Matrix Methods & Differential Equations

MATH 2090 - Fall 2022

Instructor: Dr. Serhii Myroshnychenko (smyroshn@lakeheadu.ca)

Schedule:

- ✓ Lectures: Tuesday, Thursday 15:30 – 17:00 EST at **M339**.
- ✓ Labs: Friday 12:00 – 13:00 EST at **A248** + 30 min/week at **TBD**.
- ✓ Office hours**:** Monday 18:00 – 19:00, Wednesday 16:00 – 17:00 EST or by appointment at **F118E** or via Zoom.

Recommended textbook:

- *Advanced Engineering Mathematics*, D.G. Zill and M.R. Cullen, published by Jones and Bartlett.

Important dates:

- First Day of Classes: **September 6th**.
- Fall Study Week: **October 24th – October 28th**.
- Midterm: **October 28th**.
- Last Day of Classes: **December 6th**.
- Final: **TBD**.

Exams: There will be one midterm exam during the **lab hour**. The final exam will be scheduled by the registrar's office. The exams will be closed book with no calculators or other aids allowed.

Grade: Please note that **no** alternate grading scheme will be used in this course.

Written Homework	20%
Online Assignments (WeBWorK)	20%
Midterm	20%
Final	30%
Quizzes	10%

Homework: Written HW is assigned **every three weeks**. Online assignments are assigned **weekly**.

Lab Hour: No new material will be covered in the labs. The lab will reinforce concepts through examples, as well as provide students with the opportunity to ask questions about the content given in class or assignment problems. Though the lab is not mandatory, it is very beneficial to attend and **required to take quizzes**.

Course Policies:

1. Late assignments will be **accepted and reviewed, but not graded**. There will be **no** make-up exams. If you miss the midterm for a legitimate reason which you can document (e.g. doctor's note), the weight of the midterm will be *transferred* to the final exam. The documented proof of absence should be provided no later than 3 days after the is scheduled.

2. All electronic devices (phones etc.) are prohibited during the exams. In case when such a device is detected during the exam (**activated or not**), it would be treated as an **academic misconduct** situation.

Accommodations: Lakehead University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. If you think you may need accommodations, you are strongly encouraged to contact Student Accessibility Services (SAS) and register as soon as possible. For more information please visit:

https://www.lakeheadu.ca/students/student-life/student-services/accessibility/

Awards and scholarships for current/returning students:

https://www.lakeheadu.ca/studentcentral/financing-budgeting/scholarships-for-current-returning

Any questions? Feel free to reach out to the instructor by e-mail or ``in-person'' with any questions, concerns, comments you might have. Also, check-out the following useful page for several related student resources:

https://www.lakeheadu.ca/students/student-life/student-conduct/resources

Tentative schedule

Week	Topics
1	Matrices over real numbers. Addition, subtraction, transpose, and multiplication with conformance rules. Determinant of a square matrix, adjoint of matrix elements, inverse of a matrix.
2	Applications to linear equations.
3	Characteristic equation. Eigenvalues and eigenvectors. Normalization of eigenvectors. Statement of Cayley Hamilton theorem. Diagonalization of matrices using eigenvalues and eigenvectors.
4	Linear first order separable differential equation and its solution.
5	Separable ordinary differential equations. Homogeneous second order linear differential equations with constant coefficients and response to initial conditions. Cauchy-Euler equation. Laplace transform definition, linearity, computation of the Laplace transform of exp(at).
6	Unit step Laplace transform and 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.
7	Inverse Laplace transform by partial fractions. Applications of Laplace transform to ODEs with constant coefficients and forcing functions.
8	Representation of a system of linear ODEs as x' = Ax+Bu. The matrix exponential exp(At) and its computation using diagonalization.
9	The solution of a system of linear differential equations x'=Ax+Bu in time domain using exp(At). Connections to Laplace transforms and Convolution Theorem.
10	Periodic functions (one variable) - Complex Fourier series and coefficient calculations. Real Fourier Series as emergent from this. Real Fourier series coefficient expressions.
11	Parseval's theorem and calculations of the time integral $f(t)^2$ dt over a period directly and from complex Fourier, and Real Fourier series using the coefficients.
12	Fourier transforms. Computation of the Fourier transform of a rectangular pulse and sinusoids.