Ordinary Differential Equations

Math-UA 262-003
MA-UY 4204 B

Instructor Info

Zhuo-Cheng Xiao

Office Hrs: Mon 1-2 pm & Thur 2-3 pm

Rm 921, WWH (Courant Bldg)

Brightspace and Gradescope

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Course Info

Mon & Wed

2:00 - 3:15 pm

194M Rm 203

Recitation Info

Fri

2:00 - 3:15 pm

194M Rm 203

TA Info

Tianrui (Michael) Sheng

Office Hrs: Thur 1-2pm; Fri 3:30-4:30pm

ZOOM

Overview

Together, we are involved in one of the most significant human enterprises: describing, analyzing, and predicting the chaotic and unknown future. This course is the first course in ordinary differential equations (ODEs) and an elementary part of a much bigger picture of the dynamical system and applying mathematics to real-world problems.

If predicting the future is a one-million-word novel, then college mathematics such as calculus and linear algebra are ABC about it. Based on that, we will focus on some "grammar" (mathematical theories and proof of ODE) and "making sentences" (solving ODE problems and numerical simulations). I hope this course can also provide a glimpse of more advanced theory courses such as dynamical systems, partial differential equations, and functional analysis, as well as a tryout of solving real-world modelling problems.

Materials

Required Texts

Differential Equations and Their Applications. (Braun, 4th edition, 1993, Springer), ("B"). Accessible for free.

Suggested Reading

Nonlinear Dynamics and Chaos. (Strogatz, 2nd Edition, 2015, CRC Press), ("S")

Learning Objectives

- Solving linear first and second-order ODEs, and methods of solving a few types of nonlinear ODEs that have exact solutions
- Proving existence and uniqueness of solutions
- Analytical skills: Laplace transforms and series solutions
- N-dim ODE systems: qualitative analysis for linear/nonlinear systems
- Boundary value problems
- More analytical skills: Green's functions and Fourier series. (optional)

Grading Scheme

20%	Weekly Homework
10%	Class Participation
40%	Midterm I & II. 20% each
30%	Final Exam

Grades will follow the standard NYU math scale:

Letter Grade	A	A-	B+	B	B-	C+	C	D	F
Cutoff	93	90	87	83	80	75	65	50	<50

Curving may (or may not) be added to uplift the letter grades during the final evaluation.

Exams

Two midterms will be in-class. Although exams will be computation extensive, we will tolerate numerical errors provided that the student correctly and concisely demonstrates all computational steps. On the other hand, only a small portion of scores will be granted if only the final answer is provided without any justifications.

FAQs

Why there are incomplete information?

This is a tentative version of syllabus. TA and recitation information will be added soon.

Homework Policy Homework should be submitted as pdf files on Gradescope, which always dues on *Monday, 5pm* unless otherwise specified, and our grader will return your homework grading with an explanation before Saturday. Both handwritten and latex formatted are fine, but the students are responsible for the submitted files' readability and completeness.

We are all affected by the great uncertainty of life, and I understand that unexpected issues are always popping up. Therefore, the lowest two homework grades will be dropped (including the missed ones). In addition, the "late" deadline for each homework is *Monday, 11:59pm* in case of emergent issues. However, submissions after the deadline but before the "late" deadline will receive a grade discounted by 10%, and submissions will not be accepted after the "late" deadline.

Make-up Policy Make-up exams or assignments are allowed in limited scenarios provided that the student gets approval from the instructor *before the due date*. An approval may be granted for typical excuses including medical reasons, religious holidays, and family emergencies.

Class Participation Students are expected to attend the classes, including recitations. Although attendance will not be strictly recorded, 10% of the final evaluation is based on class participation, including in-class interactions and discussions.

Recitations will begin from the second week in Spring 2022. Although there are multiple recitation sessions offered, the students of this section should go to recitation section #? scheduled on #?.

If students have difficulty attending classes, they should consult the instructor and their advisors in advance.

Remote Setup This course is primarily in-person until the university instructs otherwise. The remote teaching method is a substitute for short-term and emergent reasons, based on students' requirements (due to covid issues, etc.).

If the student could not attend the in-person class, they need to email the instructor in advance to require a zoom link for the remote meeting to follow the class in a synchronized fashion. However, most of the course materials will be presented on the blackboards in the classroom, which may not be well-captured by zoom. Therefore, remote class access should not be relied on if the student expects to be unable to come to class on a long-term basis.

Other Resources

- Tutoring: Courant tutoring center and the university tutoring center.
- Moses Center for Student Accessibility for students with any physical or mental inconveniences.

Academic Integrity All students are expected to adhere to the codes of academic integrity specified by New York Univerisity.

Class Schedule

Week	Date	Section	Materials
MODULE 1: First Order Linear Equations			
Week 1	01/24	1.1-2	Introduction, Solving first order linear equations
	01.26	1.2, 1.4	Separation of variables
Week 2	01/31	1.5-6	Modelling: Population growth
	02/02	1.9	Exact equations
Week 3	02/07	1.10-11	The existence-uniqueness theorem; Iterations
	02/09	1.11, 1.13	Numerical methods: Euler's methods from Talor expansion
Week 4	02/14	1.14-16	More on nmerical methods: Runge-Kutta
	02/16		Midterm 1
MODULE 2: Second Order and N-Dimensional Equations			
Week 5	02/21		President Day. No class
	02/23	2.1	Second order linear equations
Week 6	02/28	2.2-3	Constant coefficients: homogeneous equations
	03/02	2.3-5	Constant coefficients: non-homogeneous equations
Week 7	03/07	2.8, 2.8.1	Series solutions, Singular points
	03/09	2.8.2-3	Method of Frobenius, special functions
Week 8			Spring break. No class
Week 9	03/21	3.1	Solutions of n-dim linear systems
	03/23	2.6	Modelling: Oscillator problems
Week 10	03/28	3.8	Linear ODE systems: Eigenvalues and eigenvectors
	03/30	3.9-10	Linear ODE systems: Complex & Equal roots
Week 11	04/04	3.11-12	Linear ODE systems: Matrix solutions
	04/06		Midterm 2
MODULE 3: Qualitative analysis to ODE systems & More analytical methods			
Week 12	04/11	4.1-3	Stability
	04/13	4.4, 4.7	The phase plane and phase portraits
Week 13	04/18	4.6, 4.8	Qualitative properties of orbits
	04/20	4.10-13	Modelling: Populations and epidemiology

Week 14	04/25	5.2-3	Heat equations and Fourier series
	04/27	6.3-4	Orthogonal bases, Sturm-Liouville theory
Week 15	05/02	2.9-10	Laplace transfrom
	05/04	2.11, 3.13	Application of Laplace transforms
Week 16	05/09	2.12-13	Laplace transfrom, Dirac function, and Green's function
	undetermined		Final Exam