Spring 2024

MATH 707: ST: Numerical Linear Algebra

K. Wicke

MATH 707: ST: Graph Theory
Spring 2024 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: This graduate course provides an introduction to graph theory. Topics include classical concepts from graph theory such as trees, Eulerian and Hamiltonian graphs, planar graphs, graph colorings, matchings, and network flows. Additionally, the course covers some algorithmic graph theory, and gives an outlook on more advanced topics such as Ramsey theory and random graphs. The course concludes with highlighting applications of graph theory in the life sciences (e.g., biology and chemistry) and other fields (e.g., data science).

Number of Credits: 3

Prerequisites: Departmental approval.

Course-Section and Instructors:

Course-Section	Instructor
Math 707	Professor K. Wicke

Office Hours for All Math Instructors: Spring 2024 Office Hours and Emails

Required Textbook:

There is no required textbook for this course. Lecture notes with references to supplementary texts will be provided.

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, April 1, 2024**. It will be strictly enforced.

COURSE GOALS

Course Objectives:

- Knowledge of fundamental definitions and concepts in graph theory.
- Understanding of and ability to apply central graph-theoretic theorems and algorithms to solve problems.
- Proficiency in writing short proofs using standard graph theory proof techniques such as contradiction, minimal counterexamples, and induction.
- Familiarity with major viewpoints/goals in graph theory e.g., existence and characterization of graphs with certain properties, extremality, optimization, and algorithms.
- Familiarity with applications of graph theory outside of mathematics, e.g., in the life sciences.

Course Outcomes: On successful completion students will

- have a greater understanding of central concepts and ideas in graph theory and their applications in other fields;
- be able to solve introductory level and more challenging problems that involve graphs;
- be experienced in writing and presenting mathematical arguments using graph-theoretical reasoning;
- be prepared for more advanced discrete mathematics courses;
- be able to use graph theory in their own research (if applicable).

Course Assessment: Will be based on weekly/biweekly homework, two midterm exams, and one (comprehensive/cumulative) final exam.

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	20%
Midterm Exam I	25%
Midterm Exam II	25%
Final Exam	30%

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

A	90 - 100	**C+**	60 - 69
B+	80 - 89	**C**	50 - 59
B	70 - 79	**F**	0 - 49

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.

Homework: Homework assignments will be posted on Canvas and will usually be due at 11:59pm on Mondays unless announced otherwise. No late homework will be accepted. You are encouraged to work together on the homework, but do not copy any part of the homework or look up/request solutions to homework problems in online forums or websites. Each student must submit their own homework to be submitted online as a PDF file through Canvas. Feel free to ask me for help during my office hours after you have made an attempt at the question. I will also provide homework solutions that are detailed enough to allow you to understand how the question could be approached.

Homework assignments may contain both graded and ungraded parts and only the graded problems will need to be submitted. However, you should always make an attempt at the ungraded problems as well. For submission, put your name and the homework assignment number on the top right corner of every page and submit the problems in order. The purpose of written homework is to assess and provide feedback on your understanding of and ability to explain the reasoning behind complex derivations, graph algorithms, or proofs. Therefore, answers with little or no explanation or work shown will receive no credit. **The lowest homework score will be dropped at the end of the semester.**

Exams: There will be two midterm exams and one final exam. The midterm exam dates are tentative and may be subject to change.

Midterm Exam I	Feb 19, 2024
Midterm Exam II	Apr 1, 2024
Final Exam Period	May 3 - May 9, 2024

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 If you need an accommodation due to a disability please contact the Office of Accessibility Resources and Services at oars@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 at:

https://www.njit.edu/accessibility/

Important Dates (See: Spring 2024 Academic Calendar, Registrar)

Date	Day	Event
January 16, 2024	Tuesday	First Day of Classes
January 22, 2024	Monday	Last Day to Add/Drop Classes
March 10, 2024	Sunday	Spring Recess Begins
March 16, 2024	Saturday	Spring Recess Ends
March 29, 2024	Friday	Good Friday - No Classes
April 1, 2024	Monday	Last Day to Withdraw
April 30, 2024	Tuesday	Friday Classes Meet
April 30, 2024	Tuesday	Last Day of Classes
May 1, 2024	Wednesday	Reading Day 1
May 2, 2024	Thursday	Reading Day 2
May 3 - May 9, 2024	Friday to Thursday	Final Exam Period

Course Outline (tentative)

Week	Dates	Topic
1	Jan 15, 17 no class on Jan 15	Introduction to graphs and basic terminology
2	Jan 22, 24	Introduction to graphs and basic terminology continued Trees, spanning trees, and Kruskal's algorithm
3	Jan 29, Jan 31	Trees, spanning trees, and Kruskal's algorithm continued Trails, circuits, paths, and cycles
4	Feb 5, 7	Eulerian and Hamiltonian graphs Brief introduction to computational complexity theory and the class NP
5	Feb 12, 14	Examples of optimization problems on graphs

		Review for Midterm Exam I
6	Feb 19, 21	**Midterm Exam I on Feb 19** Planarity, Euler's formula, and Kuratowski's theorem
7	Feb 26, Feb 28	Planarity, Euler's formula, and Kuratowski's theorem continued Colorings and chromatic polynomials
8	Mar 4, 6	Colorings and chromatic polynomials continued Matchings, coverings, and Hall's marriage theorem
9	Mar 18, 20	Matchings, coverings, and Hall's marriage theorem continued Network flows, cuts, the max-flow min-cut theorem, and the labeling algorithm
10	Mar 25, 27	Network flows, cuts, the max-flow min-cut theorem, and the labeling algorithm continued Review for Midterm Exam II
11	Apr 1,3	**Midterm Exam II on Apr 1** Advanced topics: Extremal graph theory and Ramsey theory
12	Apr 8, 10	Advanced topics: Random graphs
13	Apr 15, 17	Advanced topics: Applications of graph theory in the life sciences and other fields
14	Apr 22, 24	Advanced topics: Applications of graph theory in the life sciences and other fields
15	Apr 29	Final Review

Updated by Professor K. Wicke - 12/23/2023
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