

UNIVERSITY OF BRITISH COLUMBIA

MATH 215/255 FALL 2015

Elementary Differential Equations I / Ordinary Differential Equations

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.

Prerequisite: Calculus II (One of MATH 101/103/105/121, SCIE 001) and Linear Algebra (one of MATH 152/221/223).

Corequisite: Calculus III (One of MATH 200/217/226/253/263).

References:

- **Textbook:** Notes on Diffy Qs: Differential Equations for Engineers, by Jiri Lebl, (online and free, paperback available)

- **Supplementary text:** Differential Equations and Their Applications, 4th Ed., by Martin Braun (accessible from inside UBC or via VPN). We will follow Braun's section 1.9 for the topic on exact equations.

Grading:

- Weekly homework (10%) due Fridays Sep 25, Oct 2, Oct 16, Oct 23, Oct 30, Nov 6, Nov 20, and Nov 27, with the lowest score dropped;
- Two 50-minute midterm exams (20% each) on Fridays October 9 and November 13;
- One 150-minute final exam (50%).
- Exam marks may be scaled according to the final exam of all sections of MATH 215/255.

Policies:

1. No calculators or notes are allowed in the midterm and final exams.
2. Homework assignments are to be handed in at the beginning of class on Fridays. Solutions will be posted on web. A selection of the problems will be graded.
3. Permission to shift the weight of your missed midterms to other exams, or to ignore missed assignments, may be granted only in the following circumstances: (a) prior notice of a valid, documented absence (e.g. out-of-town varsity athletic commitment with a letter from a coach) on the scheduled date; or (b) notification to the instructor of absence due to a medical condition with a doctor's note. Otherwise, a score of 0 will be given for the missed midterms/assignments.

Common webpage for all sections: <http://www.math.ubc.ca/~ttsai/courses/215-255-15F/>

Topics:

- Introduction
- 1. First order equations (Ch. 1, 8hr)
 - Integrals as solutions 1.1
 - Slope fields and unique existence 1.2
 - Separable equations 1.3
 - Linear equations and the integrating factor 1.4
 - Exact equations (Braun §1.9)
 - Autonomous equations 1.6
 - Numerical methods: Euler's method 1.7
- 2. Second order linear equations (Ch. 2, 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
 - Nonhomogeneous equations (undetermined coefficients and variation of parameters) 2.5
 - Forced oscillations and resonance 2.6
- 3. Laplace transforms (Ch. 6, 5hr)
 - 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, 7hr)
 - 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
 - Matrix exponentials 3.8
 - Nonhomogeneous systems 3.9
- 5. Nonlinear autonomous planar systems (Ch. 8, 5hr)
 - Critical points and linearization 8.1
 - Stability and classification of isolated critical points 8.2
 - Applications 8.3

Midterms and review 3 hr

Total 36 hr