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
101	Prof. Anthony Wachs	Buchanan A103	8-9am MWF
102	Prof. Philip Loewen	CHEM B105	9-10am MWF
104	Prof. Philip Loewen	LSK 201	1-2pm 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: September, 7
Midterm: October, 21
Last day to withdraw without record: September, 19
Last day of classes: December, 7
Final exam: TBA

Course Evaluation

Homework: 25% (Homework will be due Fridays 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. The lowest grade will be dropped.)

Midterm: 25% (October, 21, 50-minute exam to be taken in class)
Final exam: 50% (150-minute exam, date and classroom TBA)

Homework

Homework will have written components as well as MATLAB, both of which should be submitted electronically. Please follow carefully the submission instructions for each assignment. Homework solutions will be posted in Canvas.

Policies on homework and exams

- No calculators or notes are allowed in the midterm and final exams.
- Homework assignments are due 11:59pm on Canvas on Fridays. Solutions will be posted on Canvas. A selection of the problems will be graded. Late submissions are not accepted.
- 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 December 11-22, 2022 inclusive. The exact time will be announced by the University in the middle of the term. Students should not make early travel plans that overlap with the scheduled exam period.

MATLAB

The homework and exams contain problems using MATLAB.
Use MATLAB Online for free or download MATLAB to your own machine. See Getting started with MATLAB. See MATLAB Resources for examples and tutorials.
TAs are available for open office hours to answer MATLAB questions. See MATLAB Resources.

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