

MATH 37a: Differential Equations Summer 2021

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Modality: entirely online

Class-time: M, T, Th, F 11:10 – 1:10 PM Eastern Time

“Any equation that contains derivatives is called a **Differential Equation**. The universe is described by differential equations, and solving them is Job #1 in Science.” – *Larry Gonick*

Learning Goals:

1. Model real-world phenomena and applications with differential equations;
2. Study differential equations using both quantitative (analytic) and qualitative (geometrical/graphical) approaches; and
3. Develop and leverage a learning community for math.

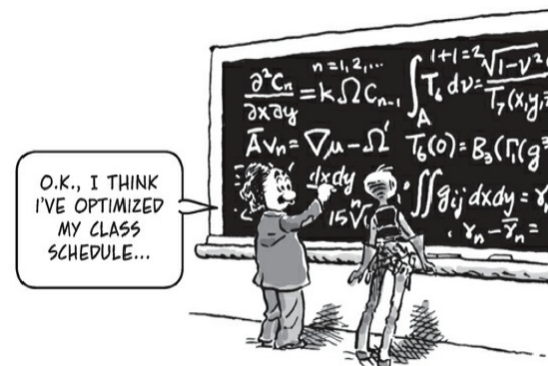


Image Source: *The Cartoon Guide to Calculus*, page 230

Prerequisite: MATH 15a or 22a and MATH 20a or 22b.

Students should have familiarity with single-variable calculus, multi-variable calculus, and linear algebra.

Course Text:

The Ordinary Differential Equations Project, 2021 Snapshot Edition, by Thomas W. Judson:

<http://faculty.sfasu.edu/judsontw/ode/html-snapshot/odeproject.html>

The text is open source and freely available online at the link above.

Other Resources and Equipment:

- **Remote Learning:** All students will need a computer/laptop with internet service, webcams and microphones to access and submit online resources, and participate in remote live classes.
- **Technology:** It is recommended that you have a graphing calculator, or some other type of graphing software such as Desmos or Wolfram Alpha.
Students with financial need should contact Student Financial Services or Academic Services to discuss options available to purchase equipment and other technology or supply needs.
- **Working in Groups:** Study groups of 3 or more students will be formed. Studying together makes it more enjoyable, and helps you learn difficult material. Even if you think you know everything, explaining concepts to some else helps you master the material.
- **Expectation:** Success in this **accelerated summer** 4-credit class is based on the expectation that students will spend a **minimum of 27 hours of study time per week** (outside of class time).

LATTE:

All course materials will be available online on LATTE. Log in at <http://latte.brandeis.edu> using your Unet username and password.

Topics:

We will cover the following sections from our textbook this semester:

Note: Some topics may be added or omitted as time permits.

Section	Topic
A First Look at Differential Equations	
1.1	Modeling with Differential Equations
1.2	Separable Differential Equations
1.3	Geometric and Quantitative Analysis
1.4	Analyzing Equations Numerically
1.5	First-Order Linear Equations
1.6	Existence and Uniqueness of Solutions
1.7	Bifurcations
Systems of Differential Equations	
2.1	Modeling with Systems
2.2	The Geometry of Systems
2.4	Solving Systems Analytically
Linear Systems	
3.2	Planar Systems
3.3	Phase Plane Analysis of Linear Systems – Real Eigenvalues
3.4	Complex Eigenvalues
3.5	Repeated Eigenvalues
3.7	The Trace-Determinant Plane
3.8	Linear Systems in Higher Dimensions
Second-Order Linear Equations	
4.1	Homogeneous Linear Equations
4.2	Forcing
4.3	Sinusoidal Forcing
4.4	Forcing and Resonance
Nonlinear Systems	
5.1	Linearization
5.2	Hamiltonian Systems
The Laplace Transform	
6.1	The Laplace Transform
6.2	Solving Initial Value Problems
6.4	Convolution

Course Text:

(Required) *The Ordinary Differential Equations Project*, 2021 Snapshot Edition, by Thomas W. Judson:
<http://faculty.sfasu.edu/judson/tw/ode/html-snapshot/odeproject.html>

The text is open source and freely available online at the link above.

Mini-Lecture Videos: Prerecorded mini-lecture videos will be made available on our course LATTE page through Perusall, a social annotation tool. Student will gain access to Perusall directly via LATTE; no additional set-up is needed.

Course Work, Grading, and Mastery:

Letter Grade:

At the end of the semester, your letter grade will be calculated using the following table. To earn the letter grade listed on the left you must meet the **minimum** shown in **ALL** columns for that row.

Letter Grade	Student Project	Student Learning Outcomes Mastered	Practice Assignments	Participation
A+	3 of 3	20 of 20	250 of 300	225 of 300
A	2 of 3	19 of 20		
A–	2 of 3	18 of 20		
B+	1 of 3	17 of 20	225 of 300	200 of 300
B		16 of 20		
B–		15 of 20		
C+	1 of 3	14 of 20	200 of 300	175 of 300
C		13 of 20		
C–		12 of 20		
D+	0 of 3	11 of 20	150 of 300	150 of 300
D		10 of 20		
D–		9 of 20		

Grading Details:

Participation: There are 15 in-class activities, each worth 20 points for a total of 300 possible points toward participation.

Practice Assignments: There are 15 practice assignments, each worth 20 points for a total of 300 possible points. For each assignment, you earn 6 **completion points** for attempting all the assigned problems and we will **grade 7 items**, each worth 2 points, using the following criteria:

2 of 2	The graded item is completely solved and sufficient work is shown. The work is clear and legible. The submission may contain some minor (numerical) mistakes.
1 of 2	The item is partially solved or incomplete. The work is clear and legible. The key idea is missing or there is a major mistake in the submission.
0 of 2	There is no evident of attempting the question. The work is not legible or too messy.

Student Project: Students pick a topic related to the course to study and prepare a short presentation. It can be on applications of the techniques we learned or topics in the textbook that we did not cover in our course. The project will be graded on a scale of 3 points using the following criteria:

3 of 3	The topic is interesting and related to the course. Sufficient work is made toward the completion of the project. The presentation is clear and organized. The mathematics is correctly presented. The speaker effectively demonstrates their ability to communicate mathematics to the audiences.
2 of 3	One of the conditions above has not met.
1 of 2	Student attempts the project but at least two of the conditions above have not met.
0 of 2	There is no evident of attempting the project.

More on Grading Details →

Student Learning Outcomes (SLO's):

Our course has the following list of Student Learning Outcomes (or SLO's); these are mathematical concepts and techniques we are learning in this class.

SLO's	Description
S1	Verify solutions of given differential equations
S2	Model problems with differential equations
S3	Solve separable differential equations
S4	Analyze a differential equation geometrically
S5	Find and classify equilibrium solutions to a differential equation
S6	Use integrating factors to solve first-order linear equations
S7	Find equilibrium solution(s) of a system
S8	Use nullclines and phase plane analysis to sketch solution curves for a system
S9	Solve linear systems with distinct real eigenvalues
S10	Phase Plane Analysis of Linear Systems with Distinct Real Eigenvalues
S11	Solve linear systems with complex eigenvalues
S12	Classify the equilibrium points of linear system with complex eigenvalues
S13	Solve linear systems with repeated eigenvalues
S14	Solve a second-order linear differential equation with constant coefficients
S15	Solve the second-order initial-value problem corresponding for a harmonic oscillator
S16	Solve a forced second-order linear differential using method of undertermined coefficients
S17	Solve and analyze a sinusoidal forcing equation
S18	Find and classifying equilibrium solutions for nonlinear systems.
S19	Solving linear differential equations with Laplace Transforms
S20	Using Laplace Transforms to Solve Differential Equations with Discontinuous Forcing Functions

Mastery Assessments:

Student mastery of the learning outcomes in the table above will be used to determine students' final grade at the end of the semester. This style of grading is designed to hold you accountable for learning the content of the course "on your personalized pace". If you get something wrong, you get to revise and/or try it again. But it also means you can't just let things go without really learning them.

Here's how it works:

- **Weekly Assessments:** Each week, you will have an opportunity to demonstrate mastery of that week's SLO's by solving a set of problems corresponding to these outcomes.
Note: A problem on an assessment can correspond to one or more than one outcomes.
- For each problem, the corresponding SLO's will be graded on a **mastered/not-yet-mastered** basis based on the quality of your submitted work (essentially at a B+/A- level).
- If you do not master a particular outcome, you can request to submit a revision or try to demonstrate mastery of that outcome again the following week. This means that you will have to review the problem, study and practice that concepts or techniques further.
- The **Final Exam** time will be used as one last Mastery Assessment – the last opportunity to demonstrate mastery of any of your remaining unmastered SLO's. There will be no new SLO's on this final assessment. No revision will be allowed for this last Assessment.

With this grading structure, you can be confident at every point in the semester that you have strong skills in all the outcomes you mastered, and will know exactly which skills and ideas need more work.

If you have questions about how this course is graded, please do not hesitate to reach out to me!

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Other Course Information

Late Work: We understand that life sometimes gets in the way of our studies, or prevents us from completing an assignment or attending class. If you aren't able to complete an assignment on time, please communicate with me as soon as possible. We'll work together to make sure you don't fall too far behind. **Note:** The summer session is really fast paced. **One day** worth of our materials is equivalent to **one week** worth of materials in a 15-week course.

Expectation: Success in this **accelerated summer** 4-credit class is based on the expectation that students will spend a **minimum of 27 hours of study time per week** in preparation for class (readings, completing practice assignments, reviewing your weekly assessments, etc.)

Accommodations:

Brandeis seeks to welcome and include all students. If you are a student who needs accommodations as outlined in an accommodations letter, please talk with me and present your letter of accommodation as soon as you can. I want to support you in any ways I can.

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 or requesting accommodations, please contact Student Accessibility Support (SAS) at 781.736.3470 or access@brandeis.edu

Academic Integrity:

You are expected to follow the University's policy on academic integrity, which is distributed annually as section 4 of the Rights and Responsibilities Handbook (see <http://www.brandeis.edu/studentaffairs/srcs/rr/index.html>). Instances of alleged dishonesty will be forwarded to the Department of Student Development and Conduct for possible referral to the Student Judicial System. Potential sanctions include failure in the course and suspension from the University. If you have any questions about how these policies apply to your conduct in this course, please ask.

Necessary Equipment and Available Resources:

Success in this online course will require a webcam with a microphone and internet access. If you need assistance with acquiring any of these items, contact emergencyfunds@brandeis.edu. *You will be required to have your camera ON during class.*

Many resources are available to help with the 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 links on the Support at Brandeis page <https://www.brandeis.edu/support/undergraduate-students/browse.html> to find out more about the resources that the University provides to help you and your classmates achieve success.

Timely communication:

Use your Brandeis email to reach out to me. I am usually able to respond quickly to most messages, within 24 hours, although during the weekends and over holidays it could take me longer. If I reach out to you, with a query or comment or in response to an email from you, I would appreciate it if you would acknowledge receipt of my message and/or respond with 24 hours, unless it is during weekend or over a holiday. Note that we will use your Brandeis email address, so you need to check it regularly.

All course announcements can be found in the [Course News & Announcements](#) page on Latte.

Name/Pronouns:

If you have a preferred name and/or preferred pronouns you would like me to use, please let me know either by email or in class. Thanks!

End of The Course Syllabus.