CSCI 150 - Discrete Mathematics

0=0
1=1
0+1=1
1+0+1=2
0+1+1+0+1=3
1+0+1+0+1+1+0+1=5
0+1+1+0+1+1+0+1+0+1+1+0+1=8
1+0+1+0+1+1+0+1+0+1+1+0+1+1+0+1+0+1+1+0+1=13

Class
Mon, Thu 1:10 PM - 2:25 PM,
By ZOOM

Professor
Saad Mneimneh, **HN 1090L**
Office hours: TBA

ONLINE/BOOK RESOURCES

Discrete Mathematics Elementary and Beyond by Lovász et al., also here.

Discrete Mathematics and its Applications, by Rosen.

A First Course in Discrete Mathematics, by Anderson.

Discrete Mathematics for Computer Scientists, by Stein at al.

Discrete Mathematics, Aduni.org.

How to Write Proofs.

Mathematics for Computer Science, Eric Lehman, Tom Leighton, Albert Meyer.

Discrete and Combinatorial Mathematics, Grimaldi.

Essential Discrete Mathematics for Computer Science, Lewis and Zax.

CHAPTER 0

New Chapter 0, Read **this** as soon as you can. The topics of this chapter will be briefly covered as they come up.

This chapter covers basic mathematical concepts that we will use at some point during the course.

Make sure you are comfortable with most of these concepts

INFORMATION ABOUT THIS COURSE

- **Make sure your email on cunyfirst is up to date**. This is the email that will be used for communication about the course. It is also the email used to create your gradescope account for this course.

- Due to Covid19, this course will be on ZOOM only

- A zoom link with password will be emailed prior to each lecture.

- Lectures **will not** be recorded; however, edited zoom lecture notes will be posted

- There will be a weekly hw, which must be submitted by the deadline using Gradescope (more below). Homework will be 10% of the grade.

- There are two tests, each for 25% of the grade. A proctoring software will require that the student's camera is on for the entire duration of the tests.

- There is one final test, which will be 40% of the grade. A proctoring software will require that the student's camera is on for the entire duration of the final test.

Tutoring Schedule

TBA

MY NOTES

(1) Introduction
- Euler formula: v-e+f=2
- Why counting? (the lazy professor example)
- Basic examples of counting (snakes and ladders)
- Addition and multiplication rules
- Handshake lemma
- Generalization (n choose k)

(2) Counting
- Permutations
- Ordered selection
- n choose k
- Sets, relations, functions
- Onto functions and one-to-one correspondence (bijection)
- Equivalence relations and partial orders
- Anagrams and forming teams
- The binomial theorem and Pascal triangle
- Selection with repetition (ordered and non-ordered)

(3) What is a proof?
- The pigeonhole principle
- Primes are infinite
- A water juggling puzzle
- Proof by contradiction, by case analysis, by picture
- What are proofs?
- A false proof of Pythagoras
- Some logic, Boolean gates/functions
- What is implication?
- Proof by counter example, contradiction (again), contrapositive
- Self reference and diagonalization, the barber paradox
- Countable vs. uncountable

(4) Two useful principles
- The inclusion-exlusion principle, two sets
- What about more than two sets?
- The lazy professor revisited
- More examples of using inclusion-exclusion
- The pigeonhole principle revisited (generalized)
- Examples of using pigeonhole
- The birthday paradox
- Simplified Ramsey theory
- Proving program termination by Ramsey (and partial order)

(5) Inductive proofs
- A weird proof
- Proof by induction, definition
- Some false proofs
- Examples of proof by induction
- Rules of thumb for induction

(6) Recurrences
- What is a recurrence?
- Cutting the plane
- Towers of Hanoi
- Fibonacci
- Solution for a_n=Aa_{n-1}+Ba_{n-2}
- Generating functions
- Sorting
- Traveling in Manhattan and the Calatan numbers
- Stirling numbers
- Balls and bins (6 variantions)

(7) Number theory
- Divisibility and primes
- The Euclidean algorithm, why not brute force?
- The extended Euclidean algorithm
- Co-primes
- Fundamental theorem of arithmetic (uniqueness of prime factorization)
- Properties and distribution of primes
- Congruence as an equivalence relation
- Multiplicative inverses
- The Chinese remainder theorem
- Fermat's little theorem and primality testing
- Cryptography, breaking it by Chinese remaindering

(8) Graphs
- Vertices, edges, and connectivity
- Trees
- Counting trees
- Finding the best tree
- The traveling salesman problem
- Hamiltonian cycles and Eulerian walks
- Graph coloring and planarity

Note: While these notes reflect what is covered in class, they are far from being perfect (e.g. typos) or complete. But they should be self contained. They are intended for class use only. Many examples and explanations are actually taken from the above references, although no referencing is explicit within the text. Therefore, I emphasize that these notes are intended for class use only. For outside visitors of this page, please use them for your own benefit only. Do not distribute.

Homework

- Homework 0 (ungraded): Read chapter 0

Gradescope

- Homework submission is electronic through gradescope

- Each submission should be one PDF file

- Each PDF file must contain a number of pages equal to the number of questions in order for the corresponding submission

- A missing question must have a blank page (or a page indicating that it's missing)

- No late homework

Grading policy

Homework 10%
Test 1 25%
Test 2 25%
Final 40%

Learning goals

This course satisfies the following learning goals as set by the department: 1a, 3a, 4.