Math 311 Graph Theory

Instructor - Garth Isaak

Lehigh University - Spring 2011 Office hours: By appointment

email, phone, office: gisaak@lehigh.edu; 610-758-3754; Christmas-Saucon 331

Class meets Tuesday, Thursday 1:10 - 2:25 in Christmas-Saucon 203

Text: Graphs and Digraphs 5th edition, by Gary Chartrand, Linda Lesniak and Ping Zhang Content: We will cover basic concepts in graph theory including matching, coloring, connectivity, Hamiltonicity and planar graphs. See the weekly description below for a more detailed description of topics to be covered.

Disabilities and Academic Integrity statements: Please see attached sheet.

Homework: There will be two types of homework problems. Each week there will be a half dozen to a dozen 'routine' problems. These typically will be computational or problems with relatively short answers illustrating basic concepts. In addition there will be four to six problems to turn in. Written solutions will be graded on correctness as well as writing style.

I will compile solutions to the 'routine' problems as well as the written homeworks. Each week you will be assigned one or two of the routine problems to write solutions for. These solutions must first be cleared with me. I will then make these available to the class. You may also be asked to give a short presentation of the solution to the class on your solutions. You should attempt the routine problems yourself before getting the solutions.

Homeworks and solutions to routine problems must be typed. We will discuss various options for typesetting mathematical notation in class. However, in order to compile to solutions you must use the mathematical typesetting system Tex as a basis. Late homework will be penalized or not accepted.

You are encouraged to discuss the ideas for the solutions of homeworks. However, the final written product must be your own. It is sometimes hard to find the line between copying and discussing. One basic rule: you can (and should) talk about homeworks and the ideas behind what you need to do. However, you should never share written solutions. It is easier than you think to notice writing that is essentially the same in homework solutions. Please see the academic integrity statement for more details.

Exams: There will be two in class exams and a comprehensive final exam. The in class exams are tentatively scheduled for Tuesday February 22 and Tuesday April 5. The final exam will be scheduled by the registrar.

Large portions of the exams will be problems similar or identical to homework problems or be based on theorems identified as ones you should know how to prove.

Grading: Your grade will be based on the best of:

- (a) exams 25% each, homework 25%.
- (b) in class exams 20% each, final exam 40%, homeworks 20%.
- (c) exams 20% each, homework 40%.

Participation will be used in borderline cases.

Math 311 - Graph Theory - Lehigh University Spring 2011

Accommodations for Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center 212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

Academic Integrity:

Students are expected to follow academic integrity policies of the university. Please the web link http://www.lehigh.edu/%7Eindost/conduct/aiforstudents.html for information and details. Basically this means that for exams you work on your own with no extra resources unless instructed otherwise.

The following is taken from the university handbook portion on academic integrity:

Lehigh University is a community that has expectations of its student members. These expectations and a list of non-inclusive examples of behavior that might breach these expectations are below.

Lehigh University expects that all students will act in a manner that reflects personal and intellectual honesty.

Proscribed Conduct

A. Cheating. This includes but is not limited to:

1. The use of any unauthorized assistance in taking quizzes, tests, or examinations.

i. The possession at any quiz or examination of any articles which are prohibited will be regarded as evidence of responsibility.

2. The dependence upon the aid of sources beyond those authorized by the instructor in writing papers, preparing reports or homework, solving problems, or carrying out other assignments.

3. The acquisition, without permission, of tests or other academic material belonging to a member of the university faculty or staff.

4. Any attempt to falsify an assigned grade in an examination, quiz, report, program, grade book, or any other record or document.

5. The creation and/or submission of falsified data in any experiment, research paper, laboratory assignment, or other assignment.

6. Collusion occurs when students willfully give or receive unauthorized or unacknowledged assistance. Both parties to the collusion are considered responsible.

B. Plagiarism. This includes but is not limited to:

1. The direct use or paraphrase, of the work, themes or ideas, of another person without full and clear acknowledgement.

2. Submitting the work of another as your own in any assignment (including papers, tests, labs, homework, computer assignments, or any other work that is evaluated by the instructor).

Math 311 - Graph Theory - Lehigh University Spring 2011

Other references:

There are many good graph theory texts at more or less the level of this course. The first two are freely available on the web. The other three are ones that I have found particularly well written. The second and third are a bit old.

Graph Theory, Reinhard Diestel Graph Theory with Applications, JA Bondy and USR Murty Algorithmic Graph Theory, Alan Gibbons Graph Theory, JA Bondy and USR Murty Introduction to Graph Theory, Douglas B. West

Course outline:

There are 14 weeks in the semester. Allowing 2 weeks for reviews and exams that leaves 12 weeks. The following is a list of 12 'topics'. We will spend approximately a week on each. If we do not have enough time some of the topics within the weeks may be omitted.

Week 1: Motivating examples and basic definitions: basic definitions; (some) graph classes; isomorphism; reconstruction; ideas of computational complexity.

Week 2: Degrees: degree lists for graphs, bipartite graphs, multigraphs, digraphs, trees, tournaments; edge switches; Havel-Hakimi reductions.

Week 3: Matchings and factors: bipartite matching including Konig's theorems and Ore's bipartite factor theorem, Tutte-Berge formula; augmenting paths.

Week 4: Trees and arborescences: tree characterizations, counting trees, minimum spanning trees.

Week 5: Connectivity and strong connectivity: shortest paths; strong orientations; kings in tournaments; blocks.

Week 6: Packing and coverings: Theorems of Gallai-Milgram, Gallai-Roy, Dilworth, Edmonds (branching); longest paths in acyclic digraphs.

Week 7: Network flows: Menger's Theorem and max flow-min cut theorem; circulations; proofs of other results using flows.

Week 8: Eulerian and Hamiltonian graphs: matrix tree theorem; Chinese postman problem; sufficient conditions and necessary conditions for Hamiltonicity; conditions for graph classes.

Week 9: Vertex coloring: basic bounds, Brook's Theorem; perfect graphs, greedy coloring.

Week 10: Edge coloring: Vizing's theorem; factorizations; stable matching and list edge coloring.

Week 11: Extremal graphs: Turan's Theorem, Ramsey Theory.

Week 12: Planar graphs: Euler's formula and edge bounds, characterizations; planar duals; 4 and 5 color theorems; 5 perfect solids