

MATH 135

Introduction to proofs, number theory, and cryptography for Honors Mathematics

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(Fall 2021)

First, let me get to know you!

- For how many of you, is this your first term in University?
- For how many of you, is this your first term doing in-person courses at UW? (sorry for what COVID did last year!)
- For how many of you is English not your native language?
- How many of you are new to living in:
 - Canada?
 - Ontario?
 - Waterloo Region?
 - Waterloo City?
- Which is your faculty?
 - Math?
 - Science?
 - Other?
- Which is your program?
 - CS?
 - Math & Business?
 - Mathematical Physics?
 - Other?

Quick introduction about myself!

- Born in Scarborough (Malvern), Ontario
- Primary School mainly in Whitby, Ontario
- Secondary School in Markham, Ontario
- Post-secondary at University of Waterloo!!!
- After UW:
 - 1) Researcher at University of Western Ontario (London, Ontario)
 - 2) PhD at Oxford University (England)
 - 3) Post-Doctoral Researcher at Kyoto University (Japan)
 - 4) Post-Doctoral Researcher at Nanyang Technological University (Singapore)
 - 5) Post-Doctoral Researcher at McMaster University (Hamilton, Ontario)
 - 6) Post-Doctoral Researcher at Harvard-Smithsonian Center for Astrophysics (USA)
 - 7) Long-term visiting researcher at a Max Planck Institute (Germany)
 - 8) Long-term visiting researcher at Jilin University (China)
 - 9) About 3 months in Hong Kong
 - 10) About 1.5 months in Indonesia
 - 11) About 1 month in Spain
- Hobbies and Interests: Basketball (Toronto Raptors!), Music (Trumpet!), Biking, Running, High-Performance Computing

Quick introduction about MATH 135!

- For many people, it's the hardest course they'll ever do.
- Extremely fast paced !!!
- Even faster this year! 36 lectures instead of 48.
 - It used to be Monday, Tuesday, Wednesday, Friday. Now it's just MWF.
 - One of the last chapters will be assigned for you to read on your own (same for all other ~1300 students)
- Please, read the course notes thoroughly, before classes!!!
 - If there's one course on which to spend a lot of time, it's MATH 135!
 - Read slowly. It's not a race. Read each line multiple times until it makes 100% sense to you.
- Proofs!
 - Calculation-based math vs proof-based. (Computational vs Abstract)
 - Math until now has been: multiplying, dividing, solving equations, graphing, derivatives, etc. (computers can do it!)
 - Proofs are completely different!
- Applications:
 - Cryptography (CO 485, CO 487, CO 481, PHYS 467, CS 467)
 - Combinatorics (MATH 239, and all of C&O)
 - Complex Analysis
 - Quantum Mechanics (PHYS 234, PHYS 334, PHYS 434, PHYS 454, AMATH 373, CO 481, PHYS 467, CS 467, etc.)
 - Electromagnetism (PHYS 242, PHYS 342, PHYS 442, etc.)
 - Dynamical Systems (AMATH 251, AMATH 351, AMATH 451, etc.)
 - Number Theory (PMATH 340, PMATH 440, PMATH 441, etc.)
 - All of math (MATH 137, MATH 138, MATH 136, MATH 235, MATH 237, etc.) and a lot of CS.

Quick introduction about Proofs!

- How many of you have done proofs before?
 - Can you give an example of something you proved before?
- Examples of how learning how to do proofs helps you?
 - Strengthening your brain power
 - Improving your ability to make strong arguments (English essays, Legal arguments, Business decisions, etc.)
- What is a proof?
- Is $n^3 - n$ divisible by 3 for all integers n ?

Quick introduction to some mathematical language!

- For all
- There exists
- Is an element of...
- Sets and elements: $\{\clubsuit, \diamond, \heartsuit, \spadesuit\}, \{1,2,3\}, \{1,2,\{1,2,3\}\}, \emptyset = \{\}$
- Natural numbers (in this course, $\{1,2,3,\dots\}$), Integers, Rational numbers, Real numbers, Complex numbers
- Negation: $\neg A, \neg(\neg A) = A$
- **Statement: sentence that's true or false**
 - Example: Given S and $P(x)$, $\forall x \in S, P(x)$.
 - What are the pieces in this example?
- **Open sentence: sentence containing an unknown, s.t. we don't know if it's true or false until specification of the unknown**
 - $P(x)$ is a sentence depending on x . $Q(x,y)$ is a sentence depending on x and y .
 - " $\forall x \in S, P(x)$ " is open in S and $P(x)$ because without knowing them, we can't say whether the sentence is T or F.

You should now be able to do Assignment #1! Please read up to Pg 18 thoroughly by Friday!

e.g. 9 pages tonight, 9 pages tomorrow! That way you can ask me questions on Friday!

Please read the assignment too, and try it over the weekend, so that you can ask me questions on Monday!