Course Outline
Matrix Methods and Differential Equations for Electrical Engineers
Fall 2023

Course Information

Lectures: Tuesdays and Thursdays from 8AM to 10AM

Lecture Room: K327

Labs: Thursdays from 2PM to 3PM

Lab Room: A248

Instructor information

Instructor: Dr. Lorena Aguirre-Salazar

E-mail: lorena.aguirresalazar@lakeheadu.ca

Office hours: Wednesdays and Thursdays from 12:45pm to 1:45pm, or by appointment

Office: Unit T3, located in the E/H parking lot, office B

Course summary

This course covers a multitude of topics in matrix methods and differential equations. Areas of study include: Matrix algebra; determinants; eigenvalues, eigenvectors, and diagonalization; separable and linear ordinary differential equations (ODEs) with constant coefficients; Laplace transforms; systems of linear ODEs with constant coefficients; Fourier series; Fourier transforms.

Course materials

Website: this course uses a D2L (courselink, `https://mycourselink.lakeheadu.ca/`) site, on which grades and important course information will be posted. You are expected to check this website regularly for announcement and course materials.

Recommended textbook: Advanced Engineering Mathematics, D.G. Zill and M.R. Cullen, published by Jones and Bartlett.

Evaluation Policy

Your final grade is comprised of the following components, weighed as indicated:

Component	Weight
Maximum between attendance and assignments	5%
Term test 1	20%
Term test 2	20%
Term test 3	20%
Project	10%
Final exam	25%

On attendance

I take attendance every lecture. If you are absent when I take attendance, or if you attend and leave before the class is over, I will mark you down as absent. Attendance records are available throughout the term. If you are absent, it is your responsibility to catch up. There will often be important information regarding assignments and tests conveyed in lecture.

On term tests

There are three term tests. Each term test is scheduled for roughly one week after we finish covering corresponding topics. If a term test is missed for a legitimate reason (e.g. illness), the weight of the test will be added to the final exam.

On project

We have an individual project in this course. There are multiple steps you need to take to complete the project. The final outcome of the project consists of two things you submit through the course website: a video of you presenting your project, and a form I provide filled out. There cannot be two people with projects that overlap.
You will present one and only one of the following:

- A mini-lecture on a section from the textbook that we do not cover in class. The mini lecture includes the name of the topic, background information (who discovered it, what was their motivation, where would the topic fit in our course), the actual topic (which formulas are applied), a substantial example (how formulas are applied and what they give), conclusions, and references.
- A mini-lecture on an application of material(s) covered in class to your field. The mini lecture includes a specific research question, background information (who discovered the application, what was their motivation), a detailed answer to the question (how formulas are applied numerically and what they give when you simulate everything), conclusions, and references.
- A mini-lecture on how you apply material(s) covered in class to a problem you are interested in. The mini lecture includes a specific research question, background

information (what your motivation was, what has been done in the past), a detailed answer to the question (how formulas are applied numerically and what they give), conclusions, and references.

Here are the steps you need to take to complete the project:

Step 1: Think of the name of the method you intend to present, or the research question you would like to answer. Submit a form I provide to the corresponding folder on the course website. I will ask you to change your project choice if somebody else is already doing something similar, or if your research question is not specific enough (if applicable).

Step 2: Once I approve your project, think of what you need to do in order to complete your project. Submit a form I provide filled out to the corresponding folder on the course website. The form contains questions on your project plan.

Step 3: Participate in a group activity in class to share your project plan with classmates. There will be an exchange of feedback.

Step 4: Submit a form filled out to the corresponding folder on the course website. The form contains questions on your project plan.

Step 5: Submit a power point presentation and a form I provide filled out to the corresponding folder on the course website. The form contains questions on your presentation.

Step 6: Present your project to classmates. There will be an exchange of feedback.

Step 7: Create a video of you presenting your project and fill out a form I provide. Submit a link to the video and the form to the corresponding folder on the course website.

Here is the breakdown of the grade for the project:

Component	**Weight**
Step 1 and getting your project approved by me	15%
Step 2	10%
Step 3	10%
Contents of the form in step 4	15%
Step 5	10%
Step 6	10%
Contents of your submission in step 7	30%

If you do not meet the deadline for a particular step, then you get zero on the corresponding component. I do not accept late submissions under any circumstances. If you do not meet the deadline corresponding to step 1, 4, or 7, you get zero on that component and all subsequent steps.

On final exam

There will be a cumulative final exam, the date and time of which will be announced as soon as it is scheduled. Missing the final exam results in automatic failure of the course.

Schedule of Activities

We will adhere to the following schedule of topics to the best of our abilities. It may be subject to minor changes due to unforeseen delays and/or expedition.

Week	Topic(s) covered	Evaluation
1 (Sep 5^{th}-Sep 8^{th})	Matrix algebra: matrices over real numbers, addition, subtraction, transpose and multiplication with conformance rules Determinants: determinant of a square matrix, adjoint of a matrix, inverse of a matrix	None
2 (Sep 11^{th}-Sep 15^{th})	Systems of linear equations: applications to linear equations Eigenvalues, eigenvectors, diagonalization: characteristic equation, eigenvalues and eigenvectors, normalization of eigenvectors	Assignment 1 is due
3 (Sep 18^{th}-Sep 22^{nd})	Eigenvalues, eigenvectors, diagonalization: the Cayley Hamilton theorem, diagonalization of matrices using eigenvalues and eigenvectors	Step 1 of the project is due on Friday September 22^{nd} at 11.59PM Assignment 2 is due
4 (Sep 25^{th}-Sep 29^{th})	Separable and linear ODEs with constant coefficients: Linear first order differential equations, separable ordinary differential equations	Term test 1 Assignment 3 is due
5 (Oct 2^{nd}-Oct 6^{th})	Separable and linear ODEs: homogeneous second order linear differential equations with constant coefficients and response to initial conditions-over damped, critically damped and under damped responses, Cauchy-Euler equations Laplace transform: definition, linearity, computation of the Laplace transform of $\exp(at)$, unit step Laplace transform	Step 2 of the project is due on Friday October 6^{th} at 11.59PM Assignment 4 is due

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Week	Topic(s) covered	Evaluation
6 (Oct 10^{th}-Oct 13^{th})	Laplace transform: sinusoid transforms using $\exp(iwt) = \cos(wt)+i\sin(wt)$, Shifting and Scaling theorems [including review of complex numbers], Laplace transform of derivative of $f(t)$, final value theorem, convolution theorem, inverse Laplace transform by partial fractions Project: Step 3 of the project should take us at most twenty minutes of class.	Step 3 of the project in class Assignment 5 is due
7 (Oct 16^{th}-Oct 20^{th})	Laplace transform: Inverse Laplace transform by partial fractions, applications of Laplace transform to ODEs with constant coefficients with forcing functions	Step 4 of the project is due on Friday October 20^{th} at 11.59PM Assignment 6 is due
8 (Oct 23^{rd}-Oct 27^{th})	STUDY WEEK ENJOY THE BREAK!	None
9 (Oct 30^{th}-Nov 3^{rd})	Systems of linear ODEs: representation of a system of linear ODEs as $x' = Ax + F$	Term test 2 Assignment 7 is due
10 (Nov 6^{th}-Nov 10^{th})	Systems of linear ODEs: the matrix exponential $\exp(At)$ and its computation using diagonalization, the solution of a system of linear differential equations $x' = Ax + F$ in time domain using $\exp(At)$.	Assignment 8 is due
11(Nov 13^{th}-Nov 17^{th})	Systems of linear ODEs: Connections to Laplace transforms Fourier Series: real Fourier series, Parseval's theorem.	Step 5 of the project is due on Friday November 17^{th} at 11.59PM Assignment 9 is due
12(Nov 20^{th}-Nov 24^{th})	Fourier Series: Complex Fourier series Project: Step 6 of the project in class. This should take us up to fifty minutes.	Step 6 of the project in class Term test 3 Assignment 10 is due
13 (Nov 27^{th}-Dec 1^{st})	Fourier Transforms: Fourier transforms – introduction – Definition, computation of the Fourier transform of a rectangular pulse, computation of the Fourier sine and cosine transforms of an exponential	Assignment 11 is due

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Week	**Topic(s) covered**	**Evaluation**
14 (Dec 4^{th}-Dec 8^{th})	No class	Step 7 of the project due on Monday December 4^{th} at 11.59PM Assignment 12 is due

How to do well in this course

We cover a lot of material fairly quickly.

Prior to each lecture, I will upload a handout consisting of partially complete notes for that class. You are expected to bring these notes to lecture, and we will fill them in together. Try to skim through the corresponding handout before the class takes place.

During class, take notes on the handouts, add pages as needed, and try to pay attention and understand at least a quarter of what we cover. You might find yourself connecting what we discuss with what you read before the session. Be gentle with yourself if you feel lost. If there is something you do not understand, please do not hesitate to ask about it. There is a good chance someone else has the same question. If you still do not understand it, then let it go so that you can focus on trying to understand what comes next. You are always welcome to come to office hours and get all the help you need. Also, I strongly suggest you try studying with peers, and that you access resources for success the University offers.

It is important to keep clear lecture notes. If you miss a lecture, please catch up on activities as soon as possible.

After class, read over the handouts and redo examples separately. Those examples are usually simple but interesting enough as for setting a good start. Then, come to the lab. While the purpose of the lectures is to introduce new material and discuss mathematical theory, it is in the lab that we will apply the lecture material to solve problems. The notes from these sessions should prove invaluable to you as you work through your assignments and study for your tests and exam.

After the lab, redo examples separately. Then, read corresponding sections from the textbook and try examples from there. Then, give assignment problems a try and check each of the answers at the back of the textbook. Bring questions to the lab or office hours.

You should study for this course at least 12 hours per week on top of class time. Please plan for reaching that minimum, and keep in mind that sometimes you will need to invest

more, depending on how strong your foundational understanding of the material is.

To study for a test or for the final the exam, go over all your notes, write your own summary of what is going to be tested, try class examples, lab examples, assignment problems, and textbook problems in that order. If you have extra time, try more problems from the textbook or explain what you learned to another person.

Lakehead-Georgian Policies

Academic and Student Code of Conduct Policies

- Academic and student policies and procedures for those enrolled in the Lakehead-Georgian programs can be found on the Lakehead-Georgian Student Portal
- All Lakehead-Georgian programs will follow the Lakehead Regulations as list in the Lakehead University Academic Calendar (`http://csdc.lakeheadu.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&loaduseredits=False`).The University Regulations include but are not limited to Registration, Examinations, Reappraisals and Academic Appeals, Special Examinations, Academic Misconduct, Withdrawal, and Timely Feedback. Additional Faculty Regulations may also apply. Please review the Academic Calendar.
- The Lakehead University Student Code of Conduct - Academic Integrity (`https://www.lakeheadu.ca/students/student-life/student-conduct`) will apply to all Lakehead-Georgian students regardless of campus of study.
- The Lakehead University Student Code of Conduct - Appeals (`https://www.lakeheadu.ca/students/student-life/student-conduct`) will apply to all Lakehead-Georgian students regardless of campus of study
- The Georgian College Student Code of Conduct (`http://www.georgiancollege.ca/student-code-of-conduct/`) will apply to the Lakehead- Georgian students studying at the Barrie campus. Additional campus policies of Sexual Violence Procedure and Protocol (`https://www.georgiancollege.ca/about-georgian/campus-safety-services/tab/sexual-violence`), Alcohol, Drugs and Tobacco (`https://www.georgiancollege.ca/about-georgian/campus-safety-services/tab/alcohol-drugs-and-tobacco`), and Information Technology Acceptable Use Procedure (`http://www.georgiancollege.ca/wp-content/uploads/2-117IT-acceptable-use.pdf`) also apply.
- The Lakehead University Student Code of Conduct – Non-Academic (`https://www.lakeheadu.ca/students/student-life/student-conduct`) will apply to the Lakehead-Georgian students studying at the Orillia campus.

Plagiarism and academic dishonesty

A breach of Academic Integrity is a serious offence. The principle of Academic Integrity, particularly of doing one's own work, documenting properly (including use of quotation

marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students should view the Student Code of Conduct -Academic Integrity (`https://www.lakeheadu.ca/students/student-life/student-conduct`) for a full description of academic offences, procedures when Academic Integrity breaches are suspected and sanctions for breaches of Academic Integrity.

Student services and support

Student advisors

- Help students build both academic and personal resilience so that they can flourish at Georgian and beyond
- Provide individual, group and web-based advising sessions
- Are housed within the academic areas
- To book an appointment with your advisor go to the Student Portal (preferred, `https://georgiancollege.sharepoint.com/sites/student/Student-Services/StudentAdvisors/SitePages/Home.aspx`) or call 705-728-1968 Ext. 1307.

Library (`http://library.georgiancollege.ca/main`)

Customer Service

- Off campus access

Research help

- Help finding books, articles and credible sources.
- Using specialty databases.
- Creating a search strategy.

Academic Success (`https://library.georgiancollege.ca/help/contact-academic-success`)

Writing centre (`http://library.georgiancollege.ca/writing_centre`)

- Improve your writing.
- Help with citing sources and laying out your paper.

Math Centre (`http://library.georgiancollege.ca/math_centre`)

- Make sense of Math questions.
- Understand concepts and develop skills.

Tutors (http://library.georgiancollege.ca/tutoring))

- Further understand course content.
- Build your study practices.

Accessibility services (https://www.georgiancollege.ca/student-life/student-services/accessibility-services/)

If you are a student experiencing a disability who may require academic accommodations and have not yet registered with Accessibility Services, please contact their office at 705-722-1523, email studentsuccess@georgiancollege.ca, or visit their offices in B110. You must be registered with Accessibility Services to access academic accommodations. Support for those students whose success at college may be affected by a disability include:

- Ongoing support from our Accessibility Advisors including arranging a confidential psychoeducational assessment where required
- Training in the use of specialized computer technology
- Classroom and test accommodations

Test Services (http://www.georgiancollege.ca/student-life/student-services/testing/)

- Accommodated testing
- Missed/Makeup testing
- Proctoring services are also available for external and Ontario Learn exams

Counselling (http://www.georgiancollege.ca/student-life/student-services/counselling/)

- Free, confidential counselling is available to all students
- Walk in counselling is available on a daily basis Monday to Friday

Career Success (http://www.georgiancollege.ca/student-life/student-services/co-op-and-career-services/)

Career assessments and exploring options

- Job search workshops
- Labour market information
- Resume/cover letter help
- Interview practice

- Graduate employment information
- Links to job postings and online resources

Campus Safety and Security Syllabus Addendum

Emergency Evacuation (`https://www.georgiancollege.ca/about-georgian/campus-safety-services/tab/fire`)

- Evacuate buildings when a fire alarm is activated or an official announcement is given. Review evacuation guidelines. (https://www.georgiancollege.ca/about- georgian/campus-safety-services/tab/fire)
- Students requiring assistance in emergency situations must inform their faculty during the first week of class.
- Familiarize yourself with all fire exit doors of classrooms and buildings you may occupy.
- Do not re-enter a building until instructions are given by the Fire Department or college personnel.

Lockdown (`https://www.georgiancollege.ca/about-georgian/campus-safety-services/tab/lockdown`)

- Lockdown is initiated when there is a potential or actual violent incident on campus that could result in a serious injury or threat to life.
- Students can download the new Safe@Georgian app to stay updated on Campus Safety and Security information including lockdown.
- Familiarize yourself with the College Lockdown procedure (`https://www.georgiancollege.ca/wp-content/uploads/Lockdown.pdf`)
- Lockdown tests occur each semester.

Resources:

- Get Out, Hide, Fight Lockdown Video (`http://youtu.be/JA8cckMbVDk`)
- Lockdown quick reference sheet (`http://www.georgiancollege.ca/wp-content/uploads/COM-15-416_LockdownProcedure_Signage_FVR3_print.pdf`)
- Lockdown Model – Get Out, Hide, Fight: Lockdown Tools and Tactics and FAQs.

Unscheduled Campus Closure (`https://www.georgiancollege.ca/about-georgian/campus-safety-services/tab/campus-closures`)

Resources:

- How to find out if your campus is closed (`http://www.georgiancollege.ca/about-georgian/campus-safety-services/#how-to-find-out-if-your-campus-is-closed`)
- Unscheduled Campus Closure Procedure (`https://www.georgiancollege.ca/wp-content/uploads/2-102Unscheduled-college-closure-2018.02.10.pdf`)

Timing of Closures/Notification:

Closure	Decision	Notification	Notes
College has made the decision to close a campus or location in the morning:	6:00 a.m.	By 6:30 a.m.	If re-opening for noon or evening classes is being considered, this will be mentioned in the message
College closes a campus(s) in the morning and expects to re- open by 12:00 noon	9:30 a.m.	By 10:00 a.m.	Only affects classes beginning at 12 noon or later
Closure expected to continue past 12:00 noon	9:30 a.m.	By 10:00 a.m.	
College intends to re-open for evening classes which commence at 5 p.m. or later	2:30 p.m.	By 3:00 p.m.	
College intends to NOT re-open for evening classes:	2:30 p.m.	By 3:00 p.m.	

*Notification will be made via:

- Georgian social media (Facebook, Twitter)
- Safe@Georgian app
- Georgian website (homepage)
- Recorded message when you call into Barrie campus at 705-728-1968
- Student or employee portal
- Georgian email account
- Radio and television announcements through local and regional media

Note: We only announce the names of campuses that are closed. If your campus is not named in a closure, it's open.