MATH_V 215/255 101/102/104 2024W1

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 be able to

- set up first- and second-order ODEs to model various real-world phenomena,
- solve analytically a range of first order ODEs and linear second order ODEs,
- use the Laplace Transform to analyze linear initial-value problems,
- analyze linear systems of ODEs, using relevant theoretical concepts (matrices, eigenvalues, etc.),
- determine the qualitative behaviour of some nonlinear ODEs, through the phase plane and methods such as linearization, and
- describe the key principles involved in the numerical solution of ODEs, and have experience solving various ODEs using Python and Jupyter Notebook.

Textbook: Notes on Diffy Qs: Differential Equations for Engineers (Links to an external site.), by Jiri Lebl, (online and free, there is a link to affordable paperback)

Course Topics:

1. First order equations (Ch. 1)

- 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
- Exact equations 1.8

2. Second order linear equations (Ch. 2)

- Second order linear ODEs (method of reduction of order) 2.1
- Constant coefficient second order linear ODEs 2.2
- Mechanical vibrations 2.4
- Nonhomogeneous equations (undetermined coefficients, variation of parameters) 2.5
- Forced oscillations and resonance 2.6

3. Laplace transforms (Ch. 6)

- Definition and examples 6.1
- Transforms of derivatives and ODEs 6.2
- Convolution 6.3

- Dirac delta and impulse response 6.4

4. Linear systems (Ch. 3)

- 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 (skipped)
- Multiple eigenvalues 3.7
- Matrix exponentials 3.8 (skipped)
- Nonhomogeneous systems (variation of parameters) 3.9

5. Nonlinear autonomous planar systems (Ch. 8)

- Critical points and linearization 8.1
- Stability and classification of isolated critical points 8.2
- Applications 8.3

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 254).
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In order to be able to concentrate on the new material relevant for this course, little time will be spent reviewing basic notions of calculus and linear algebra. The students are responsible for refreshing these topics if needed, using for example the CLP textbook and the linear algebra appendixLinks to an external site. of Lebl's textbook.

Important Dates:

- First day of class: Wednesday, September 4th, 2024
- Midterms: Friday Sep 27, Friday Oct 25, and Friday Nov 22
- Last day to withdraw without record: September 16th, 2024
- Last day of classes: Friday, December 6th, 2024
- Final exam: TBA

Course Evaluation:

- Homework: 5% (Homework will be due Sundays at 11:59pm).
- Midterms: 3 x 15% (three 45-minute exams to be taken in class)
- 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.