Math 311 Fall 2025
Ordinary Differential Equations

MWF 1:00-1:50PM Lovejoy 203

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(TA Office Hours: TBA)

Among all mathematical disciplines the theory of differential equations is the most important. It furnishes the explanation of all those elementary manifestations of nature which involve time. – Sophus Lie

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Course Description: Welcome to the beautiful and fascinating world of ordinary differential equations! The main focus of this subject is to deduce long-term behavior of quantities from knowledge of their short-term rates of change. As mathematics is said to be the language of classical science, differential equations is a fundamental part of its grammar.

In this course, you will learn to analyze ordinary differential equations and a number of concrete situations modeled by them. To inform this study, we will develop a number of analytical and graphical techniques which will leverage on your knowledge of calculus and linear algebra. We will study general existence and uniqueness theory for ordinary differential equations and their corresponding initial value problems. Together, we will learn a host of solution techniques that will allow us to solve certain ordinary differential equations, including linear differential equations and linear systems. In this way, we will build a "solution toolbox" that you will take away from this course. These solution techniques are however limited, as we will learn, and there are many differential equations – those appearing in most real-world problems – which have no closed-form solutions. To make sense of these equations, we will study the basics of dynamical systems theory, including nonlinear dynamics, chaos and bifurcation theory. With time permitting, we will also study numerical methods (algorithms) for approximating solutions.

Prerequisites: Mathematics 160 or 165, and 253.

Course notes and supplementary course material: In lieu of an official textbook, our

main source of material for the course is the MA311 Course Notes, available on the course website. Though my lectures will generally be derived from the course notes, you are expected to read the notes carefully, thoroughly, and – ideally – before you come to class.

When creating material for this course (the course notes, homework, etc.), I like to draw from many different sources. In particular, I will use *Ordinary differential Equations* by Paul Blanchard, Robert L. Devaney and Glen R. Hall; *Ordinary Differential Equations* by V. W. Noonburg; *Elementary Differential Equations and Boundary Value Problems* by Boyce and DiPrima; and *Nonlinear Dynamics* by Steven Strogatz. While you are not required to obtain these texts, you may want to take a look at them, especially if you plan to continue your studies of differential equations after this course.

Grading: Your grade will be calculated as follows:

Class participation:	5%
Weekly homework assignments:	20%
Minimum of Midterms 1 & 2:	15%
Maximum of Midterms 1 & 2:	25%
Final Exam:	35%

Exams: This course will have two midterm exams and a final exam. The exams will be at the following dates and times:

Midterm 1	**Wednesday, October 15th from 7:00-9:00PM**
Midterm 2	**Thursday, November 13th from 7:00-9:00PM**
Final Exam	**TBA**

The midterm exams will both be held in Diamond 122. It is crucial that you reserve these time slots for these exams. In the event that you are unable to attend a midterm exam, you must let me know at least two weeks prior to the exam date.

Attendance and Class Participation: You are required to attend each class session. This means that you need to be on time to class, seated, and ready to learn (take notes, participate, discuss, and engage). To learn mathematics, it is essential to discuss it with others and ask questions. Thus, you will be required to participate in class discussion and you will frequently be called on during lecture. It is for this reason that your on-time attendance is required.

With this being said, I also know that things come up that are outside of your control. To accommodate this, you are allowed 4 'free passes' this semester that can be used for missing class, arriving late, or leaving early. Absence for religious reasons or for official Colby activities does not count as using a free pass as long as you communicate with me clearly beforehand. Beyond the 4 free passes, absences and excessive tardiness will result in a reduction of your final course grade by up to a full letter grade.

Homework: Homework is the most important part of this course. It is where you will grapple with new ideas, come up with creative solutions and communicate your thoughts and understanding to others. Consequently, it is crucial that you take homework very seriously. You should start homework early and work diligently. If you are having substantial difficulty with a particular exercise,

please come talk to me during office hours. I am here to help! You are permitted and encouraged to discuss homework with your classmates, however, when it comes time to write up your solutions, you are required to do so independently and away from your peers (in another room, preferably). You are also permitted to consult other textbooks and, in this case, please give full details (beyond what's in our textbook). If you work with peers or consult material outside the textbook, you are required to cite your sources (including naming the peers with whom you worked); failure to do so is a matter of academic dishonesty and will result in grade penalties and/or reports of academic negligence/dishonesty. Also relevant to this point are the sections entitled "On AI" and "Academic Integrity" below. Your homework solutions should communicate your individual process and understanding of the material. What you turn in must be your own – and you should be able to explain every step!

I expect homework solutions to be written out correctly and presented in good mathematical prose. Your grade will depend on the correctness of your solutions and the quality of your writing. This means that your writing should follow a coherent logical structure which makes use of complete sentences and follows standard rules of grammar. Please do not submit solutions containing incoherent and unstructured calculations. You should be proud of the material you turn in!

Homework Structure and Schedule: Assignments will be posted to the course website and are to be submitted in the appropriate box outside my office door on their due date (which usually falls on a Thursday). It is crucial to keep up with the homework in this course. Therefore, short of the circumstances discussed in the attendance policy above, late homework will not be not accepted. I will drop your lowest homework score on the condition that you attend one department colloquium and write a short (one paragraph) summary.

Homework Policies:

1. All write-ups are to be submitted in hard copy. They should be single-sided with no more than one problem per page, i.e., if a homework assignment has 5 problems, you should turn in at least 5 pieces of paper.

2. Each paper you turn in should have your name and the due date printed clearly at the top.

3. Your write-ups should be paper-clipped. You can staple all papers corresponding to a single exercise together, but please paper-clip (not staple) the group of exercises together. It is your responsibility to make sure that your homework is complete and all pages are accounted for.

4. If you used technology in the solution of the problem, please provide the complete printout showing all code, inputs and outputs in sequence, and annotate the printout with comments explaining what is being done in each step.

My Email Policy: I love talking about mathematics and I always prefer to do it in person. For this reason, I like to, whenever possible, reserve email for logistical things. However, when you are stuck and cannot come see me in person, please feel free to email me. I am here to help!

As my life is busy and I have many responsibilities, I usually only check and respond to email once per day and sometimes not at all on weekends. For this reason, I try to uphold the following 24-48 hour rule: If you send an email Sunday through Thursday, I will do my best to respond within 24 hours. If you send an email on Friday or Saturday, I will do my best to respond within 48

hours. If I do not respond within these windows, feel free to email me again as I may have missed it.

On AI: Colby provides access to professional versions of Google Gemini. Many industries now require their employees to use AI on a regular basis in order to increase efficiency and outsource rote tasks. So by all means, familiarize yourself with AI, including by consulting non-AI sources concerning the enormous ethical, social, and philosophical issues surrounding it. But in this course, efficiency of output is not our objective. Our objective is to learn mathematics and learn how to communicate our understanding as thoroughly as we can. Yes, AI systems "know" differential equations. But in the days before AI, other people knew differential equations too. Indeed the only reason AI systems are at all decent at some mathematics is because humans taught them both by making their intellectual work available online and by directly teaching the AI (aka "reinforcement learning"). This does not change the fact that humans need to know mathematics, even less does it obviate the need to develop mathematical ways of thinking. Indeed, the imperative is even greater. AI systems, above all else, are excellent at sounding convincing. Only by becoming a well educated person yourself, will you be able to tell when it is wrong or be able to think up a more creative solution to some problem than the "common online wisdom" that AI defaults to.

How does one become educated? By working hard both by oneself and in community. "There is no royal road to geometry." (Euclid? 300BCE). The good news is that, if you are doing what you are supposed to, the work will be rewarding and it will pay off.

Academic Integrity: Honesty, integrity, and personal responsibility are cornerstones of a Colby education and provide the foundation for scholarly inquiry, intellectual discourse, and an open and welcoming campus community. These values are articulated in the Colby Affirmation and are central to this course. You are expected to demonstrate academic honesty in all aspects of this course. If you are clear about course expectations, give credit to those whose work you rely on, and submit your best work, you are highly unlikely to commit an act of academic dishonesty.

Academic dishonesty includes, but is not limited to: violating clearly stated rules for taking an exam or completing homework; plagiarism (including material from sources without a citation and quotation marks around any borrowed words); claiming another's work or a modification of another's work as one's own (results from AI, internet searches, or online forums count as "another's work"); buying or attempting to buy papers or projects for a course; fabricating information or citations; knowingly assisting others in acts of academic dishonesty; misrepresentations to faculty within the context of a course; and submitting the same work, including an essay that you wrote, in more than one course without the permission of the instructors.

Academic dishonesty is a serious offense against the college. Sanctions for academic dishonesty are assigned by an academic review board and may include failure on the assignment, failure in the course, or suspension or expulsion from the College.

The Colby Affirmation

Colby College is a community dedicated to learning and committed to the growth and well-being of all its members.

As a community devoted to intellectual growth, we value academic integrity. We agree to take ownership of our academic work, to submit only work that is our own, to fully acknowledge the

research and ideas of others in our work, and to abide by the instructions and regulations governing academic work established by the faculty.

As a community built on respect for ourselves, each other, and our physical environment, we recognize the diversity of people that have gathered here and that genuine inclusivity requires active, honest, and compassionate engagement with one another. We agree to respect each other, to honor community expectations, and to comply with college policies.

As a member of this community, I pledge to hold myself and others accountable to these values.