

# MATH 215/255 ALL SECTIONS 2023W1 Elementary Differential Equations I

[Jump to Today](#)

 Edit

This is the common Canvas site for MATH 215 / MATH 255 and is the source of all central course information, including the course outline, course policies, course study materials, access to online homework, course grades, and general announcements.

**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:** Elyse Yeager

## List of Math 215 / MATH 255 Sections:

Section	Instructor	Location	Time	Section Page
101	Dr. Peter Harrington	LSK 200	8-9am MWF	<a href="#">Section 101</a> ( <a href="https://canvas.ubc.ca/courses/125168/pages/section-101">https://canvas.ubc.ca/courses/125168/pages/section-101</a> ).
102	Dr. Laurent MacKay	Woodward 2	9-10am MWF	<a href="#">Section 102</a> ( <a href="https://canvas.ubc.ca/courses/125168/pages/section-102">https://canvas.ubc.ca/courses/125168/pages/section-102</a> ).
104	Dr. Peter Harrington	ESB 1012	1-2pm MWF	<a href="#">Section 104</a> ( <a href="https://canvas.ubc.ca/courses/125168/pages/section-104">https://canvas.ubc.ca/courses/125168/pages/section-104</a> ).

**Office hours:** Feel free to attend any of the office hours below that work with your schedule. If all of these hours conflict with your schedule you can also post questions on Piazza or visit the [Math Learning Center](#) (<https://www.math.ubc.ca/~MLC/>).

Instructor	Location	Time
Dr. Peter Harrington	LSK 300B	Monday 2-3pm, Friday 11:45am-12:45pm
Dr. Laurent MacKay	LSK 300B	Monday 4-5pm,

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

**Course Topics:** See [Topics \(https://canvas.ubc.ca/courses/125168/pages/topics\)](https://canvas.ubc.ca/courses/125168/pages/topics) for a list of topics in the order (roughly) that they will be covered.

### 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: Wednesday, Sept. 6
- Weekly quizzes on Wednesdays, starting Sept. 20
- Last day to withdraw without record: Monday, Sept. 18
- Extra 'Monday' class: Thursday, Oct 12
- **In class retest 1: Wednesday, Oct. 18**
- Fall reading week: Monday Nov 13 - Wednesday Nov 15
- **In class retest 2: Wednesday, Nov. 22**
- Last day of classes: Wednesday, Dec. 6
- Final exam: TBD

## Course Evaluation:

This course will use **mastery-based grading** to calculate your final course grade. Throughout the course, you will be given multiple opportunities to demonstrate mastery of 16 different **Learning Outcomes** (see the [Outcomes tab \(https://canvas.ubc.ca/courses/125168/outcomes\)](https://canvas.ubc.ca/courses/125168/outcomes) for a comprehensive list). **Once you score 'Mastery' on a given Learning Outcome (see below), you do not have to attempt any more questions regarding that Outcome on any further tests/quizzes.** This means that if you keep up with the weekly material and score 'Mastery' on each Learning Outcome on the weekly quizzes or during the in class retests, you do not have to write the final exam!

Your first opportunity to demonstrate mastery of a Learning Outcome will be on the weekly quiz, which will test 1-2 Learning Outcomes (one question per Outcome).

- If your solution to a question related to a Learning Outcome is near perfect, you will earn a score of **'Mastery'**.
- If your solution is on the right track but not near perfect you will be given a score of **'Progressing'** and if your solution is relatively incomplete you will be given a score of **'Beginning'**.
- Only 'Mastery' scores on Learning Outcomes will count towards your final grade.
- If you do not score 'Mastery' on a Learning Outcome during the weekly quiz, you can attempt it again during In class retest 1, 2, or the final exam (see the Course Schedule below for details).

Your final Mastery Score will be the percentage of Learning Outcomes that you have scored 'Mastery' on by the end of the course. This means **you control your grade**. If you are comfortable with the percentage of Learning Outcomes that you have obtained 'Mastery' on before the final exam, you do not need to write it. To see which Learning Outcomes you have obtained 'Mastery' on, go to the Grades tab and look at the Learning Mastery section.

In addition to the mastery tests, there will also be WebWork to help you practice the material and MATLAB assignments to learn how to solve ODEs with MATLAB. The WebWork and MATLAB HW will be graded regularly and you will be given a mark for each assignment. Overall, your course grade will have the following breakdown:


### Grade breakdown:

- Homework: 15%
  - 10% will be weekly WebWork due Tuesdays at 11:59pm beginning September 19 and skipping the weeks with a Retest. The lowest grade will be dropped. This is intended to account for technical difficulties, illness, and other personal situations.
  - 5% will be 5 MATLAB Homework assignments due throughout the term. The lowest grade will be dropped, again intended to account for technical difficulties, illness, and other personal situations.
- Mastery Score: 85% (Your score will be the percentage of Learning Outcomes that you have obtained 'Mastery' on by the end of the course)


## Homework:

There will be both WebWork HW and MATLAB assignments. The WebWork can be accessed from the WebWork tab and the MATLAB assignments should be submitted electronically in the Assignments tab. Please follow carefully the submission instructions for each assignment. MATLAB solutions will be posted in Canvas.

### MATLAB:

- The homework and exams may contain problems using MATLAB.
- See [ubcmath.github.io/matlab](https://ubcmath.github.io/matlab)  (<https://ubcmath.github.io/matlab/>) to create a MathWorks account and to get started with MATLAB
- Use MATLAB Online for free or download MATLAB to your own machine.
- TAs are available on Piazza or in the [Math Learning Center \(https://www.math.ubc.ca/undergraduate/advising-and-resources/drop-help\)](https://www.math.ubc.ca/undergraduate/advising-and-resources/drop-help) to answer MATLAB questions.

### Piazza:

We have a forum at [Piazza for all sections of MATH 215/255](https://piazza.com/class/llwvlhat3h7hm)  (<https://piazza.com/class/llwvlhat3h7hm>) (see Piazza link on the sidebar). 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 \(https://www.math.ubc.ca/~MLC/\)](https://www.math.ubc.ca/~MLC/) located in LSK 301/302.

- Other textbooks and resources: textbooks such as Boyce and DiPrima (any recent edition) or Edwards and Penney.
- [Practice homeworks \(https://canvas.ubc.ca/courses/125168/pages/practice-homework\)](https://canvas.ubc.ca/courses/125168/pages/practice-homework) with questions similar to quiz difficulty noted.

## Course Schedule:

### Weekly Schedule:

**Monday:** Lecture

**Tuesday:** Webwork & MATLAB HW (by 11:59 pm)

**Wednesday:** Lecture + Quiz<sup>‡</sup>

**Friday:** Lecture

Week #	1	2	3	4	5	6 <sup>†</sup>	7	8	9	10	11 <sup>‡</sup>	12	13	13.5	-
Month	September					October					November			December	
Week of	4	11	18	25	2	9 <sup>†</sup>	16	23	30	6	13	20	27	4	TBD
<a href="https://canvas.ubc.ca/courses/125168/outcomes">Outcomes (https://canvas.ubc.ca/courses/125168/outcomes)</a> Covered	1	1-3	3-5	5-6	6-7	7-9	10-11	11-12	13	14	15	16	16	16	
Matlab HW Due			1		2			3			4 <sup>‡</sup>		5		
Webwork Due			1	2	3	4		5	6	7	8 <sup>‡</sup>		9	10	
Quiz #			1	2	3	4	Retest 1	5	6	7	8 <sup>‡</sup>	Retest 2	9	10	Final
<a href="https://canvas.ubc.ca/courses/125168/outcomes">Outcomes (https://canvas.ubc.ca/courses/125168/outcomes)</a> Tested (Quiz)			1,2	3,4	5,6	7	1-9	8,9	10,11	12	13	1-15	14,15	16	1-16

<sup>†</sup>We will have an extra lecture on Thursday Oct. 12 (see [here \(https://educ.ubc.ca/make-up-monday/\)](https://educ.ubc.ca/make-up-monday/)).

<sup>‡</sup> Exceptionally, the quiz will be on Friday Nov. 17 and the WebWork and MATLAB will be due Thursday.

Note: On Retest 1 and 2, you will have the ability to obtain 'Mastery' on any Learning Outcomes that were taught prior to the retest. However, each retest is only 50 minutes long, and so it will only be practical to obtain a score of 'Mastery' on around 5 Learning Outcomes. Therefore it would be helpful for you to obtain a score of 'Mastery' on at least a few Learning Outcomes before going into the retests.

## Policies on homework and quizzes:

1. No calculators or notes are allowed in the quizzes, retests, or final exam.
2. WebWork and MATLAB assignments are due 11:59pm at Canvas on Tuesdays. Solutions to MATLAB assignments will be posted on Canvas.

If you submit MATLAB homework late, a 25% penalty will be applied for each day late.

3. Missed quiz and retest policy: If you miss a quiz or retest with a valid reason, please email [calc-coord@math.ubc.ca](mailto:calc-coord@math.ubc.ca) (mailto:calc-coord@math.ubc.ca) with the subject line: Math 215/255: [your student #] and detail your reason for missing the quiz or retest within 2 days of the test.

The course is designed to provide you multiple attempts to achieve 'Mastery' on each Learning Outcome. Our hope is that you are able to achieve a score of 'Mastery' on each Learning Outcome on your first or second attempt. In the event that you have a documented reason for missing a quiz or in-class retest (e.g. death in the family, illness), and if by November 29 you have not yet achieved 'Mastery' on the Learning Outcomes you missed, you will be given one additional opportunity to attempt the missed Learning Outcomes on December 1st. This retest opportunity is only for absences with a formally documented reason.



4. The period for final exams is December 11-22, 2023 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.
















**British Columbia law requires the use of a helmet while riding a bicycle.**

#### **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 [here](https://senate.ubc.ca/policies-resources-support-student-success) (<https://senate.ubc.ca/policies-resources-support-student-success>).

## Course Summary:

Date	Details	Due
Tue Sep 19, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632128">Webwork 1</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632128">https://canvas.ubc.ca/courses/125168/assignments/1632128</a> )	due by 11:59pm
Wed Sep 20, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632145">Quiz 1</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632145">https://canvas.ubc.ca/courses/125168/assignments/1632145</a> )	due by 11:59pm

Date	Details	Due
Tue Sep 26, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632131">Webwork 2</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632131">https://canvas.ubc.ca/courses/125168/assignments/1632131</a> )	due by 11:59pm
Wed Sep 27, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632146">Quiz 2</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632146">https://canvas.ubc.ca/courses/125168/assignments/1632146</a> )	due by 11:59pm
Fri Sep 29, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632130">Homework 1</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632130">https://canvas.ubc.ca/courses/125168/assignments/1632130</a> )	due by 11:59pm
Tue Oct 3, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632132">Homework 2</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632132">https://canvas.ubc.ca/courses/125168/assignments/1632132</a> )	due by 11:59pm
Wed Oct 4, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632133">Webwork 3</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632133">https://canvas.ubc.ca/courses/125168/assignments/1632133</a> )	due by 11:59pm
Wed Oct 4, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642965">Quiz 3</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642965">https://canvas.ubc.ca/courses/125168/assignments/1642965</a> )	due by 11:59pm
Tue Oct 10, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632135">Webwork 4</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632135">https://canvas.ubc.ca/courses/125168/assignments/1632135</a> )	due by 11:59pm
Wed Oct 11, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642967">Quiz 4</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642967">https://canvas.ubc.ca/courses/125168/assignments/1642967</a> )	due by 11:59pm
Mon Oct 16, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632144">Retest 1</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632144">https://canvas.ubc.ca/courses/125168/assignments/1632144</a> )	due by 11:59pm
Tue Oct 24, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632141">Homework 3</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632141">https://canvas.ubc.ca/courses/125168/assignments/1632141</a> )	due by 11:59pm
Tue Oct 24, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632136">Webwork 5</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632136">https://canvas.ubc.ca/courses/125168/assignments/1632136</a> )	due by 11:59pm
Wed Oct 25, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642969">Quiz 5</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642969">https://canvas.ubc.ca/courses/125168/assignments/1642969</a> )	due by 11:59pm
Tue Oct 31, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632138">Webwork 6</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632138">https://canvas.ubc.ca/courses/125168/assignments/1632138</a> )	due by 11:59pm
Wed Nov 1, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642972">Quiz 6</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642972">https://canvas.ubc.ca/courses/125168/assignments/1642972</a> )	due by 11:59pm
Tue Nov 7, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632139">Webwork 7</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632139">https://canvas.ubc.ca/courses/125168/assignments/1632139</a> )	due by 11:59pm

Date	Details	Due
Wed Nov 8, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642974">Quiz 7</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642974">https://canvas.ubc.ca/courses/125168/assignments/1642974</a> )	due by 11:59pm
Tue Nov 14, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1663299">Homework 4</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1663299">https://canvas.ubc.ca/courses/125168/assignments/1663299</a> )	due by 11:59pm
Thu Nov 16, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632140">Webwork 8</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632140">https://canvas.ubc.ca/courses/125168/assignments/1632140</a> )	due by 11:59pm
Fri Nov 17, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642990">Quiz 8</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642990">https://canvas.ubc.ca/courses/125168/assignments/1642990</a> )	due by 11:59pm
Wed Nov 22, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1642991">Retest 2</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1642991">https://canvas.ubc.ca/courses/125168/assignments/1642991</a> )	due by 11:59pm
Tue Nov 28, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1663301">Homework 5</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1663301">https://canvas.ubc.ca/courses/125168/assignments/1663301</a> )	due by 11:59pm
	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632142">Webwork 9</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632142">https://canvas.ubc.ca/courses/125168/assignments/1632142</a> )	due by 11:59pm
Wed Nov 29, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1665992">Quiz 9</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1665992">https://canvas.ubc.ca/courses/125168/assignments/1665992</a> )	due by 11:59pm
Tue Dec 5, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1632129">Webwork 10</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1632129">https://canvas.ubc.ca/courses/125168/assignments/1632129</a> )	due by 11:59pm
Wed Dec 6, 2023	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1643048">Quiz 10</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1643048">https://canvas.ubc.ca/courses/125168/assignments/1643048</a> )	due by 11:59pm
	 <a href="https://canvas.ubc.ca/courses/125168/assignments/1643050">Final exam (retest 3)</a> ( <a href="https://canvas.ubc.ca/courses/125168/assignments/1643050">https://canvas.ubc.ca/courses/125168/assignments/1643050</a> )	

# Topics

## 0. Introduction

### 1. First order equations (Ch. 1, 7 hr)

- 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 + [note](https://canvas.ubc.ca/courses/125168/pages/note-on-section-1-dot-7)  
(<https://canvas.ubc.ca/courses/125168/pages/note-on-section-1-dot-7>)
- Exact equations 1.8

### 2. Second order linear equations (Ch. 2, 8 hr)

- Second order linear ODEs (method of reduction of order) 2.1
- Constant coefficient second order linear ODEs 2.2 + [note](https://canvas.ubc.ca/courses/125168/pages/note-on-section-2-dot-2)  
(<https://canvas.ubc.ca/courses/125168/pages/note-on-section-2-dot-2>)
- Mechanical vibrations 2.4
- Nonhomogeneous equations (undetermined coefficients) 2.5
- Forced oscillations and resonance 2.6

### 3. Laplace transforms (Ch. 6, 5 hr)

- 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, 8 hr)

- 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, 5 hr)



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