related to the course should be posted and discussed on the course Piazza site (https://piazza.com/wisc/fall2021/fa21math320002/home) or brought to the office hours. The course instructor and TA will be regularly contributing to the Q&A section on Piazza.
- All other questions/problems should be sent to the Instructor or TA directly via Canvas (or email).

- Solutions to the homework sheets should be submitted on canvas in a PDF format. There is a lot of support available on the web for doing this; for example, see scanning on iPhone/iPad and scanning on Android.

Grading

This course will be assessed via weekly problem sheets (with the two lowest scores being dropped), two midterm exams, and a final exam. The scales given below may be decreased to allow for grade curving.

Assessment Weighting: 20% Assessed Homework, 20% Midterm 1, 20% Midterm 2, 40% Final.

Tentative Grading Scales: 0-59 F, 60-69 D, 70-78 C, 79-81 BC, 82-88 B, 89-91 AB, 92-100 A

Exams

The exams shall be in person and closed book. No communication with anyone (in or out of the class) is allowed during the exams. The exams are cumulative with no make-up exams. By signing up to this course you are agreeing to take two midterm exams and one final exam at the following (Madison, WI) times:

Exam	**Date & Time**	**Location**
Midterm 1	18 Oct 11:00 AM – 11:50 AM	Van Vleck B239 (in person)
Midterm 2	22 Nov 11:00 AM – 11:50 AM	Van Vleck B239 (in person)
Final Exam	22 Dec 7:25 PM – 9:25 PM	To be confirmed

Please inform the instructor of any problems sitting these exams as soon as possible.

Exam Proctoring: Exam Proctoring will be required for this course. Failure to use the proctoring service assigned will results in a zero on the particular exam. Further details will be given before each exam on canvas and in class.

Assessed Homework: Problem Sheets

A problem sheet will be posted weekly on canvas, these will be assessed and count towards your final grade (see grading above). The problem sheets shall focus on specific sections of the book, as will be indicated on the canvas course site and in class. This assessed homework is cumulative, but the two lowest scores will be dropped.

Solutions to the problem sheets should be submitted on canvas as PDFs before the posted deadline. *A grace period of 6 hours shall be given for submissions, however any late submissions without prior permission will be docked 10%.* Tentatively, the problem sheets shall be made available on Friday and due the following Thursday. The instructor should be informed of any problems with completing the assessed homework.

Non-Assessed Howework: Suggested Reading and Further Work

On top of the assessed homework, suggested reading and further work shall be posted regularly on canvas and given in class, but will not be collected or graded. This suggested work is intended to help you learn how to solve problems on your own, consolidate your knowledge, and prepare for the exams. Solutions to all the book's problems are found at http://math.mit.edu/~gs/dela/, but reading someone else's solutions is much easier than solving the problem yourself. It is highly recommended that you carefully study the assigned sections of the book: the techniques taught in Math 320(!) are most easily learnt

through practice. Feel free to post any questions about the reading on Piazza, or bring them to the office hours/discussion sessions.

Generic Course Learning Outcomes

Students will be able to

- Recall and state the formal definitions, properties, and theorems associated to elementary linear algebra and ordinary differential equations (e.g. existence and uniqueness theorems for first-order ODEs, eigenvalues and eigenvectors).
- Verify if a mathematical object has a given property used in elementary linear algebra and differential equations (e.g. that a matrix is invertible, that a set is a vector subspace, that a vector is an eigenvector).
- Check the premises of theorems used in elementary linear algebra in order to apply their conclusions (e.g.that a given matrix has zero determinant and therefore cannot be inverted).
- Resolve algebraic statements related to elementary linear algebra through appropriate computations and compute solutions to elementary systems of ordinary differential equations.
- Express informal mathematical arguments in English using appropriate mathematical terminology and notation.

Course Outline:

This course will cover Chapters 1 – 6 of the textbook by Gilbert Strang:

- Chapter 1: First Order Equations
- Chapter 2: Second Order Equations
- Chapter 3: Graphical and Numerical Methods
- Chapter 4: Linear Equations and Inverse Matrices
- Chapter 5: Vector Spaces and Subspaces
- Chapter 6: Eigenvalues and Eigenvectors

Tentative Schedule: Math 320! covers a lot of material and is not an easy course. The material will not be understood upon a first read, but should be studied in multiple iterations. Sections 1.1 (Introduction) and 1.2 (The Calculus You Need) consists of review material; however, aspects of these sections might be more detailed than what the student is used to, thus they should be studied before the first class. The rest of the course will follow the tentative schedule:

Week	**Material**	***Sections***
1	Taylor Series, FTCs, $y' = y$ by Taylor and Euler. $y' = y^2$, $y' = \sqrt{y}$ by TS	1.1, 1.2, 1.3
2	$y' = ay + q(t)$, educated guessing & general formula, Dirac & Green functions	1.4, 1.5
3	Sinusodial forcing, complex numers, Euler's formula, models	1.5, 1.6
4	Logistic equation, SIR model, MATLAB, mass-spring	1.7, 1.8, 2.1
5	Complex numers, forced damped oscillator	2.2, 2.3, 2.4
6	Gain-lag. MIDTERM 1	2.4, (2.5)
7	Variations of parameters, Laplace transforms, graphics and numerics	2.6, 2.7, 3.1, 3.4, 3.5
8	Linear systems, elimination, matrix multiplication	4.1, 4.2, 4.3

9	Inverse matrices, LU decomposition, symmetric & orthogonal matrices	4.4, 4.5,
10	Vector spaces, nullspace, EF and RREF, complete solution	5.1, 5.2, 5.3
11	Linear independence, basis, dimension, fundamental subspaces. MIDTERM 2	5.4, 5.5
12	Eigenvectors and eigenvalues, determinants	6.1, 6.2
13	Application to DE systems, $\boldsymbol{y}' = A\,\boldsymbol{y} + \boldsymbol{q}(t)$	6.3 (6.4)
14	Further examples and wrap-up	various

How to Succeed in This Course

The students should strive to attend all classes and discussion sessions, whilst the office hours and discussion boards are highly recommended. The classes are instructional lectures ran by the instructor, however they are infomal and, thus, any interruption for questions or observations are welcomed and recommended — there are no 'silly' questions in this course! Discussion sessions are ran by the TA and are typically smaller than the classes, they are for more detailed discussions or examples. The office hours are for any questions (either about the course or the bigger picture), but are also a chance to just say 'hi' and chat with a fellow mathematician. You do not have to have a specific question to come to the discussion session, but can instead just come to listen. Finally, any course related questions should be sent to me, the instructor, via canvas (https://canvas.wisc.edu/courses/261842) or via tgchandler@wisc.edu.

The following campus sevices might also be useful:

- University Health Services
- Undergraduate Academic Advising and Career Services
- Office of the Registrar
- Office of Student Financial Aid
- Dean of Students Office

Covid-19 Guidelines

Students should continually monitor themselves for COVID-19 symptoms and get tested for the virus if they have symptoms or have been in close contact with someone with COVID-19. Students should reach out to the instructor as soon as possible if they become ill or need to isolate or quarantine, in order to make alternate plans for how to proceed with the course. Students are expected to comply with the University's current COVID rules and policies that are maintained here: https://covidresponse.wisc.edu (see in particular https://covidresponse.wisc.edu/faq/).

Students who do not comply with these rules can be asked to leave the classroom, and students who repeatedly fail to comply will be referred to the Office of Student Conduct and Community Standards. Any student who requires an exemption to current policies must contact the McBurney Office, as instructors do not have the authority to grant such exceptions.

Course Evaluation

Students will be provided with an opportunity to evaluate this course and your learning experience. Student participation is an integral component of this course, and your confidential feedback is important to me. I strongly encourage you to participate in the course evaluation.

Privacy of Student Records & the Use of Audio Recorded Lectures Statement

Lecture materials and recordings for this course are protected intellectual property at UW-Madison. Students in this course may use the materials and recordings for their personal use related to participation in this class. Students may also take notes solely for their personal use. If a lecture is not already recorded, you are not authorized to record my lectures without my permission unless you are considered by the university to be a qualified student with a disability requiring accommodation. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

Students' Rules, Rights & Responsibilities

To see the Undergraduate Guide's Rules, Rights, and Responsibilities informations, please refer to https://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext

Diversity & Inclusion Statement

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.

Academic Integrity Statement

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Accommodations for Students with Disabilities Statement

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (UW-855) require the university to provide reasonable accommodations to students with disabilities to access and participate in its academic programs and educational services. Faculty and students share responsibility in the accommodation process. Students are expected to inform faculty [me] of their need for instructional accommodations during the beginning of the semester, or as soon as possible after being approved for accommodations. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to provide reasonable instructional and course-related accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center)

Academic Calendar & Religious Observances

The 2021 academic calendar and relgious observances can be found at https://secfac.wisc.edu/academic-calendar/