MAT244
Introduction to Ordinary Differential Equations

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Lectures: Wednesdays, 1-4pm, room 203 of McLennan Physical Laboratories

Office hours: Tuesdays, 10am-11am, and Wednesdays 4:30pm-5:30pm, room 6191 of the Bahen Centre; the office is around a corner at the end of a hallway. I am happy to meet with you during office hours. Please don't feel that any question is too simple to ask me. If you want to meet with me and you cannot come during these times, email me to schedule an appointment. If few people come during the regular office hours I can reschedule them part way through the semester.

Textbook: Boyce and DiPrima, *Elementary differential equations and boundary value problems*, 10th ed.

1) Overview A system is said to be *deterministic* if knowing its state at the present time determines the past and the future states of the system. We often encode the state of a system as an element of $\mathbb{R}^n$ for some n; if we want to keep track of the positions and momenta of two particles moving in three dimensional space then the state of our system would be an element of $\mathbb{R}^{12}$, while if our system is a single point on a string whose displacement we care about, then its state (=displacement from original position) would be an element of $\mathbb{R}$. If the state of a system changes instantaneously we can often express the way the system changes using a differential equation, and having a solution of this differential equation tells us what the state of the system at past or future times is.

You will learn how to solve various types of differential equations, and you will also learn how to understand the behavior of solutions of systems in some cases where we cannot write down an explicit solution of a differential equation. Even if we can't write down a solution of an equation we can in some circumstances prove that there is a single solution, meaning that there is only one function that satisfies the differential equation and that takes a certain value at time 0.

By the end of the course you will know what phase spaces and vector fields are, you will be able competently to work with systems of differential equations, you will have been introduced to the calculus of variations, and you will have practiced the various methods for finding explicit solutions of differential equations.

2) Expectations
You are entitled to expect me to:

- Come prepared to every class
- Provide timely and useful feedback
- Test you on material that matches the lectures and the recommended problems

As your instructor, I will expect that you will:

- Come to my office hours or ask during the lecture if there are topics in lectures that you don't understand
- Do all the recommended exercises
- Be especially careful on the assignments, since you have time to double check your work.

3) Evaluation and grades

Final exam counting for 40%
Three tests each counting for 15%
Three assignments each counting for 5%

If you have an accepted reason for missing a test, each of the other two tests will count for 22.5%.

The assignments are meant to prepare you for the tests and to make you better at writing mathematics. A higher standard of explanation is demanded on the assignments, for which you can read your textbook and for which you have no time constraints, than is demanded on the tests. If a question on an assignment counts for 5 marks, you will get $5x$ on it, where x is the following: 0 for an incoherent solution or a solution that doesn't complete the hard part of a question, 0.5 for a solution that is incomplete, has a mistake (these are assignments so you should check your solutions carefully, and even switching a positive sign for a negative sign is a mistake here), or is poorly organized (this is indeed a matter of taste!), and 1 for a solution that is correct and understandable.

4) Schedule

Date	Topics
May 15	Phase space, vector fields, Euler's method for numerical approximation.
May 22	First order differential equations: separable differential equations, linear differential equations, exact differential equations.
May 29	First order differential equations: the fundamental theorem of ordinary differential equations.
June 5	**Test 1** for 1.5 hours. Second order linear differential equations.
June 12	**Assignment 1 due.** Second order linear differential equations: variation of parameters.
June 19	Solving differential equations using power series.
June 26	No class.
July 3	**Test 2** for 1.5 hours. Calculus of variations: Euler-Lagrange equation.
July 10	**Assignment 2 due.** Calculus of variations: Lagrange multipliers.
July 17	Systems of linear differential equations (July 21 is last day to drop the course.)
July 24	Systems of linear differential equations.
July 31	**Test 3** for 1.5 hours. Then nonlinear systems of differential equations.
August 7	**Assignment 3 due.** Exam review.

Before each lecture I will post on the course website recommended exercises from Boyce and DiPrima.

I will post the assignments at least two weeks before they are due.