NC STATE UNIVERSITY

CSC565/MA565/OR565 Course Syllabus

Graph Theory

Spring 2024

Instructor Information

Name	Office Phone	Mobile Phone	Email	Office Location
Donald Sheehy	919-513-0453	N/A	drsheehy@ncsu.edu	EB II, Room 3280
Sid Sheth, TA	N/A	N/A	ssheth4@ncsu.edu	EB II, Room 3233

Office Hours

I hold office hours directly after class. For in-person classes, I will find a location near the classroom, which may or may not be my office. I will announce the precise location in class. For online or hybrid classes, I will have office hours in my office (also after class) simultaneously in-person and on Zoom. There will be a slight delay between the end of class and the start of the zoom session to account for travel time.

Note: I'm in EB2 in room 3280. If you haven't been there before, it can be a little tricky to find. The easiest way to get there is to enter the main CSC department through the glass door at the top of the atrium stairs (on the CSC side. the other side is ECE). Then, take the first left. That's the hall with my office.

Preferred Method of Communication & Response Time

- **Preferred method of communication:** The preferred method of communication for the course is through Piazza.
- **Last Resort:** If you need to contact me directly, my preferred method of communication is email. You can expect to receive a response within two business days (i.e. not over the weekend).
- **Email guidelines:** First, ask yourself if this question could possibly be answered by a TA or if the answer could possibly be of interest to other students in the class. If so, use Piazza.

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Course Information

Course Website: NC State WolfWare

Meeting Time and Location:

MW 10:15-11:30
EB 3, Room 2207

Course Credit Hours: **3**

Catalog Description

Basic concepts of graph theory. Trees and forests. Vector spaces associated with a graph. Representation of graphs by binary matrices and list structures. Traversability. Connectivity. Matchings and assignment problems. Planar graphs. Colorability. Directed graphs. Applications of graph theory with emphasis on organizing problems in a form suitable for computer solution.

Structure

The course will be flipped. This means that students will be expected do readings and watch lecture videos outside of class. In class, we will work through problems, practicing collaborative problem solving.

Prerequisites/Corequisites

CSC 226 or MA 351

Minimum Technical and Digital Information Literacy Skills

Basic computer literacy including the ability to navigate and use web-based tools is assumed.

General Education Program (GEP) Information

GEP Category Fulfilled

None.

GEP Corequisites

None.

Learning Outcomes

By the end of the course, students will be able to:

1. Use the vocabulary of graph theory to describe a range of natural problems.

2. Model newly encountered questions as graphs problems.

3. Identify the differences between the combinatorial, geometric, topological, computational, and algebraic of graph theory in general as well as specific graph questions.

4. Work in a group to solve problems.

Course Materials

Required textbook

The textbook for the course will be provided in digital format by the instructor. The book is:

Graph Theory Across Categories by Don Sheehy

Other required materials

Other readings will be supplied via the course website.

Technology Requirements

NC State University Libraries offers Technology Lending, where many devices are available to borrow for a 7-day period. Computer labs are available in various locations around campus for student use.

Computer

A computer is [required/recommended] for students taking this course. NC State's Online and Distance Education provides technology requirements and recommendations for computer hardware, and NC State's Office of Information Technology provides recommendations for your computer at NC State.

Other devices

No other peripheral tools will be needed for the course.

Software and digitally-hosted course components

The following software and tools may be used in this course. Some tools are a part of NC State's enterprise tools. See information about their purpose, how to access them, accessibility information, and privacy policies. The same information for any other tools required in this course is provided in the list below.

- **Youtube**. The lectures will be viewed outside of class. They are available as a playlist at http://go.ncsu.edu/graphtheoryPiazza. Our main communication system will be Piazza. This is the best place to ask questions and get quick answers.
- **Moodle**. Moodle will be used for three purposes. (1) Broadcast announcements to the whole class from the instructors. (2) Grade reporting. (3) Distribution of class documents including policies, homework assignments, and other readings.
- **Gradescope**. We will accept and return homework via Gradescope.

- **Perusall**. We will use Perusall to access and interact with the textbook..
- **Zoom**. Office hours may be conducted via Zoom. If for some reason, we are unable to meet in person for a class session, the lecture will be conducted over Zoom. In such cases, I will announce it over Moodle. We will have a single Zoom link for all meetings related to the class.
- **LaTeX**. You will be expected to typeset your homework with LaTeX. This is a standard skill that all computer scientists should be able to pick up on their own. Overleaf is recommended for beginners to get started. The internet is full of tutorials to help you and the homework assignments themselves will give you some good examples if this is new for you.

Other Student Expenses

- None.

Communication Guidelines

Respecting our learning community

The NC State Code of Student Conduct outlines expectations for behavior in the classroom (whether virtual or physical) and the consequences for students who violate these expectations. Any behavior that impacts other students' ability to learn and succeed will be addressed, but expressing diverse viewpoints and interpretations of course content is welcome.

Community guidelines for this course include:

- Use a respectful tone in all forms of communication (email, written, oral, visual)
- Maintain professionalism (avoid slang, poor grammar, etc.) in your written communication.
- Respect regional dialects and culturally embedded ways of oral communication.
- Stay home or in your dorm room if you are exhibiting symptoms of a contagious illness (fever, chills, etc.).
- Enter our virtual and/or physical classroom community respectfully by refraining from lewd or indecent speech or behavior, helping to maintain a safe physical environment, not using your cell phone for voice or text communication except when explicitly given leave to do so, and not attending class under the influence of any substance.
- Treat each community member with respect by not recording others without their consent or engaging in any form of hazing, harassment, intimidation, or abuse.
- Respect cultural differences that may influence communication styles and needs.

Plan for interaction between instructors and students

For most communications, office hours or the course Piazza page is the best place to post questions and get timely replies. Piazza allows you to send messages that are only visible to the teaching staff. Email should be a last resort. Please allow at least two business day (i.e. not over the weekend) for a reply to any email query.

Expectations for learner participation and interaction

Some course activities will require you to interact with other students in the course. This is especially the case for in-class exercises. It is a major part of your learning experience to be able to communicate your knowledge. If there is a group exercise, these are not optional. If you refuse to participate in these activities, you may be asked to leave.

Grading and Feedback

Grading criteria, details, and timing of feedback

Percentage of grade	Component	Details and timing of feedback
12 %	Perusall	• You will need to do the reading and have some interaction on Perusall.
18 %	Small Assessments	• These will be very short multiple choice question sets to ensure that you did the reading and watched the lectures. I will strive to have 7-11 of these, counting only the top 6 scores at 3 points each.
40 %	Homework	• There will be seven quizzes throughout the course and you will have two opportunities to take each quiz. The highest grade you earn on each quiz will count towards the overall grade. • *You will receive a grade immediately after submitting each quiz.**
30 %	Final Exam	• The Exam is Cumulative • You must complete it on your own.

*modifications to the timing of grades/feedback, if required, will be announced via email.

Grading scale

This course uses this grading scale:

Low	Letter	High
97 ≤	A+	≤ 100
93 ≤	A	< 97
90 ≤	A-	< 93
87 ≤	B+	< 90

83 ≤	B	< 87
80 ≤	B-	< 83
77 ≤	C+	< 80
73 ≤	C	< 77
70 ≤	C-	< 73
67 ≤	D+	< 70
63 ≤	D	< 67
60 ≤	D-	< 63
0 ≤	F	< 60

Requirements for earning a grade of “Satisfactory”

If you are taking this course for credit only (S/U), your grade will be reported as S (Satisfactory) when coursework is equivalent to a C- or better or U (Unsatisfactory) when coursework is equivalent to less than a C-. For more information, see the Credit Only Courses regulation.

Requirements and procedures for auditing this course

Auditing this course is approved on a case-by-case basis. Please contact the course instructor to attain approval. Refer to the Audit regulation for more information and links to required forms.

Course Schedule

Please note: the course schedule is subject to change, but should be relatively stable. The number correspond to week numbers and

1: **Foundation of Set Theory** Jan 8, 10

HW 0: Sets, Due Friday, Jan 12

2: **Graphs and Invariants** Jan 15,17

3: **Coloring and Connectivity** Jan 22, 24

4: **Graph Search, Trees, and Euler Tours** Jan 29, 31

HW 1: Graphs, Due Friday, Feb 2

5: **Topology and Embeddings** Feb 5, 7

6: **Jordan Curve and Euler's Formula** Feb 12, 14

7: **Duality and Crossing** Feb 19, 21

HW 2: Topology, Due Friday, Feb 23

8: **Simplicial Complexes and Fary's Theorem** Feb 26, 28

9: **Contractions and Minors** March 4,6

Spring Break March 11-15

10: **Kuratowski and Wagner March** 18, 20

HW 3: Simplicial Complexes, Due Friday,

11: **Linear Algebra of Graphs** March 25, 27

12: **Laplacians and Matrix Invariants** April 1, 3

13: **Spectral Embeddings and Tutte Embedding** April 8, 10

HW 4: Linear Algebra, Due Friday, April 12

14: **Maxwell-Cremona and Steinitz** April 15, 17, 22

Take Home Final (Cumulative) Exam: Due Friday April 26

Course Policies

Proctored exams

None.

Late assignments and Homework Policies

There are 6 units in the course. There are 5 homeworks, one per unit with the last unit pushed to the final exam. The lowest homework score will be dropped. You may submit the homework late at a penalty of 3 points per day. Assignments submitted more than 14 days past the due date will not be accepted. **Please, do not ask for an extension.** If you want to go over the solutions, you may have to come to office hours. You may submit homework with a group of at most 4 people. This does not apply to the final exam.

Incomplete grades, withdrawals

Information on incomplete grades can be found at REG 02.50.03 – Grades and Grade Point Average. If you encounter a serious disruption to your work not caused by you and you would have otherwise successfully completed the course, contact your instructor as soon as you can to discuss the possibility of earning an incomplete in the course for the semester, including an agreement on when the remaining work must be done in order to change the grade to the appropriate letter grade.

If you must withdraw from a course or from the University due to hardship beyond their control, see Withdrawal Process and Timeline | Student Services Center for information and instructions.

Attendance

Attendance is required. I know this is difficult as there are often reasons that keep us from being able to attend. I will not be actively taking attendance, but the point is, you should plan to attend. The class is sufficiently interactive that I will know if you are regularly absent.

If you need to miss class, there is no need to contact the instructor and get permission. If you want to know what was missed, you can be confident that we covered the material from the book in the sections indicated on the course website.

Related NC State Policy: REG 02.20.03 – Attendance Regulations

University Policies

Academic integrity and honesty

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct 11.35.01 sections 8 and 9. Therefore, students are required to uphold the Pack Pledge: "I have neither given nor received unauthorized aid on this test or assignment." Violations of academic integrity will be handled in accordance with the Student Discipline Procedures.

Please refer to the Academic Integrity web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Student privacy

Originality Checking Software

- [x] Software may be used in this course to detect the originality of student submissions.
- [ ] Software is not used in this course to detect the originality of student submissions.

Class recording statement:

- [x] In-class sessions are recorded in such a way that might also record students in this course. These recordings will NOT be used beyond the current semester or in any other setting outside of the course.
- [ ] In-class sessions are recorded in such a way that might also record students in this course. These recordings MAY be used beyond the current semester or in any other setting outside of the course. Contact your instructor if you have concerns.
- [ ] Students will not be able to be identified in any course recordings, or the course will not be recorded at all.

Class privacy statement:

- [x] This course requires online exchanges among students and the instructor, but NOT with persons outside the course. Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework.

All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

- ☐ Student information in this course may be accessible to persons beyond the instructor and students in the course. This course may involve electronic sharing or posting of personally identifiable student work or other information with persons not taking or administering the course. Students will be asked to sign a consent form allowing disclosure of their personally identifiable work. No student must sign the consent form as a condition of taking the course. If a student wants to avoid signing the consent form, he or she has the right to ask the instructor for an alternative, private means of completing the coursework.

Other Policies

Students are responsible for reviewing the NC State University PRR's which pertain to their course rights and responsibilities:

- Equal Opportunity and Non-Discrimination Policy Statement and additional references
- Code of Student Conduct
- Grades and Grade Point Average
- Credit-Only Courses
- Audits

Student Resources

Academic and Student Affairs maintains a website with links for student support on campus, including academic support, community support, health and wellness, financial hardship or insecurity, and more. Find Help on Campus.

Disability resources

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office (DRO). For more information on NC State's policy on working with students with disabilities, please see the Policies, Rules and Regulations page maintained by the DRO and REG 02.20.01 Academic Accommodations for Students with Disabilities.

Safe at NC State

At NC State, we take the health and safety of students, faculty and staff seriously. The Office for Institutional Equity and Diversity supports the university community by providing services and resources to support and guide individuals in obtaining the help they need. See the Safe at NC State webpage for resources.

Supporting Fellow Students in Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remain a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose

personal behavior concerns or worries you, either for the classmate's well-being or yours. If you feel this way, I would encourage you to report this behavior to the NC State CARES website. Although you can report anonymously, it is preferred that you share your contact information so they can follow up with you personally.

Course Evaluations

ClassEval is the end-of-semester survey for students to evaluate the instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students' responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full-semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8 am on the first day of finals.

- Contact ClassEval Help Desk: classeval@ncsu.edu
- ClassEval website
- More information about ClassEval

Syllabus Modification Statement

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order in which we will cover them. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction.