CSCI-4260/MATH-4150: Graph Theory

`https://www.cs.rpi.edu/~slotag/classes/SP26t/index.html`

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Office Hours: Monday/Thursday 2-3pm in 317 Lally and by appointment
`https://rensselaer.webex.com/meet/slotag`

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Mentor: Anthony Fabius
Office Hours: Tuesday 1-3pm in AE 118

Class Hours: 10-11:50pm Monday/Thursday in LOW 3051

1 Course Description

This course discusses fundamental concepts of Graph Theory and its applications in computer, social, and natural sciences. The topics include: graphs as models; representation of graphs; trees; universal trees; distances; matchings; connectivity; flows in networks; colorings; cycles; planarity; and other computational problems and algorithms. Concepts and methods will be presented through proofs, exercises, and applications.

1.1 Prerequisites

Students should have taken a course in discrete mathematics, such as CSCI-2200 Foundations of Compute Science or MATH-4090 Foundation of Analysis. Additionally, although not formally required, it's useful for students should have moderate programming experience to best understand the coding-based application demonstrations and algorithmic discussion. Students will not be required to write their own code, although knowledge and understanding of algorithms, complexity, and basic data structures is **very useful**.

1.2 Course Resources

The course textbook is *Introduction to Graph Theory - 2nd Edition* by Douglas B. West. The textbook can be found at the student bookstore or online through Amazon/Ebay/"etc". Course notes, code, and additional resources will be available through the course website.

While it isn't *absolutely necessary* to acquire the book to succeed in the course, it is still *highly recommended*. The additional discussions, proofs, examples, and problems in the book are a very worthwhile supplement to what is covered in class. Any other introductory graph theory is likely to cover similar material and would be useful for these same reasons.

2 Course Schedule

Classes will meet every Monday and Thursday at 10am up through April 27th. There will be no class on January 19th or February 16th. There will be class on February 17th. Spring Break is March 2nd–5th.

For an up-to-date schedule with class notes and content, check the website.

3 Coursework and Grading Policies

Exam policy: There will be one in-class midterm exam worth 20% of the course grade (**February 26th**) and a final worth 30% of the course grade (during finals week). **Exams will be closed notes, closed book, and closed neighbor**. There will be no makeups for exams unless there is either a verifiable excuse or a prior arrangement is made with the instructor. Students who know they are going to miss a test *must notify me at least a week in advance*. Special circumstances can be accommodated *only if I am notified about them in advance*. For students who miss the midterm and do not notify me in advance, the final exam will be worth 50% of their final grade. Any questions about scores or grading must be discussed ASAP with the instructor, especially before final grades are posted.

Homework policy: Homeworks will comprise 40% of the course grade. There will be approximately 7 homeworks throughout the semester, on a weekly to bi-weekly basis. Working together on homeworks is allowed, so you can discuss general approaches, proof techniques, etc. However, you can't just copy+paste each others' work. You need to complete everything on your own.

Weekly Problems: WPs will comprise 10% of the course grade. There will be approximately 12-13 WP assignments throughout the semester, on an approximate weekly basis. WPs will be open book and open classmate – consider them as practice of the week's material – **but you must still complete all problems on your own**. WPs will be released before Thursday classes, where there will usually be time in class to work on them and ask questions. They will generally be collected by Midnight on the Thursday they are assigned and discussed.

Late Submission Policy: You will have 7 late days total to use for homework and WP submissions (max two late days per assignment). No other late submissions will be accepted outside of extenuating and formally-approved circumstances. Homeworks and WPs will be collected in Submitty for the entire duration of the course. Generally, no explicit makeup

assignments will be given.

AI/LLM Policy: In the sake of fairness and equity, you are free to use AI tools to assist with your assignments. However, as mentioned above, you should still work through and understand the problem solutions on your own. Simply copy+pasting a solution is considered an academic integrity violation. Fully understanding the proofs in the homeworks will go a very long way towards preparing you for the exams.

Grade Modifiers Policy: Grade modifiers will be used in this class. You can expect to earn a B- if your score is greater than 79.5 and less than 83, B if your score is greater than 83 and less than 86, B+ if your score is greater than 86 and less than 89.5. The similar modifier points occur for the A, C and D ranges except that there is no A+ nor D- under the RPI Grade Modifier Policy. **Requests for grade changes will be ignored, unless there was an identifiable error by the grader**.

Curve Policy: Curves will be applied to exam and final grades up to the discretion of the instructor. I usually just use a flat point adjustment to change the arithmetic mean grade. This means that you can't rely on a big ol' curve to boost up your grade if you're in the tail of the distribution; but if you do all the work and put in time studying, you'll probably do quite well. This course isn't intended to be exceptionally difficult overall, though the exams **are** intended to be challenging enough to actually test your understanding of the material.

Grading Methodology: Grading of graph theoretic proofs is generally difficult, due to the number of ways a graph property or statement can be proven. In lieu of graders looking for specific statements or approaches, a more general methodology will be used for grading the proofs in this class. Most proofs will be worth 4 points, with the following rubric.

- **4 pts:** The proof is fully correct. No identifiable logical gaps, incorrect statements, or other inconsistencies.
- **3 pts:** The proof is nearly correct, but has at most 1 minor flaw, logical gap, inconsistency, etc.
- **2 pts:** The general approach of the proof is correct, but has several flaws, is not complete, or has some substantial error. If you are an average student, you can expect most of your proofs on exams to be awarded 2 pts.
- **1 pt:** There is at least one correct statement in some attempted proof. Generally, it is worth it to at least attempt a proof on an exam or homework, since some attempt will likely earn you at least 1 pt.
- **0 pts:** There is little to no effort made for the proof. There are no correct statements or other redeeming qualities.

Expected Amount of Work: WPs are given most weeks and usually include 1 substantial proof or several shorter-answer questions. Homeworks are assigned bi-weekly and will usually

include 10 problems of varying difficulty. Exams generally also have 10 problems of a similar level of varying difficulty, as well. Overall, you can expect to solve about 100 graph theoretic problems throughout the semester. Some will be quite trivial and some will be very hard. From opinions of prior students, the workload is at or just slightly above average compared to other CS/MATH 4000-level classes, but nowhere near Data Structures or most 2000-level CS classes.

4 Academic Integrity

Collaboration is fully allowed for WPs, partially allowed for homeworks, but is completely forbidden for exams. For WPs and homeworks, you are still **required to complete every problem on your own**. You can't just share and copy answers or copy and paste from an LLM, but you can gather ideas and approaches from various sources and use that to construct your own solution. This means that turning in an identical copy of your classmate's of LLM's work or otherwise misrepresenting another's work as your own will be considered an academic integrity violation. Don't be lazy.

The evaluation of student performance is a service provided by Rensselaer. Attempts to undermine this service lower Rensselaer's reputation. Therefore, it is essential that academic honesty be preserved. Students who violate the spirit or letter of these rules are subject to penalties according to the principles outlined in the Rensselaer Handbook of Student Rights and Responsibilities:

`https://rpi.app.box.com/file/1632872852550?s=p1b39vybm914b5cao4csrgl84bfrrh2l`

In this class, first-time violations to the above policies will result in a zero on the homework/quiz/exam with which the violation occurred. Any subsequent violations will result in failure of the course. These punishments are up to the discretion of the instructor, but, generally speaking, I probably won't be particularly forgiving for egregious violations.

5 Policies for a Healthy Learning Environment

We are all different. The instructor will do his best to create an open and welcoming learning environment for all students. In this class, there is a zero-tolerance policy for harassment, bullying, racism, sexism, or any other behaviors that negatively harm this open and welcoming environment. The instructor reserves the right to immediately fail you, remove the course from your registration, banish you from the class forever, and refer you to the school for further disciplinary action should you violate this policy.

6 Disability Service for Students

Please contact me as soon as possible if you require any accommodations for the course.

7 Learning Outcomes

At the end of this course, you will:

- understand some of the main topics and results in basic Graph Theory
- gain problem solving skills and proof techniques for problems on graphs
- have learned several graph applications and algorithms
- recognize that everything is a graph – yes, even you