

Math {3,6}47 — Graph Theory

Instructor Greg Warrington
Office West 338
Phone 336.758.3759
Email warrings@wfu.edu
Web page www.wfu.edu/~warrings/math347
Office hours MWF 2-3; T 2-4; F 12-1 (tentative)

OVERVIEW: Graph theory is applicable whenever you have objects and relationships between certain pairs of those objects. (Which is, of course, everywhere.) The abstractness of mathematical graphs allow one to unify such disparate things as the web, bus routes, chemical molecules, and course scheduling. This introductory course will survey various types and properties of graphs and explore some recurring questions that can be asked about graphs.

While there are an incredible number of applications of graphs, our primary aim will be to rigorously explore the abstract properties of graphs.

PREREQUISITES: There are no formal prerequisites for this course. Familiarity with set notation (e.g., $A \cup B$ or $A \setminus \{a\}$), matrices, and basic combinatorial identities (e.g., “the number of ways of choosing two jelly beans at random from a pile of ten identical beans is $(10 \cdot 9)/2 = 45$ ”), will be useful. However, they will be utilized at a slow enough pace that any gaps can be filled in as the course progresses.

More important is some familiarity with the notion of a rigorous proof and, in particular, the principle of mathematical induction. Hopefully, this course will develop the student’s ability to analyze and create proofs.

TEXT: *A First Look at Graph Theory*, Clark & Holton, 1991. The ISBN for the paperback version is 981-02-0490-6.

TOPICS: We will be covering the first nine chapters of the text. We will make minor adjustments as the semester progresses. The chapters are as follows:

- (1) *An Introduction to Graphs:* Basic terminology
- (2) *Trees and Connectivity:* Questions relating to those graphs for which there is at most one way of getting from point to another. Trees arise when, for example, determining where electrical wires should be strung to connect towns while minimizing the amount of wire used.
- (3) *Euler Tours and Hamiltonian Cycles:* When can you find a route for a postal worker that avoids backtracking?
- (4) *Matchings:* When can you assign all students to their first choice first year seminar?
- (5) *Planar graphs:* A class of graphs that can be drawn easily on a piece of paper. They arise, for instance, in studying maps.

- (6) *Colouring*: Two examples of coloring problems are 1) coloring the states on a map of the US so that now two adjacent states share the same color 2) scheduling final exams so that no student has two exams scheduled at the same time.
- (7) *Directed graphs*: Sometimes the “relationships” between the objects being studied only go in one direction. For example, a graph whose “objects” are intersections, and whose “relationships” are one-way streets is a directed graph.
- (8) *Networks*: Remember that big power outage last August....
- (9) *Ramsey Theory*: No matter how random something is, if it’s big enough, there will be little pockets of it that look very ordered. So, if you want to find a pocket of order of a specific form, how big is “big enough”?

ORGANIZATION: A sizable portion of the class time will consist of discussions. I will try to minimize the amount of time I am standing up at the board lecturing.

GRADING: I have listed below a numerical breakdown of how the grades will be determined. I will try to give you updates throughout the semester so that you know where you stand in terms of letter grades. But if you have questions at any point about any aspect of your grade, please talk to me. The midterms and final will probably both have in-class and take-home portions.

- 35% — Participation & homework. There will be weekly homework assignments. I will also expect you to present solutions to some of the homework problems and examples relating to issues we have discussed in class.
- 20% — Midterm 1.
- 20% — Midterm 2.
- 25% — Final.

HOMEWORK ASSIGNMENTS:

- (1) Assignments should 1) be stapled 2) have your name on them 3) be legible. A good proof is not only logically correct, but also convincing. Failure to follow these guidelines will result in points being taken off.
- (2) Late assignments will only be accepted for good reasons (e.g. — family emergencies, serious illness). If you know you are going to be absent ahead of time, you should discuss this with me.
- (3) You are welcome to work in groups on any of the homework assignments. However, you must hand in your own written work. It is not necessary to list your collaborators if they are members of the class. You must reference any books you utilize in completing the assignments.