Syllabus for MAT 416/513—Introduction to Graph Theory

0. Instructors:

Professor: Hal Kierstead, 649 GWC, kierstead@asu.edu
Office hours: T,Th 2:45-4:15 starting outside the classroom, then moving to GWC649, and by appointment.
TA: Luke Nelson lenelson@asu.edu
Office hours: T 11:30-12:30 and Th 10:30-12:30, 2-4:00 WXLR 303;
T 3-4 MVHAL A125 and Th 3-4 PSH 131.

Final exam: Thursday, May 5, 2016 12:10 PM to 2:00 PM

1. Course Description

MAT 416 is an undergraduate level (MAT 598 is a graduate level) introduction to graph theory. While no background in graph theory is required, students should have the theorem proving skills of a strong MAT 300 student (strong mathematics BS for MAT 598). A collection of central theorems and their proofs will be presented (see item 4). Proof techniques will be emphasized, and students will be expected to know proofs of all the central theorems, as well as to be able to use these theorems and the proof techniques to prove new theorems. The instructor will lecture on theorems from the textbook, emphasizing the strategies for their proofs, often presenting alternative proofs, and discussing how these are used to build a theory. An important aspect of the lectures is the exposure of students to open questions of current interest by instructors who are active in graph theoretical research.

2. Student Learning Outcomes

Upon successful completion of this course:

- MAT 416 students will be prepared to start graduate study in graph theory, while MAT 598 students will be prepared to undertake advanced study in graph theory aimed toward original research and a Ph.D.
- Students not specializing in graph theory will nevertheless be prepared to follow applications of graph theory to other disciplines—especially in computer science and operations research, but also in social science and mathematical biology.
- Students will know a core of some 25 basic theorems and be able to present proofs of these theorems.
- Students will have a solid overview of the questions addressed by graph theory and will have been exposed to current areas of research.
- MAT 598 students will be prepared to teach an undergraduate graph theory course.

3. List of Assignments

Regular homework assignments will be given every two weeks. Each assignment will contain about eight problems that will be specified in class. These problems will require students to write carefully reasoned proofs, each consisting of approximately one page of mathematical text—not just calculation.

4. Grading

Coursework consists of homework, two midterms and a final. The most important indicator of achievement is the grade on the final at the end of the course. In order to master the material it is essential that the students do the homework, but the homework will not be graded competitively. Rather students will be encouraged to work with each and go to the instructor for help in designing their proof strategies. Their homework will be evaluated. Midterms will be designed to reflect the final examination, but on a limited syllabus. Problems on the final will consist of three types: (1) proofs of basic theorems, (2) homework problems, and (3) new problems. Approximately 50% of the grade will come from the final exam, and 25% will come from each midterm. However, for students who show continued improvement the final may be weighted more heavily.

5. Required Readings
Optional, but highly recommended, text: D. West, Introduction to Graph Theory (latest edition): http://www.amazon.com/Introduction-Graph-Theory-2nd-Edition/dp/0130144002
Supplementary text: R. Diestel, Graph Theory (Fourth or latest edition):
http://diestel-graph-theory.com/index.html

6. Weekly schedule

Week	Topic
1/12 1/14	Graphs, multigraphs, directed graphs (N1.1). Induction (N1.2). Ramsey's Theorem (N1.3),
1/29 1/21	Graph isomorphisim (N1.4), special graphs, decomposition (N1.5). Connection (N1.6), Characterizing bipartite graphs (N1.7). HW 1: 1–9; due 1/28.
1/26 1/28	Hamiltonian cycles: Dirac's Theorem (N1.8). Eulerian circuits: characterization of Eulerian graphs (N1.9).
2/2 2/4	Cut-vertices, -edges. Trees: equivalent conditions for trees, and and related results (N2). Homework 2:10-20; due 2/11.
2/9 2/11	Max-flow, Min-Cut theorem (N3.1): Berge's theorem (N3.2). Bipartite matching (N3.3): Konig-Egervary theorem, Hall's theorem, and König's corollary. Homework 3: 21–33; due 2/23.
2/16 2/18	General matchings (N3.4): Tutte's theorem, Berge-Tutte formula; Petersen's 1-factor theorem, Petersen's 2-factor theorem N(3.5).
2/23 2/25	N(3.6): Vertex and edge connectivity , Whitney's inequality, cubic graphs,... expansion lemma. (N3.7) 2- and 3-connected graphs: Whitney's theorem.

3/1, 3/3	Thomassen's 3-connectivity theorem. Homework 4: 34–44 ; due 3/24. Midterm in class on N(1.1-3.6).
3/15 3/17	Menger's theorems …
3/22 3/24	with applications. Vertex-coloring, chromatic number, constructions of Mycielski and Zykov,
3/29 3/31	Brooks' theorem. Turán's Theorem, Edge-coloring, chromatic index of bipartite graphs.
4/5 4/7	Vizing's Theorem. List coloring, Kernel lemma and Galvin's Theorem. Homework 5: 45–55; due 4/12.
4/12 4/14	Planar and plane graphs, Euler's Formula, Kuratowski's Theorem Kuratowski graphs; Preparation for Kuratowski's Theorem. Homework 6: 56,…,62; Due 4/19
4/19, 4/21	Kuratowski's theorem List coloring of planar graphs: Thomassen's Theorem, planar duals.
4/26, 4/28	Midterm 2 Lower bound for Ramsey's Theorem,
5/5 5/9	Final Exam: 12:10–2:00 Qualifier: 9:00-12:00

7. Academic Integrity
In the "Student Academic Integrity Policy" manual, ASU defines "'Plagiarism" [as] using another's words, ideas, materials or work without properly acknowledging and documenting the source. Students are responsible for knowing the rules governing the use of another's work or materials and for acknowledging and documenting the source appropriately." You can find this definition at: http://www.asu.edu/studentaffairs/studentlife/judicial/academic¡integrity.htm#definitions
Academic dishonesty, including inappropriate collaboration, will not be tolerated. There are severe sanctions for cheating, plagiarizing and any other form of dishonesty.

8. Disability Accommodations: Qualified students with disabilities who will require disability accommodations in this class are encouraged to make their requests to me at the beginning of the semester either during office hours or by appointment. **Note:** Prior to receiving disability accommodations, verification of eligibility from the Disability Resource Center (DRC) is required. Disability information is confidential.

Establishing Eligibility for Disability Accommodations: Students who feel they will need disability accommodations in this class but have not registered with the Disability Resource Center (DRC) should contact DRC immediately. Their office is located on the first floor of the Matthews Center Building. DRC staff can also be

reached at: 480-965-1234 (V), 480-965-9000 (TTY). For additional information, visit: www.asu.edu/studentaffairs/ed/drc. Their hours are 8:00 AM to 5:00 PM, Monday through Friday.