# Math 27 -- Combinatorics -- Spring 2022
# Syllabus and General Course Information

**Professor:** Noah Aydin **Office:** RBH 319 **Phone:** 5674 **E-mail**: aydinn@kenyon.edu
**Class Times**: TR: 1:10-2:30 pm **Classroom:** RBH 203
**Student Hours:** M & W 1:10-2pm; T,R & F 9:10-10 am and by appointment. In-person or over zoom
See my weekly schedule. Zoom Link for student hours.
**Class web page**: http://www2.kenyon.edu/depts/math/aydin/teach/227
**Textbook:** *An Invitation to Combinatorics* by S. Shahriari, Cambridge University Press, 2022, ISBN 9781108476546

**Course Description and Objectives**: This course introduces students to combinatorics, one of the active and important branches of modern mathematics. Combinatorics is concerned with the existence, enumeration, analysis, and optimization of discrete structures. It is an exciting, active, and applicable area of mathematics which blends the use of general principles with ad hoc arguments. Unlike many other areas of mathematics -- e.g., analysis, algebra, topology--the core of combinatorics is neither its subject matter nor a set of "fundamental" theorems. More than anything else, combinatorics is a collection of techniques, attitudes, and general principles for solving problems about discrete structures. This course will be an introduction to the techniques and methods of combinatorics. In the process of learning how to solve combinatorial problems, you will develop an appreciation for the fun, power, and the vast scope of this area of mathematics. Combinatorial techniques are useful in a broad range of fields including computer science, many other areas of mathematics, linguistics, engineering, natural and social sciences, biological sciences, and operations research.

The course will focus on problem solving. Active learning methods will be used throughout the semester. The main topics for the course are: (1) Induction and Recurrence Relations, (2) The Pigeonhole Principle and Ramsey Theory, (3) Permutations and Combinations, (4) Binomial coefficients, (5) Stirling Numbers, (6) Integer Partitions, (7) The Inclusion-Exclusion Principle, (8) Generating Functions, and (9) Graph Theory.

**Course Learning Goals**: Math 227 serves the general student learning goals of Mathematics department in the following ways.
1. Understand the mathematical derivations and appropriate uses of combinatorial counting techniques.
2. Recognize various types of distribution problems in pure and applied mathematics and solve problems related to them.
3. Derive recurrence relations and solve them by appropriate techniques.
4. Recognize basic graph concepts and features such as connectedness, trees, cycles, components, and isomorphism.
5. Apply graph-colorings to address combinatorial questions in graph-theoretic models.
6. Understand the vast utility of generating functions, and how their algebra relates to operations on sequences.
7. Employ criteria for existence problems, such as the pigeonhole principle, Ramsey property, and tests of connectedness in graphs.
8. Employ combinatorial techniques of optimization, such as finding the minimum number of monochromatic triangles in a graph.
9. Clearly write about combinatorial concepts, problems, and solutions.
10. Read combinatorial material with clarity, understanding, and persistence.

**Grading and Evaluation Criteria:**
Final grades will be determined based on the performance in the following components.

| Component | Percentage |
|---|---|
| Written Homework (weekly) | 20 |
| Daily Quizzes | 15 |
| Class Participation & Presentations (daily) | 10 |
| Mini midterm Project | 5 |
| Midterm Exam 1 | 10 |
| Midterm Exam 2 | 15 |
| Final Presentation | 10 |
| Final Paper | 15 |

**Class Format and Daily Reading.** This course will be based on the flipped classroom model. There will not be traditional lectures in class meetings. Instead, lectures will be delivered via recorded videos that accompany the textbook. For each class meeting, you will read one or two sections from the textbook and watch the accompanying video lecture(s) BEFORE the class. To encourage you to do the readings before class, there will be a short quiz at the beginning of each class based on the readings and the videos. Most of the quizzes will be on Moodle, so bringing a laptop to class is necessary. Most of the class time will be devoted to solving problems in groups and presentations and discussions of those

problems. The problems will be either from the textbook or given as handouts. Note that daily quizzes and participation are a significant part of the course grade.

One of the most important and useful skills that you can pick up in a math class is to learn how to *read a math book*. Reading math is difficult and, unlike some other types of reading, you have to constantly stop, think about the material, maybe write stuff on paper in order to figure things out for yourself, and, often, reread what you have already read to catch the subtle points. It is essential that you push yourself to read the text. While doing homework problems you may need to read the relevant material again in the text.

**Textbook Video Lectures:** For most of the material that we will cover, in addition to the text, there will be video-taped lectures covering the same material, and following the text closely. When watching the videos, you can slow down or speed up the pace, you can go back to re-watch confusing parts, and you can take breaks whenever you want to. As such, you may find learning from the videos "easier" than reading the text. However, you should not skip reading. Figure out what combination of reading and watching videos is most helpful for you.

**Written Homework Assignments:** The only way to learn mathematics is by doing problems. *The one who does the work does the learning.* Homework sets will be assigned weekly and will be due at the beginning of the class. The details are available on the course calendar page. You are encouraged to discuss problem concepts and solution techniques with your fellow students, but you need to write up solutions independently and what you submit as homework must be your own work. You are responsible to learn and follow Math Department's guidelines on collaboration on Homework. Homework solutions should be legible and presented in a logical fashion, with problem number clearly indicated. Messy work that is difficult to follow may receive no credit. You should often accompany your mathematical work with explanations and ideas written in complete sentences. Excellent performance on written homework is perhaps the most important indicator of success in this course. The payback from hours of hard work on homework assignments will be a deeper understanding of combinatorics and, ultimately, the likelihood of a high grade in the course.

**Exams and Papers:** There will be two midterm examinations. The first one is scheduled for Thu, February 24 (week 6), and will be in-class. The second exam will be a take-home and will be given in week 12. Instead of a final examination, there will be a final project with two components: a paper and a presentation. Every student in class will present their final project during the last week of class, and the final paper will be due at the official final exam time for this course, which is Monday, May 9 at 6:30 pm. More details, guidance, and a timeline on the final project are available on this page. Additionally, there will be a smaller writing project that will be assigned right after the spring break.

**Late and Make-up Policy:** All assignments must be turned in at the beginning of the class period on the assigned due date, unless specified otherwise by the instructor. No credit will be given to unexcused late papers. If you have a legitimate excuse, let me know as soon as you can. Normally, there will be no make-up for daily quizzes. Several low quiz scores will be dropped at the end of the semester. The only exception to this policy will be in situations in which all of the following conditions are met: i) the student has a legitimate excuse, ii) the student informs the instructor before the class, and iii) the student is able to take the quiz during the regular class time synchronously with the class. For the midterm exam, a make-up can only be given with a justified and documented excuse

**Attendance, Engagement and Tardiness:** Active participation in class activities as part of your group is critical for your success in this course. You should be FULLY engaged and committed for your own learning. Hence, coming to class every day is critical. Being late to the class is disruptive. After one unexcused absence, each unexcused absence will lower your overall course grade by (n-1)*1% where n is the number of unexcused absence. According to Math Dept's Class Attendance Policy, a total of 6 absences (whether excused or not) will result in expulsion from the course. Tardiness and walking out of the classroom are distracting for everyone. Unless there is a real emergency, please do not leave the classroom before the class is over. Two tardiness or leaving the room during the class will count as an unexcused absence.

**Academic Honesty:** The rules set forth in the 2021-2022 Course Catalog apply to all aspects of this course. Any work submitted for credit must result directly from your own understanding, thoughts, and ideas. Presenting the work of others as your own is strictly prohibited. You must follow the guidelines given in this document in general and Math Department's guidelines for written homework in particular. If you have any questions or uncertainty, please ask your professor for clarification.

**Inclusivity:** Demonstrating respect for each other is central to including all members of our class. While this respect can be shown in many ways, I highlight a few here.

- Students will be invited to share their names and pronouns in class, and it is expected that class members will use these self-disclosed identifiers.
- Because of life threatening allergies, we will refrain from eating and drinking in the classroom.
- During the group work, class discussions and presentations, we will be respectful in addressing other people and their work. Respectful and constructive criticism of work is essential to the learning process and growth.

*If you are facing an unsafe or hostile environment in our class in any way, please let me know as soon as is comfortably possible.*

**Accessibility Accommodations**: If you have a disability which requires an accommodations in this class, please feel free to discuss your concern with me, but you should also consult the student access and support services (sass@kenyon.edu, x5692). It is SASS that has the authority and expertise to decide on the accommodations that are proper for your disability. Though I am happy to help you in any way I can, I cannot grant any accommodations without a notification from SASS.

**Statement on Civil Rights and Title IX**

Kenyon College seeks to provide an environment that is free of bias, discrimination, and harassment. If you have experienced any form of harassment/misconduct/assault, interpersonal violence, or stalking we encourage you to report it. If you report the incident to a faculty member, they must notify Kenyon's Civil Rights & Title IX Coordinator and share the information you provided. More information can be found on the following College web pages:
Sexual Harassment & Misconduct Policy: www.kenyon.edu/directories/offices-services/title-ix/policy/
Discrimination & Discriminatory Harassment Policy: https://www.kenyon.edu/directories/offices-services/ocr/discrimination/
ADA/504 Student Grievance Procedures:
www.kenyon.edu/directories/offices-services/ocr/discrimination/504-ada-grievance/student-grievance-procedure-resolving-complaints-under-ada-section-504/

**COVID-19 Class Policies**

For the health and safety of all on campus, students studying in-person are required to know and follow Kenyon's COVID-19 policies and the local public health rules. Kenyon's policies include proper wearing of masks or facial coverings indoors. If a student fails to follow any of the college COVID-19 policies, they will not be permitted in the classroom nor allowed to engage in class activities, including office hours. Violations will be reported to college officials. If a student is unable to attend class due to illness, quarantine or other circumstances related to COVID-19, please contact the appropriate college officials. They will notify your instructors of any necessary accommodations. It is also necessary to let the professor know of your absence as soon as possible to discuss how to stay current with the course material and deadlines. The professor will work with the student to implement the accommodations requested by college officials. Since this class operates on a flipped-classroom model, accommodating students in isolation or quarantine will be relatively easier. If the instructor feels well enough to teach the class, but is exhibiting symptoms or is in quarantine or isolation, he will facilitate the course remotely. In this case, he will send instructions for joining the class via email.

**How to Study for this Class**

- Regular work and genuine engagement in the material are the most important aspects of deep learning in any math class.
- Read the assigned sections from textbook and watch the accompanying video, when there is one available, BEFORE the class. You may not understand everything in the first reading but that's OK. Do your best. Take notes to ask questions in class.
- Come to the class and actively participate in problem solving other class activities and discussions. Do not hesitate to ask and answer questions, or contribute to class discussions in other ways. Daily quizzes and presentation of problems in class are significant part of your grade.
- Start doing homework problems early. Do not wait until the last minute.
- Do homework problems regularly. Do a few problems every day instead of trying to do everything the last night.
- If you have any questions, some see Prof. Aydin during the regular student hours (no appointment needed) or make an appointment. See Prof Aydin's weekly schedule to find a mutually convenient time.
- You are welcome to chat with Professor Aydin for matters outside the course content as well.
- Form study groups. Research shows studying in groups is really beneficial. BUT make sure that you write your own solutions independently at the end. Follow Math Dept's guidelines on healthy collaboration.