Saint Mary's University

Department of Mathematics
& Computing Science

MATH 2303 – Differential Equations I

Winter 2023

Territorial Acknowledgement

Saint Mary's University acknowledges that the university is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People.
This territory is covered by the "Treaties of Peace and Friendship" which Mi'kmaq, Wəlastəkwiyik (Maliseet), and Passamaquoddy Peoples first signed with the British Crown in 1726.
The treaties did not deal with surrender of lands and resources but in fact recognized Mi'kmaq and Wəlastəkwiyik (Maliseet) title and established the rules for what was to be an ongoing relationship between nations.

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Please put "MATH 2303" in the subject line, use the *plain text format*, and make sure that you are clearly identified (first and last names). I do not answer anonymous email. I do not check emails during evenings or weekends. I usually answer during the first business day after receiving an email.

Lectures: Synchronous.

Mondays and Wednesdays, 1:00pm–2:15pm (Halifax time)

Loyola Academic room 170

Office hours: – *Ask-Me-Anything* hours –

Monday 2:30pm–5:00pm

Wednesday 10:00am–12:00pm and 2:30pm–5:00pm.

Friday 10:00am–11:30am.

Prerequisites: Good knowledge of Calculus I and II (MATH 1210 and MATH 1211).

Overview: The course consists of two one-and-a-quarter-hour *lectures* and a one-and-a-quarter hour *recitation* each week.

This course is a first exploration into the world of Ordinary Differential Equations, that were already introduced in Introductory Calculus II (MATH 1211).
The main topics will be the following:

- First-order differential equations (separable, exact, linear; integrating factors; modelling electric circuits).
- Second-order (and higher-order) differential equations (homogeneous linear, constant coefficients, non-homogeneous; undetermined coefficients; variation of parameters; models of forced oscillations and resonance; electric circuits).
- Laplace transform method (linearity, transforms of derivatives and integral, shifting; applications to systems of differential equations, convolutions, the delta function, impulse response, transfer function).
- Fourier series.

Textbook: We will cover Chapters 1, 2, 3, 4, 6, and 7 (and 10, time permitting) from the textbook

R. Kent Nagle, Edward B. Saff, Arthur David Snider, *Fundamentals of Differential Equations*, 9th edition, Pearson (ISBN 9780321977069).

Digital copies are available for purchase from the SMU Bookstore.

A diary of the lectures will be regularly kept on the Brightspace calendar with the sections covered in each class. Please, refer to that when preparing for the final exam because that will be the official and ultimate syllabus for the class.

Evaluations: The course mark will be calculated as follows:

20% workshops/quizzes,
35% midterm exam,
45% final exam.

Note that there is no "100% final exam" option in this course. The term work contributes 55% to the final grade. In order to obtain a passing grade of at least "D" you *must pass* the Final Exam.
Final letter grades are assigned according to the Academic Calendar.

Assignments: A list of problems is attached to this syllabus. After every class the instructor will let you know what sections were covered that day.
These assignment problems will *not* be collected by the instructor, they are given for practice and preparation for the workshops, tests and exams.
You are urged to start working on the assigned problems for a given section, as soon as the material corresponding to that section has been covered in lecture. The list will also be available on BrightSpace.

Recitations: Recitations happen every week and last 1 hour and 15 minutes.
During recitation you will be handed out workshops and quizzes:

- A **workshop** is a set of exercises based on the material covered in previous lectures.
  You are expected to be prepared: read the material and solve the assigned problems in advance. You will have between 50 and 75 minutes to complete the workshop (depending on the week). You can freely use your notes and the textbook for help.

  Discussions and work group are highly encouraged!

  However, no copying is permitted during group work and discussion is expected among all members of the group.
- A **quiz** is a shorter set of exercises based on approximately the same material as the workshop.
  You will have 15 to 25 minutes (depending on the week) to complete the quiz.

  You will need to work individually and you will have no access to textbook/notes.

Exams: There will be one Midterm and the Final Exam.
The midterm exam will be written in class, during scheduled times. It will tentatively take place during Week 6, *during the week's recitation*. The exact date and contents of the midterm will be communicated at least 10 days in advance.
Date for the final exam will be scheduled by the university registrar. The final exam will cover material from the entire course.

Both exams are closed-book, no notes are allowed.

Missed tests / workshops: There are no make-ups for midterm and workshops. If you missed the midterm or a workshop due to *extenuating circumstances*, fill the Declaration of Extenuating Circumstances form, available from the student's Academic Advising Office, and talk to your instructor. No special arrangements to accommodate travel that coincides with any tests will be made.

Expectations: All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Calculators: unless otherwise stated, basic 4-function calculators and scientific calculators (like Sharp EL 531 and Casio FX 300MS, for example) are permitted in class tests.

Academic Integrity: This course will adhere to the SMU Academic Integrity Policy as found on the Academic Integrity and Student Responsibility page.

Students are expected to do their own work during tests and exams. The following activities, although not exhaustive, are examples of activities that are prohibited:

- Copying from another student;
- Allowing another student to copy from you;
- Using unauthorized aids, including: sheets, cell phones and calculators, during test or exam;
- Getting aid from or giving aid to another student during tests and exams;
- Having another student write for you or writing for another student.

Offenders are subject to discipline. Students are urged to read the Academic Integrity Handbook.

An incident of academic dishonesty can have extremely negative consequences: it could delay or bar a student from graduating. A note on a transcript referring to academic dishonesty could very well bar a student from graduate school or affect job opportunities.

This course is a precious opportunity for you to learn something new and valuable. It's an investment on your future. Failing to acquire it will sadly be your loss.

Intellectual property:

Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, quizzes, assignments, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member.

Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Regulations.

Disabilities:

Saint Mary's University is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations shall first contact the Fred Smithers Centre before requesting accommodations for this class.

Students who need accommodations in this course must contact the instructor in a timely manner (at least one week before examinations) to discuss needed accommodations.

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Tentative outline of the course

Week	Section	Topic	Assignments
1 (Jan 9th)	1.1, 1.2, 2.1	Welcome! - Background - Solutions and Initial Value Problems - Introduction: motion of a falling body	Exercise set 1.1: 7, 9, 11, 13, 15 Exercise set 1.2: 3, 5, 11, 15, 21
2 (Jan 16th)	2.2, 2.3, 2.4	- Separable equations - Linear equations - Exact equations	Exercise set 2.2: 9, 13, 21, 23, 29, 31 Exercise set 2.3: 9, 11, 15, 19, 21, 31 Exercise set 2.4: 11, 17, 19, 21, 25, 29
3 (Jan 23rd)	2.5, 2.6, 3.4	- Special integrating factor - Substitution and transformation - Mathematical modelling (Newtonian mechanics)	Exercise set 2.5: 7, 9, 11, 13 Exercise set 2.6: 11, 13, 15, 17, 23, 25, 27, 33, 37, 39 Exercise set 3.4: 1, 5, 7
4 (Jan 30th)	4.1, 4.2, 4.3	- Introduction: the mass-spring oscillator - Homogeneous linear equations: general solution - Auxiliary equations with complex roots	Exercise set 4.1: 3, 5 Exercise set 4.2: 5, 7, 9, 11, 13, 15, 17, 19 Exercise set 4.3: 11, 13, 15, 17, 19, 21, 23, 25, 27

5 (Feb 6th)	4.4, 4.5. 4.6	- Non-homogeneous equations: the method of undetermined coefficients - The superposition principle and undetermined coefficients revisited - Variation of parameters	Exercise set 4.4: 17, 21, 23, 25, 29, 31 Exercise set 4.5: 17, 19, 21, 25, 27, 29, 31, 33, 41 Exercise set 4.6: 5, 7, 11, 13, 15, 17
6 (Feb 13th)	4.7, 3.2	- Variable-coefficient equations - Mixing problems - *Midterm*	Exercise set 4.7: 9, 11, 13, 15, 17, 19, 37, 39, 41, 43 Exercise set 3.2: 1, 5, 7
*** (Feb 20th)	***	*** spring break ***	***
7 (Feb 27th)	4.9, 4.10, 5.7	- Free mechanical vibrations - Forced mechanical vibrations - Electrical systems	Exercise set 4.9: 3, 5, 7, 9 Exercise set 4.10: 3, 9, 13 Exercise set 5.7: 1, 3, 5
8 (Mar 6th)	6.1, 6.2, 7.1	- Basic theory of linear differential equations - Homogeneous linear equations with constant coefficients - Introduction: a mixing problem (Laplace)	Exercise set 6.1: 1, 3, 5, 11 Exercise set 6.2: 7, 9, 11, 13, 19, 21
9 (Mar 13th)	7.2, 7.3, 7.4	- Definition of the Laplace transform - Properties of the Laplace transform - Inverse Laplace transform	Exercise set 7.2: 5, 7, 9, 11, 13, 15, 17, 19 Exercise set 7.3: 5, 7, 9, 13, 15, 17,21, 25, 33, 35 Exercise set 7.4: 5, 7, 9, 21, 23, 25, 27, 29, 33, 35

10 (Mar 20th)	7.5, 7.6, 7.7	- Solving initial value problems - Transforms of discontinuous functions - Transforms of periodic and power functions	Exercise set 7.5: 5, 7, 9, 11, 13, 15, 17, 23, 29 Exercise set 7.6: 5, 7, 11, 13, 15, 21, 23, 27, 29 Exercise set 7.7: 1, 3, 5, 7
11 (Mar 27th)	7.8, 7.9, 7.10	- Convolution - Impulses and the Dirac delta function - Solving linear systems with the Laplace transform	Exercise set 7.8: 3, 9, 11, 13, 17, 19, 21 Exercise set 7.9: 13, 15, 17, 19, 21, 23 Exercise set 7.10: 1, 3, 5, 9
12 (Apr 3rd)	10.3, 10.4	- Fourier series - Fourier cosine and sine series - Review & conclusions	Exercise set 10.3: 9, 11, 13, 15, 17, 19 Exercise set 10.4: 5, 7, 9, 11, 13, 15

Disclaimer: the instructor reserves the right to make changes to the course outline and course content should this be necessary for academic or other reasons. Every effort will be made to minimize such changes.