MATH 676: Advanced Ordinary Differential Equations
Fall 2022 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: A rigorous treatment of the theory and applications of differential equations and introduction to the modern theory of dynamical systems and their applications. Effective from: Fall 2019.

Number of Credits: 3

Prerequisites: Math 222, Math 337, and Math 545 or Math 645.

Course-Section and Instructors:

Course-Section	Instructor
Math 676-001	Professor R. Goodman

Office Hours for All Math Instructors: Fall 2022 Office Hours and Emails

Required Textbook:

Title	*Differential Dynamical Systems + Notes*
Author	J.Meiss
Edition	Revised Edition
Publisher	SIAM
ISBN #	978-1611974638

Required Software: MATLAB with dfield and pplane (tutoring available).

University-wide Withdrawal Date: The last day to withdraw with a **M** is **Monday, November 14, 2022.** It will be strictly enforced.

COURSE GOALS

Course Objectives and Outcomes

- Develop a better and more rigorous grasp of key concepts in modern dynamical systems theory
- Gain a deeper understanding of stability, bifurcations and chaos and related concepts such as attractors
- Learn how to apply dynamical systems theory in further studies in science and engineering.

Course Assessment: The assessment of objectives achieved through homework assignments, projects, regular in-class quizzes, and the midterm and final examinations.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework + Project + Quizzes	20%
Midterm Exam	35%
Final Cumulative Exam	45%

Your final letter grade will be based on the following tentative curve.

A	88 - 100	**C**	62 - 67
B+	82 - 87	**D**	55 - 61
B	75 - 81	**F**	0 - 54
C+	68 - 74		

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Homework and Quiz Policy: Homework is due on the assigned date; late homework will reduce the number of points awarded, and will only be accepted at discretion of the instructor. Quizzes are given on an announced topic at times specified by the instructor.

Exams: There will be one midterm exam during the semester and a cumulative final exam during the final exam week:

Midterm Exam	October 31, 2022
Final Exam	December 16 – 22, 2022

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Scott Janz, Associate Director of Disability Support Services at 973-596-5417 or via email at scott.p.janz@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website.

Important Dates (See: Fall 2022 Academic Calendar, Registrar)

Date	Day	Event
September 5, 2022	Monday	Labor Day
September 6, 2022	Tuesday	First Day of Classes
September 12, 2022	Monday	Last Day to Add/Drop Classes
November 14, 2022	Monday	Last Day to Withdraw
November 22, 2022	Tuesday	Thursday Classes Meet
November 23, 2022	Wednesday	Friday Classes Meet
November 24 to November 25, 2022	Thursday and Friday	Thanksgiving Recess - Closed
November 26, 2022	Saturday	Saturday Classes Meet
December 14, 2022	Wednesday	Last Day of Classes
December 15, 2022	Thursday	Reading Day
December 16 to December 22, 2022	Friday to Thursday	Final Exam Period

Course Outline

Date	Section #	Subject Topic and Homework (HW) Assignment
9/7	1.1 -1.7	*Modeling, Mechanical Systems, Nullclines, Lorenz Model*
9/12	2.1 - 2.3	*Linear Systems, Exponentials*
9/14	2.4, 2.5	*Fundamental Solution, Semisimple-Nilpotent Decomposition*
9/19	2.6 – 2.8	*Linear Stability, Floquet Theory*
9/21	3.1, 3.2	*Existence and Uniqueness, Banach Fixed Point Theorem*
9/26	3.3 – 3.5	*Dependence on Initial Conditions, Intervals of Existence*
9/28	4.1 – 4.4	*Flows, Global Existence, Linearization, Lyapunov Functions*
10/3	4.5 – 4.7	*Topological Conjugacy, Hartman- Grobman Theorem*
10/5	4.9, 4.10	*Limit Sets, Nonwandering Sets, Basins of Attraction*
10/10	4.11, 4.12	*Stability of Periodic Orbits, Poincaré Maps (Notes on Discrete-time systems)*
10/12	5.1, 5.2	*Stable and Unstable Manifolds, Homoclinic and Heteroclinic Orbits*
10/17	5.3, 5.4	*Stable and Unstable Manifold Theorems*
10/19	6.1 – 6.4	*Nonhyperbolic equilibria and Symmetries in the Phase Plane*
10/24	6.5 – 6.7	*Index Theory, Poincaré—Bendixson Theorem, Lienard Systems*
10/26	6.6, 6.7	*REVIEW for MIDTERM EXAM*
10/31	----------	*MIDTERM EXAM*
11/2	7.1-7.2	*Chaotic Dynamics & Lyapunov exponents*
11/7		
11/9		
11/14	8.1 - 8.3	*Bifurcations, Unfolding and Normal Forms, Saddle-Node Bifurcations*
11/16	8.5 - 8.7	*Andronov—Hopf, Takens—Bogdanov and Homoclinic Bifurcations*
11/21	8.8 – 8.14	*Melnikov's Method and Shilnikov Bifurcation*
11/28	9.1 – 9.3	*Hamiltonian Dynamics, Poisson Flows*
11/30	9.4 – 9.6	*Action Symmetries*
12/5	9.7, 9.8	*Variational Approach*
12/7	9.9, 9.10	*Variational Approach*
12/12	9.12-9.14	*Integrability, KAM Theory, Onset of Chaos*

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Updated by Professor R. Goodman - 7/12/2022
Department of Mathematical Sciences Course Syllabus, Fall 2022