Syllabus for MA 637 – OV
Graph Theory and Combinatorics – Summer 2025
Instructor: Dr. Shannon Starr
Class Times: Tues, Thurs 10:20am – 12:20pm
Class Room: Heritage Hall Building, Room 221

Combinatorics may be viewed as that part of mathematics which can be done without resorting to infinite cardinals or infinitesimals. But calculus is sometimes used to simplify algebra. We will begin with a quick review of ZFC set theory, including (proof by) induction. Then we will discuss bijective enumeration. A good example will be counting labelled trees of n vertices: there are n-to-the-power-of-(n-2). We will also describe applications of combinatorics to theoretical probability.

In graph theory, a major goal will be the proof of Kuratowski's planarity theorem, which may be viewed as an elementary precursor to algebraic topology. In addition we will start with Veblen's theorem for closed Eulerian trails. We will demonstrate Hierholzer's algorithm using Python and Matlab to emphasize the concrete nature of the class. As another example, we will mention the Hamiltonian cycle problem, which is NP-complete.

Learning outcomes: You will learn the basics of computer algorithms as they pertain to graph theory and combinatorics. In addition:

1. Perform basic combinatorial calculations, such as those in probability theory.

2. Perform basic computations related to algorithms such as Hierholzer's algorithm for calculating Eulerian trails in graph theory.

3. Learn to use the Online Encyclopedia of Integer Sequences.

4. Understand basic graph theory arguments, such as Sperner's lemma and its corollary Brouwer's fixed point theorem.

5. Combinatorial problems arising in graph theory, such as Kirchoff's matrix-tree theorem.

4. Duality for planar graphs, including proving that there are only 5 Platonic solids: tetrahedron, cube, octahedron, dodecahedron and icosahedron.

5.Learn the Cauchy-Binet theorem for rectangular arrays, including the linear algebra corollary that the determinant is multiplicative.

6. Understand Kuratowski's planarity theorem.

Instructor email: slstarr@uab.edu

Typical responses are 24 hours later on weekdays.

Office hours: Monday and Wednesday 11-11:50am in University Hall 4008, and by appointment.
You may also attend via Zoom, on the Zoom link that I will put on the UAB canvas page, if you prefer that. During my office hours, I will have Zoom turned on. Priority will frequently be given to in-person students. But you make an appointment (for in-person or Zoom meeting) to insure a time.

Required textbook:

(1) *Free online lecture notes written by Dr. Peter ONeil, Professor Emeritus. Downloadable pdf files will be available on Canvas.*

Supplementary textbook:

(2) *Free online lecture notes written by Dr. Starr, available on Canvas*

Grades:

HW(40%) + GroupProjects(20%) + Quizzes(10%) + Midterm(10%) + Final(15%)

Homework: Approximately 5 homeworks assigned on Canvas. You turn in your solutions as files on Canvas. Late responses to HW will not be accepted, but the lowest 1 score will be dropped. Students in MA 560 will be assigned extra HW problems

Projects: There will be 3 group projects. You will work on the projects in groups of 1-to-4 students. The number of questions you answer will depend on how many people are in your group. These are either computer projects or mathematics questions that take more effort than typical homework problems.

Midterm: There will be 1 in-class midterm, later in the semester on the topics raised in HW assignments and projects. This is primarily to test that students all know the same material, since students are encouraged to work together on HW assignments.

Take-home final: This will be 15% of the grade. It will involve a shorter-than-usual project, as well as HW-style questions.

A = 88–100, B = 75–87, C = 62–74, D = 50–61.

There will be a group project or activity in this course. Please make sure to check the group project instructions page to locate your group and your group space in Canvas. In this group project activity, you will collaborate with other students to submit a report/video/ presentation. As a team, you will work together to break the project up into separate tasks and decide on the tasks or sub-tasks each member is responsible for. Be sure to leave enough time to put all the pieces together before the group assignment is due and to make sure nothing has been forgotten. At the end of the project, you will be required to fill out a group self-evaluation form to evaluate other team members contributions to the project. This peer evaluation score is worth 15% of yo ur group project grade.

Homework problems will be posted on Canvas

http://www.uab.edu/online/canvas

All other materials, such as class announcements, codes, grades, etc., will be posted in Canvas. (Students should log in to Canvas every day.) Homework assignments, projects and the take-home final will only be collected on Canvas.

By working steadily and regularly, you will increase your chances to succeed in this course!

UAB Policies and Resources

Misconduct

The University of Alabama at Birmingham expects all members of its academic community to function according to the highest ethical and professional standards. Students, faculty, and the administration of the institution must be involved to ensure this quality of academic conduct. Review the Academic Integrity Code linked below.

Academic misconduct undermines the purpose of education. Such behavior is a serious violation of the trust that must exist among faculty and students for a university to nurture intellectual growth and development. Academic dishonesty and misconduct includes, but is not limited to, acts of abetting, cheating, plagiarism, fabrication, and misrepresentation. Candidates are expected to honor the UAB Academic Honor Code as detailed in the most current UAB Student Catalog. Please consult this resource for additional

information regarding the specific procedures to be undertaken when a student violates the UAB Academic Honor Code.

https://www.uab.edu/one-stop/policies/academic-integrity-code

DSS Accessibility Statement

Accessible Learning: UAB is committed to providing an accessible learning experience for all students. If you are a student with a disability that qualifies under Americans with isabilities Act (ADA) and Section 504 of the Rehabilitation Act, and you require accommodations, please contact Disability Support Services for information on accommodations, registration and procedures. Requests for reasonable accommodations involve an interactive process and consist of a collaborative effort among the student, DSS, faculty and staff. If you are registered with Disability Support Services, please contact DSS to discuss accommodations that may be necessary in this course. If you have a disability but have not contacted Disability Support Services, please call

(205) 934-4205 (voice) (205) 934-4205 (TDD) (205) 934-8170 (Fax)

or consult their webpage

https://www.uab.edu/students/disability/

or visit their office located in Hill Student Center Suite 409, 1400 University Blvd., Birmingham, AL.

Non-harassment, Hostile Work/Class Environment

The UAB College of Arts and Sciences expects students to treat fellow students, their Course Instructors, other UAB faculty members and staff as adults and with respect. No form of hostile environment or harassment will be tolerated by any student or employee.

Course Netiquette

There are course expectations concerning etiquette on how we should treat each other online. It is very important that we consider the following values during online discussions and email: **respect**, **confidentiality**, **format** and **relevance**. Every person's opinion is valued. During online discussions, be sure to state opposing views diplomattically. Do not insult people or their ideas, nor use negative, inappropriate language. When discussing topics, be sure to be discreet about how you discuss children, teachers and colleages. Do not use names of people or facilities. When posting online messages use proper grammar, spelling and complete sentences. Avoid using all capitals (which signifies yelling). Avoid shortcuts and abbreviations such as "cu l8r." Instead say, " See you later." Think before you type. Keep posts relevant to the online discussion topic.