MAT 344 | Study tips

q.utoronto.ca • Text: Applied Combinatorics - Keller & Trotter

About our textbook

Our textbook has a recurring cast of students who discuss the material at the end of each chapter. This may seem a bit weird at first, but you should always read these. Previous students reported that reading the Discussion sections were useful for consolidating information.

Similarly, you should always read the introductions for each chapter. These are very short sections that talk about the motivation for each chapter, so you know what you are working towards.

The difficulty of Combinatorics

You will find that, compared to other fields of mathematics, Combinatorics is very concrete and is largely driven by problem-solving. This is not to say that it is an easy subject! One difficulty is that due to the diversity of the problems that combinatorics considers, there is no "fundamental theorem of combinatorics" that you can understand and use to solve most problems. Rather, we will encounter several topics, and every problem will require some new insight. To learn anything well, you must consistently practice it. To succeed in the class, you will need to consistently work on new problems every week.

You will also find that problems are also less like each other than in other fields. In Calculus, for example, differentiation and integration both have many rules that you can internalize, practice, and the problems are mostly about applying these rules in a certain order to compute some quantity. Combinatorics is very different. Every problem will require some independent thinking. This should not discourage you! This is what makes Combinatorics a very enjoyable subject. Combinatorial proofs are very clear and satisfying, and you will learn important problem-solving skills that are much more widely applicable than, say, L'Hôpital's rule.

How to succeed in this class

So how do you succeed in the class? As with any skill, mathematical problem-solving is not some innate immutable ability, but rather an acquired skill that you can constantly improve. Our textbook and the other similar books mentioned in the syllabus have a lot of great questions. We will discuss many problems in lecture, but do not expect to do well in the class by just listening to the lecturer or the TA. Seeing and understanding the solution to a problem is very different from coming up with it yourself, especially under time pressure!

When working on a problem, especially on a proof question, it is easy to feel that you are "stuck", that you have no idea how to even start. If this happens to you (and it happens to everyone, including the instructor, all the time), your first instinct may be to ask someone for

help, or look at the solution. It seems like you can "save time" by understanding the solution, and you can easily solve the problem afterwards. However, this understanding is deceptive. Discovering a solution to a problem by yourself leads to a more robust understanding and will also make you feel better about yourself.

So if you are feeling stuck, take a moment before asking for help! Try the following first:

- Look at the smallest/easiest examples: What would the statement be for $n = 2, 3$? Is it easy to prove the statement in this case?
- Try to interpret formulas! Combinatorial proofs rely on this a lot. When faced with a statement like the identity
$$\binom{n}{k} = \binom{n-1}{k} + \binom{n-1}{k-1}$$
you may be tempted to expand both sides into factorials, and manipulate the algebra. But there is a straightforward combinatorial proof that provides much more insight!
- Take a break from the problem! Move on to another one, and come back to the one where you felt like you were stuck in half an hour, two hours, or a day! Sometimes you just need to reset your thinking.

How to ask for help

If you have tried all of the above and still can not make progress, how should you seek help? Again, you should try not to go straight to the solution, whether online or in the book. You want to practice solving problems, not reading solutions! Try asking your peers first. Mathematical problem solving should be a collaborative effort! The lecturer or the TAs may be able to *answer* your questions, but you should not be looking for answers, but for ways to get better at working the problems yourself. How to get in contact with other students? Use the discussion feature on Quercus to ask your question or look for partners for a study group.

Be aware of opportunities when you can answer another student's question. People learn the most effectively when they explain their thought process to another person. Also, they may point out mistakes in your argument that you might have missed.

If all else fails, then of course, you are always welcome to ask your questions during office hours.The best way of asking questions is to first explain where you are in the problem, what you have tried and why you think those attempts failed. Then ask for a hint on how to proceed.

Once you understand the solution

Once you understand the solution to a problem, try to come back to it in a few days. Does it still seem easy? Do you remember all the steps? Try explaining it to someone to see if you can convince them that you are right. Maybe there is a simpler way of doing it? Ask your peers how they solved the same question! There is a lot of merit in knowing more than one way of proving something, after all, many combinatorial proofs rely on simply counting the elements of the same set – only in two different ways.