MATH 215/255 Elementary Differential Equations I

Course syllabus

Purpose

This course is an introduction to ordinary differential equations (ODEs) and models that involve ODEs in several areas of application including physics, chemistry, biology, ecology, and engineering. It is expected that a successful student passing this course will:

- understand the background theory of linear systems of ODEs,
- be able to solve analytically a range of first order ODEs and linear second order ODEs,
- be able to understand the qualitative behaviour of some nonlinear ODEs, through the phase plane and methods such as linearization, and
- have familiarity with the concept of numerical solution of an ODE, and have experience solving various ODEs using MATLAB.

Instructor-in-Charge: Prof. Anthony Wachs.

List of Math 215 / MATH 255 Sections

Section	Instructor	Location	Time
201	Prof. Khanh Dao Duc	LSK 200	10-11am MWF
202	Prof. Anthony Wachs	Buchanan B213	10-11am MWF

Textbook

Notes on Diffy Qs: Differential Equations for Engineers, by Jiri Lebl, https://www.jirka.org/diffyqs/diffyqs.pdf (online and free, there is a link to affordable paperback)

Pre-reqs and Co-reqs

Pre-reqs: Calculus II (one of MATH 101, MATH 103, MATH 105, MATH 121, SCIE 001) and Linear Algebra (one of MATH 152, MATH 221, MATH 223).
Co-reqs: Multivariable Calculus (one of MATH 200, MATH 217, MATH 226, MATH 253, MATH 263).

Important Dates

First day of class: Monday 08 January 2024
Midterm: Friday 16 February 2024
Quizzes: Friday 2 February 2024 and Friday March 15 2024
Last day to withdraw without record: Friday 19 January 2024
Last day of classes: Friday 12 April 2024
Final exam: TBA

Course Evaluation

Homework: 5% (Homework will be due Sundays at 11:59pm except (i) over the week of the midterm the homework is due Thursday at 11:59pm and (ii) the week following the midterm there will be no homework).

Quizzes: 20% (two 30-minute exams to be taken in class, Friday 2 February 2024 AND Friday March 15 2024)
Midterm: 25% (50-minute exam to be taken in class, Friday 16 February 2024)
Final exam: 50% (150-minute exam, look up date and location on UBC's Official Exam Schedule)

Homework

- 10 homework assignments have written components.
- 5 homework assignments have computational components in Python/Jupyter. The goal is for students to learn more about the content of the course through computation.
- All homework assignments must be submitted electronically. Please follow carefully the submission instructions for each assignment. Homework solutions will be posted in Canvas.

Important notes and policies on homework assignments

- There are 15 homework assignments in total. Each homework assignment is worth 0.5% of your final course mark. However, assignments are not marked, instead they are (randomly) checked for appropriate content. Students who tried to solve at least half of the problems in each assignment will receive full mark for this assignment. We implement a "we trust you" policy and assume that all students will try hard to solve the problems in the homework assignments, and will receive full credit for trying hard.
- However, students who submit empty files or garbage files as their homework submission will receive a penalty of - 10 points on their final course mark.
- You only need to submit 10 homework assignments out of 15 to get the full 5 marks of your final course mark. If you submit more than 10 homework assignments, you will bank 0.5 bonus point per homework assignment. A student who submits all 15 homework assignments with appropriate content receive a 2.5 pts bonus on their final course mark.
- While homework assignments are due Sundays at 11:59pm, some due dates may be adjusted to align with the pace of the course.
- While assignments are not marked and only amount for 5% of the final course mark, it is extremely important that students try hard to solve them. They are key to the understanding of the course material and constitute the most effective way to be prepared for the various tests in the course. Please take this advice very seriously.
- Late submissions are not accepted.
- Solutions to assignments will be posted on Canvas and discussed by the TA in the tutorial sessions.

Policies on quizzes, midterm exam and final exam

- No calculators or notes are allowed in the quizzes, midterm and final exams.
- Permission to shift the weight of your missed midterm to other exams, or to ignore missed assignments, may be granted only in the following circumstances:
  (i) prior notice of a valid, documented absence on the scheduled date (e.g. out-of-town varsity athletic commitment with a letter from a coach),

(ii) notification to the instructor of absence due to a medical condition with a doctor's note, or
(iii) inability to return to campus due to Covid-19 travel restrictions, with a proof.
Otherwise, a score of 0 will be given for the missed midterm/assignments. However, the UBC policy on Academic Concession allows students to request academic concession without documentations ONCE per course. For such request please fill the corresponding form.

- The period for final exams is Apr 16 to Apr 27 inclusive. Students should not make early travel plans that overlap with the scheduled exam period.

Python/Jupyter

- Login to Syzygy to get started with Python and Jupyter
- See Python for UBC Math for examples and resources
- Visit Python/Jupyter TAs in the Math Learning Center

Piazza

We will have a Piazza forum for all sections of MATH 215/255. You can ask and answer questions there. It is more efficient than emailing questions to the instructors since many students will have similar questions, the answers from your classmates may be easier to understand, and the process of discussion is also beneficial. Instructors and TAs will occasionally check if there are questions unanswered.

Additional Resources

- Math Learning Centre (MLC): Teaching Assistants are available to answer MATH215/255 related questions at the Math Learning Center located in LSK 301/302.
- Other textbooks and resources:
  - Elementary Differential Equations and Boundary Value Problems, William E. Boyce and Richard C. DiPrima, 10th or 11th edition, Wiley.
  - Elementary Differential Equations with Boundary Value Problems, C. Henry Edwards and David E. Penney, 6th edition, Pearson.
  - Math department past exam database https://secure.math.ubc.ca/Ugrad/pastExams/

Statement on UBC's Policies and Resources to Support Student Success

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available at https://senate.ubc.ca/policies-resources-support-student-success/

Additional general information

https://www.math.ubc.ca/general-syllabus-information

Lectures schedule and corresponding textbook sections

Chapter 1. First order equations (7hr)
- Introduction 0.2
- Integrals as solutions 1.1
- Slope fields and unique existence 1.2
- Separable equations 1.3
- Linear equations and the integrating factor 1.4
- Autonomous equations 1.6
- Numerical methods: Euler, Improved Euler and Runge-Kutta 1.7 + notes
- Exact equations 1.8

Chapter 2. Second order linear equations (8hr)
- Second order linear ODEs (method of reduction of order) 2.1
- Constant coefficient second order linear ODEs (2.2 and notes)
- Mechanical vibrations 2.4
- Non-homogeneous equations (undetermined coefficients) 2.5
- Forced oscillations and resonance 2.6

Chapter 3. Laplace transforms (5hr)
- Definition and examples 6.1
- Transforms of derivatives and ODEs 6.2
- Convolution 6.3
- Dirac delta and impulse response 6.4

Chapter 4. Linear systems (8hr)
- Introduction to systems of ODEs 3.1 & 3.3
- Eigenvalue method 3.4
- Two dimensional systems and their vector fields 3.5
- Second order systems and applications 3.6
- Multiple eigenvalues 3.7
- Non-homogeneous systems 3.9

Chapter 5. Nonlinear autonomous planar systems (5hr)
- Critical points and linearization 8.1
- Stability and classification of isolated critical points 8.2
- Applications 8.3