New York University | Courant
Tandon School of Engineering
MA-UY 2034 Linear Algebra & Differential Equations
Course Outline

Spring 2018 All Tuesday & Thursday Sections

Course Coordinator: Dr. Lindsey Van Wagenen
Office: RH305D
Email: vwagenen@nyu.edu
Phone: 646-997-3737
Office Hours: M afternoons by appointment
T 6:00—7:00pm
W 3:00—6:00pm
Other times—please send an email and we can arrange a convenient time to meet.

Course Website: NYU Classes

Course Pre-requisites: You are expected to have mastery of the concepts and skills covered in MA-UY 914, MA-UY 1024/1324, and MA-UY 1124/1424.

Course Description: Linear algebra and differential equations are central to modern mathematics and engineering. The concepts in linear algebra have the power to explain fundamental principles and simplify calculations in engineering, computer science, mathematics, physics, biology, statistics, digital media and economics. In this course you will learn the basic concepts and skills of linear algebra that are needed for later math courses, such as differential equations, multivariable calculus, and by other courses needed for your major. The course combines abstract thinking with elementary calculations. The abstract concepts you will learn in linear algebra are as important as the computations. Differential equations play an important role in modeling virtually every physical, technical, or biological process, from celestial motion to aerospace design, from bridge design to animation, from financial trends to the interactions between neurons. This course is an introduction to the field of differential equations and will include the study of the fundamental concepts and techniques for the analytic and numeric solutions of ordinary differential equations, as well as classic applications.
Course Objectives: Students are expected to:

- Formulate, solve, apply, and interpret systems of linear equations in several variables using Gaussian elimination;
- Learn the properties of matrices and apply them to the solutions of systems of linear equations;
- Understand the notions of vector spaces and basis, and apply their understanding to the solution of problems;
- Develop an understanding of linear transformations and be able to apply that knowledge;
- Learn to calculate eigenvalues and eigenvectors, and be able to use them in context.

- Model and solve first order differential equations.

- Solve higher order linear ordinary differential equations and initial value problems.
- Solve a linear system of first order differential equations with constant coefficients.
- Be familiar with elementary concepts of numerical analysis, especially numerical solutions of initial value problems for ordinary differential equations.
- Formulate, solve, apply, and interpret systems of linear equations in several variables.

Course Structure: This 4-credit one-semester course meets for two 110 minutes lectures each week. You are also expected to study outside of class, a good ‘rule of thumb’ is two to three hours of study for each hour of class.

Course Requirements: (The grading policy is detailed in a section below).

- Two Weekly Lectures
- Mandatory WebAssign Online Homework—WebAssign can be accessed from NYU Classes.
- 3 In-Class Exams
- Final Exam

Examinations: Three 105-minute exams will be given during class time, and a 120-minute cumulative Final Exam. The only calculator permitted is the TI-30, no substitutions.
Exam Dates

- Exam 1 Thursday, February 15, 2018.
- Exam 2 Thursday, March 22, 2018.
- Exam 3 Thursday, April 19, 2018.
- Final Exam, Scheduled during the Final Exam Period.

Important Exam Information:

- No cell phones, iPads or other devices that can communicate with the internet or with others may be used. Any such equipment found with the power on may well be interpreted as "cheating".
- The Department of Mathematics reserves the right to impose the strongest academic sanctions for violations of Academic Integrity.
- It is NYU Tandon policy that an out-of-sequence exam can be administered only if there is prior authorization by the Office of Student Affairs.
  We cannot accommodate out-of-sequence exams, quizzes, and finals for reasons of convenient travel, even if you have already purchased tickets. Please note carefully the date of your exams and final and plan your travel schedule accordingly. Please refer to the full make-up exam policy online:
  - https://math.nyu.edu/tandon/policy.html

Religious Observance Policy As a nonsectarian, inclusive institution, NYU policy permits members of any religious group to absent themselves from classes without penalty when required for compliance with their religious obligations. The policy and principles to be followed by students and faculty may be found here: The University Calendar Policy on Religious Holidays. The procedure to be followed by students who require consideration due to religious observance can be found at http://engineering.nyu.edu/life/student-affairs/advocacy-privacy-and-compliance.

Moses Center for Students with Disabilities If you are student with a disability who is requesting accommodations, please contact New York University’s Moses Center for Students with Disabilities at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 2nd floor.

Textbook:
Worldwide Differential Equations with Linear Algebra by Robert McOwen.
You can purchase a copy Digital $14.95 / Print $39.95

If you have any difficulty purchasing the textbook online please contact Dr. Van Wagenen at vwagenen@nyu.edu

Also recommended for a more in-depth treatment of the topics, you may use a combination of:
Having a copy of a good Linear Algebra & DE textbook will greatly facilitate learning the course material!

**Homework**  We will be using WebAssign for this course. You can access WebAssign from NYU Classes.

The best 90% of your homework points will count—in other words 10% of the homework points will be dropped.

If you have any questions about accessing WebAssign, please contact Dr. Van Wagenen at vwagonen@nyu.edu. If you have problems with a particular question in WebAssign, please use the Communications tab inside WebAssign to request help and someone will respond to your question.

There are NO routine extensions for homework unless there is a documented personal or medical emergency. The homework is designed to help you master the material covered by each of the exams and therefore the relevant homework is due before each of the exams.

**Grading Policy**

**Course Grade:** Your final course grade will be the highest of the averages calculated using the table below:

<table>
<thead>
<tr>
<th></th>
<th>Average 1</th>
<th>Average 2</th>
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<tbody>
<tr>
<td><strong>In-Class Exams</strong></td>
<td>All 3 exams, 20% Each 60%</td>
<td>Best 2 exams, 25% each 50%</td>
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<tr>
<td>Final Exam</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
<td>10%</td>
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**Conversion of Course Average to Course Grade**

<table>
<thead>
<tr>
<th>Course Average</th>
<th>Course Grade</th>
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<tbody>
<tr>
<td>90-100</td>
<td>A</td>
</tr>
<tr>
<td>87-89</td>
<td>A-</td>
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<tr>
<td>84-86</td>
<td>B+</td>
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<tr>
<td>80-83</td>
<td>B</td>
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<tr>
<td>77-79</td>
<td>B-</td>
</tr>
<tr>
<td>74-76</td>
<td>C+</td>
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Exam Regrading: You have an opportunity to review your exams and to discuss the grading with your instructor or Dr. Van Wagenen. If you feel a question needs to be re-graded you must write a note describing what you feel needs attention, staple it to your exam and submit the exam and note to the Math Dept. Help Desk in RH305 within 10 days after the exams have been returned or made available at the Help Desk.

Course Lecture Syllabus

Lecture 1 First Order Differential Equations
- 1.1 Differential Equations and Mathematical Models
- 1.2 Geometric Analysis and Existence and Uniqueness

Lecture 2 First Order Differential Equations
- 1.3 Separable Equations & Applications
- 1.4 Linear Equations & Applications

Lecture 3 First Order Differential Equations
- Euler’s Method
- Applications & Modeling

Lecture 4 Differential Equations
- 1.5 Additional Methods for Solving First Order DE

Lecture 5 Laplace Transform
- 3.1 Laplace Transform and Its Inverse

Lecture 6 Laplace Transform
- 3.2 Transforms of Derivatives and Initial Value Problems

Lecture 7 Catch up & Review

Lecture 8 Exam 1 Covers material from Lectures 1–7

Lecture 9 Systems of Linear Equations and Matrices
- 4.1 Introductions to Systems and Matrices
• 4.2 Gaussian Elimination

**Lecture 10 Systems of Linear Equations and Matrices**
• 4.3 Reduced Row-Echelon Form and Rank
• 4.4 Inverse of a Square Matrix
• Applications

**Lecture 11 Systems of Linear Equations and Matrices**
• 4.5 Determinant of a Square Matrix
• 4.6 Cofactor Expansion

**Lecture 12 Vector Spaces**
• 5.1 Vector Spaces in $\mathbb{R}^n$
• 5.2 General Vector Spaces

**Lecture 13 Vector Spaces**
• 5.3 Subspaces and Spanning Sets
• 5.4 Linear Independence

**Lecture 14 Vector Spaces**
• 5.5 Basis and Dimension
• 5.6 Row and Column Spaces
• Applications

**Lecture 15 Catch up & Review**

**Lecture 16 Exam 2** Covers material from Lectures 1—15

**Lecture 17 Second-Order Differential Equations**
• 2.1 Introduction to Higher-Order Equations
• 2.2 General Solutions for Second-Order Equations

**Lecture 18 Second-Order Differential Equations**
• 2.3 Homogeneous Equations with Constant Coefficients
• 2.4 Nonhomogeneous Equations with Constant Coefficients

**Lecture 19 Second-Order Differential Equations**
• Variation of Parameters (Supplemental Notes provided on NYU Classes)
• 2.6 & 2.7 Selected Topics: Cauchy-Euler, Laplace Transforms & Applications

**Lecture 20 Linear Transformations**
• 6.1 Linear Transformations & Introduction Eigenvalues

**Lecture 21 Linear Transformations and Eigenvalues**
• 6.1 Eigenvalues Continued
• 6.2 Diagonalization and Similarity

Lecture 22 Linear Transformations and Eigenvalues
• 6.3 Symmetric and Orthogonal Matrices-Definitions
• Applications

Lecture 23 Catch up & Review

Lecture 24 Exam 3 Covers material from Lectures 1—23

Lecture 25 Systems of First-Order Equations
• 7.1 Introduction to First-Order Systems
• 7.2 Theory of First-Order Systems

Lecture 26 Systems of First-Order Equations
• 7.3 Eigenvalue Method for Homogeneous Systems

Lecture 27 Systems of First-Order Equations
• Variation of Parameters Method for Nonhomogeneous Systems
  (Supplemental Notes provided on NYU Classes)
• Applications

Lecture 28 Catch up & Review

Comprehensive Final Examination scheduled during Finals Week.

Additional Learning Resources:

<table>
<thead>
<tr>
<th>General Math Workshops</th>
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<tr>
<td><strong>Days</strong></td>
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Internet Resources
http://tutorial.math.lamar.edu/  Paul's Online Math Notes, Choose Class Notes and then the course you want.
www.Youtube.com There are many good Linear & DE lectures, the Khan Academy is a favorite for many students.

Important: General Exam Policies

Valuables (especially your laptop!):
Please do not bring your laptop or any other valuable items to the exam. You are required to leave your bags and books at the front of the exam room.

Time and Place:
It is your responsibility to consult the web site to know when and where an exam is being held. You will not receive any special consideration for being late or missing an exam by mistake.

Identification:
You are required to bring your NYU ID to the exam. If for any reason you are unable to do so, another photo ID, such as a drivers license, is acceptable.

Before the Exam:
You must wait outside the exam room before the start of an exam. You must sit only in seats where there is an exam for your course. You must not move the exam to a different seat.

Neatness and Legibility:
You are expected to write as neatly and legibly on your exam. Your final answer must be clearly identified (by placing a box around it). Points will be deducted if the grader has difficulty reading or finding your answer.

Missed Exams:
If you missed an exam due to a medical reason, then University policy requires you to provide written documentation to the Office of Student Affairs(JB158). It is University policy that the Mathematics Department may not give make-up exams without prior authorization by the Office of Student Development.

Academic Integrity:
Any incident of cheating or dishonesty will be dealt with swiftly and severely. The University does not tolerate cheating. (There is no such thing as "a little bit of cheating.") During an exam you are not allowed to borrow or lend a calculator;
borrowing or lending a calculator will be considered cheating.

TI-30 is the only calculator allowed! No Exceptions!

During Exams no cell phones, iPads or other devices that can communicate with the internet or with others may be used. Any such equipment found with the power on may well be interpreted as "cheating".

The Department of Mathematics reserves the right to impose the strongest academic sanctions for violations of Academic Integrity.

NYU School of Engineering Policies and Procedures on Academic Misconduct

Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who

A. breach the School’s rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School’s Policy on Academic Misconduct.

B. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person’s work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.

2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
3. **Plagiarism:** intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.

4. **Unauthorized collaboration:** working together on work that was meant to be done individually.

5. **Duplicating work:** presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.

6. **Forgery:** altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.