Brandeis UNIVERSITY

Math 37A: Differential Equations

Contact Details

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Meeting Times

Class time
Monday, Tuesday, Wednesday & Thursday, 11.10AM – 1.10PM EDT – Zoom link

Office Hours
4PM-5.30PM EDT on Tuesdays, 8AM-9.30AM on Thursdays – Zoom link

Course Description

Overview:
Differential equations is an essential topic in applied mathematics as many (if not most) important models in the physical and social sciences are expressed as differential equations. However, most practically useful differential equation-based models do not omit solutions that can be expressed in terms of elementary functions. Thus we typically try to classify solutions in terms of their key properties. For instance, what is the long-run behavior of the solutions to a given equation? Is there a unique solution? How does the behavior of the solution change as parameters are varied? This course will introduce students to the core techniques needed to qualitatively analyze the solutions of simple differential equations in low dimensions. Since it is often useful to compute numerical approximations to solutions we will also cover some basic techniques to numerically solve differential equations.

We will illustrate our techniques by analyzing models from a variety of applied fields such as population dynamics, epidemiology (the SIR model), physics (Hooke's Law) and ecology (vegetation models from my own research).

The main topics of the course will be:

1. First order DEs,
2. First order systems,
3. Linear systems,
4. Oscillations,
5. Nonlinear systems.

Additionally, we will discuss and implement some simple schemes to solve differential equations numerically - these lessons will be integrated into the main topics.

Learning outcomes

Upon successful completion of Math 37A students will be able to:

- Solve simple first and second order differential equations analytically
- Demonstrate that classes of differential equations have unique well-defined solutions
- Qualitatively analyze simple low dimensional differential equations
- Interpret differential equation models and their properties in the context of applications (e.g. ecology, epidemiology, elasticity)
- Implement numerical schemes to solve simple nonlinear differential equations

Teaching/learning strategies

Each topic will have a (pre-recorded) lecture video and short reading quiz – these will be posted on LATTE the day before the class session on a given topic. The class session will begin with some time for questions about the lecture topic (discussion of additional examples, clarifying difficult points, etc.). The remainder of the class session will be devoted to group problem solving and discussion. Each Thursday class time will finish with a short learning reflection in which students will record their most important progress and biggest challenges from that week on Piazza (in groups).

Community

In order to foster a sense of community and give students a forum to communicate with each other, there will be a class Piazza page. The intention is that students will use Piazza to ask questions, answer questions, point out errors (of which there will probably be many!), or engage in other constructive activities related to the class content. Piazza participation contributes a small percentage to your overall grade and will be assessed (very generously) on a pass/fail basis – more details in the class grading policy.

Prerequisites

Math 15A or 22A (linear algebra), & Math 20A or 22B (multivariable calculus). In particular, we will freely use techniques of integration, eigenvalues, eigenvectors and differentiation of multivariable functions.

Course Requirements

Academic Integrity

Every member of the University community is expected to maintain the highest standards of academic integrity. A student shall not submit work that is falsified or is not the result of the student's own effort. Infringement of academic honesty by a student subjects that student to serious penalties, which may include failure on the assignment, failure in the course, suspension from the University or other sanctions (see section 20 of R&R). Please consult Brandeis University Rights and Responsibilities for all policies and procedures related to academic integrity. Students may be required to submit work to TurnItIn.com software to verify originality. A student who is in doubt regarding standards of academic

honesty as they apply to a specific course or assignment should consult the faculty member responsible for that course or assignment before submitting the work. Allegations of alleged academic dishonesty will be forwarded to the Department of Student Rights and Community Standards. Citation and research assistance can be found at Brandeis Library Guides - Citing Sources (https://guides.library.brandeis.edu/c.php?g=301723).

Assignments

There will be two (short) homework assignments each week (after week 1) – one due at 11AM EDT on Monday and the other due at 7PM EDT Thursday. Each student will work on a small project which will include a written component and a brief video presentation (approx. 3-5 minutes) explaining their work. The project will consist of analyzing a simple differential equation model (with some applied context) analytically and numerically using the techniques developed in the course.

There may be some extra credit puzzles/challenges (on an ad-hoc basis).

Exams/Quizzes

Every lecture video will focus on 1-2 sections of the textbook and will be accompanied by a short reading quiz intended to aid retention - these quizzes will be marked on a pass/fail basis. There will be one mid-term exam and one final exam - the material for each exam is cumulative.

Participation

Students are required to attend and participate in live class sessions via Zoom. Students are not required to enable their video, although this is encouraged, and students can interact via voice or text chat as they prefer. Students must actively contribute to group work sessions by helping their group to solve problems (suggesting approaches, highlighting difficulties, etc.) to be considered in attendance at a given session. 70% attendance is required for full marks in terms of class session participation (see Evaluation below).

Evaluation

Late homework or reading quizzes will not be accepted without evidence of extenuating circumstances. Reading quizzes will be marked pass/fail with the pass mark set individually for each quiz (typically 80% or so correct) and your 4 lowest quizzes will be dropped from your grade. Your lowest scoring homework submission will also be dropped from your grade.

Class Element	Grade %	Due date
Live class session participation	5%	Daily
Reading quizzes	5%	Daily (11AM EDT, i.e. before class time begins)
Piazza participation	5%	Ongoing
Homework	30%	Bi-weekly
Mid-term exam	15%	July 23rd (TBA, asynchronous options)
Final exam	20%	August 6th (1PM, EDT)

Class Element	Grade %	Due date
Project	20%	August 10th (1PM EDT)

Essential Resources

Accommodations

Brandeis seeks to welcome and include all students. If you are a student who needs accommodations as outlined in an accommodations letter, I want to support you. In order to provide test accommodations, I need the letter more than 48 hours in advance. I want to provide your accommodations, but cannot do so retroactively. If you have questions about documenting a disability of requesting accommodations, please contact Student Accessibility Support (SAS https://www.brandeis.edu/accessibility/) at 781.736.3470 or access@brandeis.edu.

Course Materials

The textbook for this course is *Differential Equations* (4th edition) by Blanchard, Devaney & Hall. The textbook is freely available to all Brandeis students via the Brandeis Library here.

Apps or Tools/Equipment

All students will need a laptop or PC to access the lecture videos, submit work via LATTE and participate in live classes via Zoom. Additionally, you will use your computer to run MATLAB and Mathematica (both freely available to all Brandeis students). Please contact me as soon as possible if you are concerned you do not have an appropriate device for this course.

LATTE

LATTE is the Brandeis learning management system: http://latte.brandeis.edu. Login using your UNET ID and password. All course materials, including lecture videos, homework assignments, and reading quizzes, will be posted to LATTE.

Library

The Brandeis Library collections and staff offer resources and services to support Brandeis students, faculty and staff. These include workshops, consultations, collaboration, materials and instruction on emerging trends in technologies such as machine learning, emerging trends in research such as data visualization, and emerging trends in scholarship such as open access. Librarians at the Circulation Desk, Research Help Desk, Archives & Special Collections, Sound & Image Media Studios, MakerLab, AutomationLab, and Digital Scholarship Lab are available to help you.
https://www.brandeis.edu/library/about/index.html

Student Support

Brandeis University is committed to supporting all our students so they can thrive. The following resources are available to help with the many academic and non-academic factors that contribute to student success (finances, health, food supply, housing, mental health counseling, academic advising, physical and social activities, etc.). Please explore the many links on this Support at Brandeis page (https://www.brandeis.edu/support/undergraduate-students/browse.html) to find out more about the resources that Brandeis provides to help you and your classmates to achieve success.