Syllabus

Course Information:

Location: Tech M345
Time: Monday, Wednesday, Friday, 4-4:50pm

Discussions (Optional): Tech L251
Time: Wednesday, Thursday, 5-5:50pm

Course Staff and Information:

Instructor: Shravas Rao, shravas@northwestern.edu

Office hours: Monday, 1-1:50pm (Mudd 3536), Wednesday 3pm-3:50pm (Mudd 3303), Friday, 3pm-3:50pm (Mudd 3532)

Teaching Assistant: Yiding Feng, yidingfeng2021@u.northwestern.edu

Office hours: Sunday 4pm-6pm (Tech L221)

Teaching Assistant: Paula Koyongo, PaulaKayongo2023@u.northwestern.edu

Office hours: Tuesday 5-6pm (Mudd 3108), Friday 5-6pm (Mudd 3532)

Peer Mentors: Joo Seung Lee, joolee2015@u.northwestern.edu; Rikki Pan, RuiqiPan2022@u.northwestern.edu; Tianfu Wang, TianfuWang2021@u.northwestern.edu

Office hours: Monday 12pm-1pm (Mudd 3536), 3pm-4pm (Mudd 3534), Tuesday 4pm-5pm (Mudd 3108)

Course Objectives and Learning Outcomes

In this course, students should develop mathematical thinking and problem-solving skills associated with writing proofs (further detailed in the Part I objectives). Students should also be exposed to a wide variety of mathematical concepts that are used in the Computer Science discipline, which may include concepts drawn from the areas of Number Theory, Graph Theory, Combinatorics, and Probability. Potential objectives in these areas are listed in Parts II-IV.

Part I: Proofs, and Mathematical Preliminaries

1. Introduction to Logic, Proofs.
2. Principle of Mathematical Induction, Strong Induction.

Part II: Counting, Combinatorics, Probability

1. Counting, Mapping, Functions, Bijection, Inclusion-Exclusion formula.
2. Pigeonhole principle, Generalized Pigeonhole.
3. Permutations and Combinations. Picking with repetition, without repetition.
4. Binomial formula, Pascal Triangle, Generating functions.
5. Introduction to Probability: Random Events, Conditional Probabilities, Independence, Bayes Rule.
6. Random variables, Expectation, Variance of random variables.

7. Markov's inequality. Chebychev inequality.
8. Deviation from the mean, Statistical significance.

Part III: Graph Theory

1. Introduction to graphs, Properties of graphs.
2. Connectivity, Connected components, Distances.
3. Trees, Cycles, Spanning Trees.
4. Planarity, Graph Coloring, Bipartite graphs.
5. Matchings, Hall's theorem, Stable marriage.
6. Linear Algebra: Adjacency matrix, Edge-vertex matrix. Relating graph properties. Eigenvalues, Eigenvectors.
7. Independent set, Vertex cover, Network Flows, Cuts.
8. Linear Programming, Duality.

Part IV: Number Theory & Miscellaneous

1. Prime numbers, Divisibility, Factoring.
2. Modular arithmetic, groups.
3. Cryptography, Computational Complexity.
4. Turing Machines, Reductions, NP-hardness.

Textbook

There is no required textbook for this course. The following textbook is suggested reference book: Mathematics for Computer Science by Lehman, Leighton, and Meyer (e-book:`http://www.seas.harvard.edu/courses/cs20/MIT6_042Notes.pdf`)

Discussion Sections

There will be two discussion sections a week, each covering the same material. Attendance is recommended but not required.

Assignments

There will be one problem set per week except on weeks with exams and the first week of courses. Assignments should be submitted on Canvas in pdf format. It is recommended that you use LaTeX.

The lowest homework grade will be dropped. However, late homework will not be accepted except in extreme circumstances. It is recommended that you submit a first draft in advance to avoid technical delays.

Some assignments may have optional problems. These problems will not contribute to or affect your grade.

Important: On canvas there will be a separate assignment for each problem, to make grading go more smoothly. You must submit the appropriate problem to the appropriate assignment. An easy but recommended approach is to submit one pdf containing all solutions to all assignments.

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Collaboration: You are allowed to collaborate, but only in disjoint groups of three. You can change groups from week to week. You must include your collaborators on the assignment.

All members of the group must write solutions individually, in their own words, and submit their own assignment. Examples of things not allowed include, but are not limited to, the following.

- Copying or directly referring to the final submission of past or present students.
- Copying or directly referring to solutions from the internet.
- Providing your final submission of homework assignments to other students.
- Publically distributing, including uploading to the internet, homework solutions. This includes websites like CourseHero and Chegg.

If you are looking for a group to collaborate with, you can use the Search for Teammates tool on piazza.

Academic Integrity: Failure to properly cite external sources such as websites for homework assignments is a violation of academic integrity and will be dealt with accordingly. Further, you may not share written work, or get help from anyone besides staff, collaborators, or refer to solutions from the web or previous versions of the course.

Solutions: Solutions to homework assignments will be discussed in the discussion sessions and posted outside the instructor's door in Mudd 3217 for at least 2 weeks. Solutions will not be posted to Canvas.

Exams

There will be one midterm in class on February 10, 2020. The final will be on March 17, 2020 from 12pm-2pm.

Grades

Problem sets will make up 40% of the course grade, the midterm 25% and the final 35%. The overall difficulty of the problem sets, midterm, and final will be taken into account when assigning grades. Participation in lectures and discussion sessions and upward trends will also be taken into account.

Attendance

Class attendance is recommended, but not required.

Academic Integrity

A primer on the academic integrity policy at Northwestern can be found here: `https://www.northwestern.edu/provost/policies/academic-integrity/` Violations of academic integrity in this course will be punished by receiving zero credit on the affected assignments, disqualification from bonus credit for the remainder of the course, and/or other sanctions listed in Section I.D of "Academic Integrity: A Basic Guide", subject to the severity of the offense.