NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 676: Advanced Ordinary Differential Equations
Fall 2015 Graduate 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 of systems of differential equations: existence and uniqueness of solutions, dependence on initial conditions and parameters. Linear systems, stability, and asymptotic behavior of solutions. Nonlinear systems, perturbation of periodic solutions, and geometric theory of systems of ODEs.

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 C. Diekman

Required Textbooks:

Title	*Differential Dynamical Systems*
Author	Meiss
Edition	---
Publisher	SIAM
ISBN #	978-0898716351
Recommended	*Differential Equations and Dynamical Systems* by Lawrence Perko, Third Edition, Springer / ISBN 0-387-95116-4

University-wide Withdrawal Date: Please note that the last day to withdraw with a W is **November 2, 2015**. It will be strictly enforced.

COURSE GOALS

Course Objectives and Outcomes

- Students will obtain an understanding of the qualitative theory of systems of nonlinear ordinary differential equations and properties of their solutions.
- Students will apply analytical and computational methods to develop intuition about the behavior of finite-dimensional dynamical systems.

Course Assessment: The assessment of objectives is achieved through homeworks and exams.

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	30%
Midterm Exam	35%
Final Exam	35%

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

A	88 - 100	**C+**	68 - 74
B+	82 - 87	**C**	60 - 67
B	75 - 81	**F**	0 - 59

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. AttendanceNote

Homework Policy: Homework will be assigned and collected approximately bi-weekly. Late homework it not accepted.

Exams: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

Midterm Exam	October 15, 2015
Final Exam Week	December 15 -21, 2015

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: To properly report their absence during a midterm or final exam, please review the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

ADDITIONAL RESOURCES

Accommodation of Disabilities: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of

Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at:

- http://www.njit.edu/counseling/services/disabilities.php

Important Dates (See: Fall 2015 Academic Calendar, Registrar)

Date	Day	Event
September 1, 2015	T	First Day of Classes
September 7, 2015	M	Labor Day - University Closed
September 8, 2015	T	**Monday Classes Meet**
September 8, 2015	T	Last Day to Add/Drop Classes
November 2, 2015	M	Last Day to Withdraw
November 25, 2015	W	**Friday Classes Meet**
November 26 - 29, 2015	R - Su	Thanksgiving Recess - University Closed
December 10, 2015	R	Last Day of Classes
December 11 & 14, 2015	F & M	Reading Days
December 15 - 21, 2015	T - M	Final Exam Period

Course Outline

Lecture	Date	Sections	Topic
1	9/1	1.1-1.7	Review: 1D Flows; 2D Phase Space and Nullclines
2	9/3	2.1-2.3	Review: Linear Systems and Diagonalization
3	9/8	2.4-2.6	Review: Fundamental Solution Theorem for Linear Systems
4	9/10	2.7	Linear Systems: Stability
5	9/15	2.8	Non-autonomous Systems and Floquet Theory
6	9/17	3.1-3.3	Existence and Uniqueness Theorem
7	9/22	3.4-3.5	Dependence on Parameters; Maximal Interval of Existence
8	9/24	4.1-4.4	Flows, Global Existence, Linearization
9	9/29	4.5-4.6	Stability; Lyapunov Functions and Hamiltonian Systems
10	10/1	4.7-4.8	Topological Equivalence; Hartman-Grobman Theorem
11	10/6	4.9-4.10	Limit Sets, Attractors & Basins
12	10/8	4.11-4.12	Stability of Periodic Orbits; Poincare Maps
13	10/13	--	Review for Midterm Exam
14	10/15	--	**MIDTERM EXAM**
15	10/20	5.1-5.3	Stable and Unstable Manifolds; Heteroclinic Orbits
16	10/22	5.4	Local Stable Manifold Theorem
17	10/27	5.5-5.6	Global Stable Manifolds and Center Manifolds

18	10/29	6.1-6.4	Nonhyperbolic Equilibria & Nodes; Centers; Symmetries & Reversors
19	11/3	6.5-6.6	Index Theory; Poincare-Bendixson Theorem
20	11/5	6.7-6.8	Lienard Systems; Behavior at Infinity
21	11/10	7.1-7.3	Chaos; Lyapunov Exponents, Strange Attractors; Hausdorff Dimension
22	11/12	8.1-8.2	Bifurcations of Equilibria
23	11/17	8.3-8.4	Unfolding Vector Fields, Saddle-Node Bifurcation in 1D
24	11/19	8.5	Normal Forms
25	11/24	8.6-8.7	Saddle-Node Bifurcation in Rn; Degenerate Saddle-Node Bifurcation
--	11/26	--	Thanksgiving
26	12/1	8.8-8.9	Andronov-Hopf Bifurcation; Cusp Bifurcation
27	12/3	8.10-8.11	Takens-Bogdanov Bifurcation; Homoclinic Bifurcation
28	12/8	8.12-8.13	Melnikov's Method
29	12/10		**REVIEW FOR FINAL EXAM**

Updated by Professor C. Diekman - 8/31/2015