MATH 115 GRAPH THEORY

Summer 2024

Instructor:	Suzana Șerboi	**Time:**	MWF 01:00PM-03:30PM
Email:	smilea@ucsc.edu	**Place:**	Merrill Acad 130

Description: Graph theory, trees, vertex and edge colorings, Hamilton cycles, Eulerian circuits, decompositions into isomorphic subgraphs, extremal problems, cages, Ramsey theory, Cayley's spanning tree formula, planar graphs, Euler's formula, crossing numbers, thickness, splitting numbers, magic graphs, graceful trees, rotations, and genus of graphs.

Prerequisites: MATH 21 or AM 10 and either MATH 100 or CSE 101.

Canvas: I will be using the Canvas learning management system to post/update the syllabus and other course resources. You can log in at `https://canvas.ucsc.edu` using your CruzID and Gold password.

YuJa: Lectures will be recorded. The recordings will be available after class under the Yuja tab in Canvas.

Office Hours: After class, or by appointment, or post your questions on our class forum Ed Discussion.

Main References: The first textbook serves as the main textbook. The second book serves as a book that provides more depth for topics from the first book.

- G. Chartrand and P. Zhang: *A First Course in Graph Theory*, Publisher: Dover (2012)

- D. West: *Introduction to Graph Theory*, Edition: 2, Publisher: Pearson (2017)

Grading Policy: Canvas Quizzes (10%), Homework (30%), Midterm (30%), Final (30%).

Letter Grade Distribution (the final grades may be curved, if necessary):
A+: 100% to 99%; A: < 99% to 94%; A-: < 94% to 90%; B+: < 90% to 86%; B: < 86 % to 82%; B-: < 82 % to 78%; C+: < 78 % to 74%; C: < 74 % to 70%; C-: < 70 % to 66%; D+: < 66 % to 62%; D: < 62 % to 58%; D-: < 58 % to 54%; F: < 54 % to 0%.

Important Dates: Midterm Exam **Monday, July 8**, Final Exam **Friday, July 26**

Summer Session 1 (June 24 - July 26, 2024) Deadlines:
• Add/Swap - Th., June 27 • Drop - Mon., July 1 (tuition reversed) • Request "W" Grade - Sun., July 14 (no tuition reversal) • Change Grade Option - Sun., July 21 • Grades Due - Th., August 1

Course Policies:

- Exams will only be offered in person. There are no make-up exams given. If you miss the midterm exam or your final exam score is higher than your midterm score, your final exam score will replace your midterm score.

- I will drop 2 homework scores and 3 quiz scores to account for ANY issues or unforeseen circumstances. Please DO NOT email me to ask to be excused for missing class or to ask for assignments extensions.

Class Communication & Ed Discussion
    Course announcements will be made via Ed Discussion and NOT Canvas! Ed Discussion will be used for ALL communication and questions outside of lectures and office hours. You should send me an email ONLY if your question is of a sensitive or personal nature. If you have a question regarding homework, concepts, logistics, etc. - please post it on Ed, talk to me after class or in office hours.

Ed (or Ed discussion) is an online threaded discussion platform that supports document and image upload, math equations, embedded video, runnable code snippets, and image annotation. This tool is integrated in Canvas.

Homework & Gradescope

You will be able to see the assignments and due dates in Canvas and Gradescope. Homework must be submitted via Gradescope. You don't need an extra account for Gradescope - it is integrated in Canvas. See the instructional video on how to submit an assignment. When you submit your files, you will be prompted to select, for each specified problem, the pages on which the associated work/solution are located. You are required to accurately identify the pages associated to each problem as described in the video linked above. If you fail to do so, you may lose credit for each problem for which the pages are not correctly identified. It is your responsibility to make sure your submission is legible and easy to read. If you submit work that is difficult or impossible to read, you will not receive credit for it, and you will not be allowed to resubmit.

A few problems are selected and graded for each homework. You should be able to see the grading rubric and comments in Gradescope when the scores are released. If you think a grading error occurred, you can submit a regrade request in Gradescope.

Accommodations for Students with Disabilities

UC Santa Cruz is committed to creating a learning environment that meets the needs of its diverse student body including students with disabilities. If you have a disability, or think you may have a disability, you can work with the Disability Resource Center (DRC) to request disability accommodations. The Disability Resource Center is the campus office responsible for authorizing disability-related academic accommodations, in cooperation with the students themselves and their instructors. You can find more information about DRC, including contact information and the application process here: https://drc.ucsc.edu.

Academic Integrity

The Mathematics Department has a zero tolerance policy towards any incident of academic dishonesty. If cheating occurs, consequences within the context of the course may range from getting zero on a particular assignment, to failing the course. In addition to these sanctions, every case of academic dishonesty is referred to the students' college Provost, who sets in motion an official disciplinary process. Cheating in any part of the course may lead to failing the course and suspension or dismissal from the university.

What is cheating? In short, it is presenting someone else's work as your own. Examples include, but are not limited to, letting someone else do your homework assignment for you, copying another student's midterm or final exam, allowing your own work to be copied, or in any way facilitating the cheating of others. Although you may discuss problems with fellow students, your collaboration must be at the level of ideas only. Legitimate collaboration ends when you "lend", "borrow", or "trade" written solutions to problems, or in any way share in the act of writing your answers. For the full policy and disciplinary procedures on academic dishonesty, students and instructors should refer to the Academic Integrity page at the Division of Undergraduate Education: https://ue.ucsc.edu/academic-misconduct.html.

Title IX

The Title IX Office is committed to fostering a campus climate in which members of our community are protected from all forms of sex discrimination, including sexual harassment, sexual violence, and gender-based harassment and discrimination. Title IX is a neutral office committed to safety, fairness, trauma-informed practices, and due process. Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. If you have experienced sexual harassment or sexual violence, you can receive confidential support and advocacy at the Campus Advocacy Resources & Education (CARE) Office by calling (831) 502-2273. In addition, Counseling & Psychological Services (CAPS) can provide confidential, counseling support, (831) 459-2628. You can also report gender discrimination directly to the University's Title IX Office, (831) 459-2462. Reports to law enforcement can be made to UCPD, (831) 459-2231 ext. 1. For emergencies call 911.

Tentative Course Outline

- Lecture 1 (M 06/24): 1.1 Graphs & Graph Models, 1.2 Connected Graphs

- Lecture 2 (W 06/26): Proof methods review (Appendix 3), 1.3 Common Classes of Graphs

- Lecture 3 (F 06/28): Mathematical Induction review (Appendix 3), 2.1 The Degree of a Vertex

- Lecture 4 (M 07/01): 2.2 Regular Graphs, 2.3 Degree Sequences

- Lecture 5 (W 07/03): 3.1 The Definition of Isomorphism, 4.1 Bridges

- Lecture 6 (F 07/05): 4.2 Trees, 4.3 The Minimum Spanning Tree Problem

- Lecture 7 (M 07/08): Review, MIDTERM EXAM

- Lecture 8 (W 07/10): 5.1 Cut vertices, 5.2 Blocks

- Lecture 9 (F 07/12): 5.3 Connectivity, 5.4 Menger's Theorems

- Lecture 10 (M 07/15): 6.1 Eulerian Graphs, 6.2 Hamiltonian Graphs

- Lecture 11 (W 07/17): 7.1 Strong Digraphs, 7.2 Tournaments

- Lecture 12 (F 07/19): 8.1 Matchings, 8.2 Factorization

- Lecture 13 (M 07/22): 9.1 Planar Graphs, 10.2 Vertex Coloring

- Lecture 14 (W 07/24): 10.3 Edge Coloring, Review for Final Exam

- Lecture 15 (F 07/26): FINAL EXAM

Student Learning Outcomes:

1. **Introduction to Graph Theory** Define graphs and graph models, including common classes, connected graphs, multigraphs, and digraphs. Illustrate and differentiate between various types of graphs.

2. **Degrees** Determine the degree of a vertex and analyze regular and irregular graphs. Understand degree sequences and the relationship between graphs and matrices.

3. **Isomorphic Graphs** Define and identify graph isomorphisms.

4. **Trees** Explain the concept of bridges and trees, and solve the minimum spanning tree problem.

5. **Connectivity** Identify cut-vertices, blocks, and understand the concept of connectivity. Apply Menger's Theorem to solve problems related to graph connectivity.

6. **Traversability** Define and identify Eulerian and Hamiltonian graphs. Analyze Hamiltonian walks and understand their significance.

7. **Digraphs** Understand and analyze strong digraphs and tournaments.

8. **Matchings and Factorization** Define and find matchings in graphs, and understand the concepts of factorization and decompositions.

9. **Planarity** Define and identify planar graphs and understand graph embeddings on surfaces.

10. **Coloring Graphs** Explain the Four Color Problem and apply vertex and edge coloring techniques to solve graph coloring problems.

By mastering these outcomes, students will gain a comprehensive understanding of graph theory and its applications, preparing them for more advanced studies or professional work involving graph theoretical concepts.