Math 226 A Differential Equations

A1 Lecture TR 9:30 - 10:45 am CAS 224
You **must** be registered for lecture (A1) and one of the corresponding discussion sections (A2-A6).

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Description: Differential Equations is your chance to apply what you have learned in mathematics courses up to now to real life (i.e. the sciences). There are two main goals for this course. The first is to learn the techniques involved in applying the calculus you already know to the study of differential equations. The second is to provide you with a quantitative way of investigating the physical world. To be successful, you must train yourself to "see" differential equations in the world around you and then use that vision to unlock a new way of understanding and predicting behavior. This is arguably more important than being able to execute algorithms.

Text: Differential Equations, 4e, Cengage, by Blanchard, Devaney, Hall.
Textbook Purchasing Options: There exists a physical and an electronic version of the textbook. One or the other or both is fine. The BU bookstore prices are insane and almost any other method will save money.
It may also be helpful to obtain a copy of the DE tools software that comes with the textbook - this can be downloaded for free on the publisher's website. Note you will need to download a Java runtime software (v8) to run this software. This can be found from Oracle's website. I believe Amazon Coretto 8 will also work.

Attendance: Every student is expected to attend each class and each discussion. There are **no makeup quizzes or exams**. If you miss a quiz for an acceptable reason (e.g., athletics, jury duty, substantiated illness, family emergency or religious reasons), your other quizzes will count for commensurately more. If you miss a midterm exam for an acceptable reason, your final exam will count for 55%.
Do not make arrangements to leave before the final exam.

Help and Tutoring:
In lecture, questions can and should be asked at any time. Discussion is a great setting for questions as a smaller-class format.
Office hours are always drop-in, no appointment necessary. If the scheduled times do not work for you, please email me or the TA to make an appointment.
The math tutoring room is available five days a week: `https://www.bu.edu/math/tutoringroom/`.
ERC offers peer tutoring as well: `https://www.bu.edu/erc/programs/tutoring/`.

Grading:	Discussion quizzes	20%	due weekly Friday
	Midterm1	25%	Thursday Oct 9
	Midterm2	25%	Thursday Nov 20
	Final Exam	30%	Thursday Dec 18 9am-11am

Important dates: `https://www.bu.edu/reg/calendars/semester/`
Final Exam dates: `https://www.bu.edu/reg/calendars/final-exams/`

Ungraded Practice Homework: You will be assigned many exercises from the text. It is both true that these exercises are necessary practice for you to gain proficiency and that we lack the resources to grade all of it. It is *strongly recommended* that you write out solutions to each homework problem and keep these solutions in a notebook. This will aid you in preparing for exams. Exam questions could exactly or almost exactly match practice homework exercises.

Discussion and quizzes: A2-A6 are discussion sections. Attendance is mandatory. Discussion may have a reinforcement / lesson component, question-and-answer for textbook exercises, or exam review. Most discussions will have a quiz component for the last 15 minutes. Quizzes comprise two questions related to the material covered in the previous week.

Midterm Exams: The midterms are written to take at most 75 minutes.
The midterms are *not* cumulative. Content on an exam may show up **indirectly** on later exams, e.g., linear DEs are on Midterm1, but you'll also need to solve linear DEs for Midterm2.

Final Exam: The final exam **is cumulative** and written to take at most 120 minutes.

Curve: Most assessments are curved. Other components may be curved. The curve can only benefit; it is impossible to be "curved down."

Accommodations for Disabilities or Conditions: Any student requesting accommodations should visit `https://www.bu.edu/disability/accommodations/`

What is allowed: On homework, you can use anything. You can refer to notes and the textbook. You can talk to each other, use calculators, google whatever. Check out WolframAlpha and Desmos. If you have not heard about these resources, ask me! But be warned: over reliance on external aids may result in overestimating one's understanding of the material.
On quizzes and exams, it's you and a writing implement. Questions are designed so a calculator is unnecessary. We will discuss expectations regarding simplifying responses.

Communication: I will endeavour to respond to emails within 24 hours. For faster responses to questions about content, use Campuswire. In your email *include the course and section in the subject of your email*, e.g. "MA226A". I teach over 300 students and sometimes multiple sections of the same course.

Academic Conduct: It is useful to discuss mathematics with others. But all written submissions should be your own. No collaboration is allowed on exams. Even the appearance of potential academic dishonesty is taken seriously. Your work in this course is governed by BU's `https://www.bu.edu/academics/policies/academic-conduct-code/`,which you are expected to be familiar with and abide by.

Course Outline:

Midterm1 and Final content

Chapter 1: First-order Differential Equations

1.1 Modeling via Differential Equations
1.2 Analytic Technique: Separation of Variables
1.3 Qualitative Technique: Slope Fields
1.4 Numerical Technique: Euler's Method
1.5 Existence and Uniqueness of Solutions
1.6 Equilibria and the Phase Line
1.7 Bifurcations
1.8 Linear Equations
1.9 Integrating Factors for Linear Equations

Chapter 2: First-order Systems

2.1 Modeling via Systems
2.2 The Geometry of Systems
2.3 The Damped Harmonic Oscillator
2.4 Additional Analytic Methods for Special Systems
2.5 Euler's Method for Systems
2.6 Existence and Uniqueness for Systems
2.7 The SIR Model of an Epidemic

Midterm2 and Final content

Chapter 3: Linear Systems

3.1 Properties of Linear Systems and the Linearity Principle
3.2 Straight-Line Solutions
3.3 Phase Portraits for Linear Systems with Real Eigenvalues
3.4 Complex Eigenvalues
3.5 Special Cases: Repeat and Zero Eigenvalues
3.6 Second-Order Linear Equations
3.7 The Trace-Determinant Plane

Chapter 4: Forcing and Resonance

4.1 Forced Harmonic Oscillators
4.2 Sinusoidal Forcing
4.3 Undamped Forcing and Resonance

Final content only

Chapter 5: Nonlinear Systems

5.1 Equilibrium Point Analysis
5.2 Qualitative Analysis

Chapter 6: Laplace Transforms

6.1 Laplace Transforms
6.2 Discontinuous Functions
6.3 Second-Order Equations
6.4 Delta Functions and Impulse Forcing