Course Information:

Location: Zoom: 993 1071 1270, password 961615
Time: Monday, Wednesday, Friday, 4:10-5pm (CST)

Discussions (Optional): Thurs 8am Zoom: 953 1055 3776, password: 162293
Thurs 6pm, Zoom: 973 7157 1672 password: 162293

Course Staff and Information:

Instructor: Shravas Rao, shravas@northwestern.edu

Office hours: Monday, Wednesday 3-3:50pm, Friday 2-2:50pm (CST) Zoom: 944 9747 3794

Teaching Assistant: Aravind Reddy, arareddy@u.northwestern.edu

Office hours: Monday 10am-12pm

Peer Mentors: Karan Bhasin, karanbhasin2022@u.northwestern.edu
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Office hours: Friday 10:30-11:30am, 12:50-1:50pm, 3-4pm, 5-8pm, Sunday 2-3pm, 7-9pm, Monday 6-8pm, 9-10pm, Tuesday 3-4pm, 6-8pm, 9-10pm

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 and can be found on canvas: Mathematics for Computer Science by Lehman, Leighton, and Meyer.

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.

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.

Exams

There will be one in-class midterm on October 19, 2020 (along with a second slot of October 20, 2020 at 8am). The final will be on December 7, 2020 7-9pm (along with a second slot of December 8, 2020 at 8am). More information about the mechanics of the midterm and final will be given closer to the dates.

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.

Accomodations

Any student requesting accommodations related to a disability or other condition is required to register with AccessibleNU (accessiblenu@northwestern.edu; 847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. All information will remain confidential.

Academic Integrity

A primer on the academic integrity policy at Northwestern can be found here: `https://www.northwestern.edu/provost/policies/academic-integrity/`. Policies specific to the McCormick School of Engineering & Applied Science can be found here: `https://www.mccormick.northwestern.edu/students/academic-integrity.html`. Violations of academic integrity in this course will be punished by receiving zero credit on the affected assignments, and/or other sanctions listed in Section I.D of "Academic Integrity: A Basic Guide", subject to the severity of the offense.

Inclusion

This classroom will be a place where you will be treated with respect, and all individuals will be welcomed, regardless of ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability –and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Transition to Remote Learning

This quarter, this class will be taught remotely. In particular, the various aspects of the course will be modified in the following ways.

- Lectures and discussions will be conducted through Zoom. All lectures and discussions will be recorded and hosted on canvas.

  When you enter the Zoom meeting you should mute your microphone. During lectures or discussions, if you have questions, please either use the raise your hand feature at which point the presenter (either the instructor or TA) will unmute you and allow you to ask your question, or send the presenter (either the instructor or the TA) a message, which they will answer.

- The recordings from this class will be shared only with students enrolled in the course. All recordings will be deleted at the end of the Fall 2020 term. Recordings will be accessible on canvas and panopto.

- Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those

resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

- All office hours will also be conducted through Zoom. Office hours will not be recorded. During office hours, if you have a general question, like hints or pointers on a problem, please consider asking in the main room so that everyone can hear your question. If you have a more specific question or want to ask your question privately, the person holding your office hours will move you to a breakout room, and you can ask your question there.

  For this class, it is entirely appropriate to join the Zoom meeting for office hours while working, and ask questions as they come up, as you might do for in-person office hours.

- Both the midterm and the final will be conducted through canvas, similar to how homework will be conducted, but with a shorter time frame. More details will be given closer to the dates.

In general, if you are having any difficulties related to the transition to remote learning (or in general) please feel free to let the course staff know, we are willing to be flexible.