CSE 15
Discrete Mathematics

Lecture 1 – Introduction & Proposition Logic

CSE 15: Fall 2018 (Syllabus)

- Instructor
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  - Office Hours:
    - T/R 10:30-11:30am
    - Or by appointment (send an e-mail)
- TAs
  - Mina Naghshnejad
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- All email inquiries received before 5pm during school days will be replied within 48 hours
  - Guidelines for proper email communications
    - https://medium.com/@lportwoodstacer/how-to-email-your-professor-without-being-annoying-af-cf64ae0e4087

Course Overview

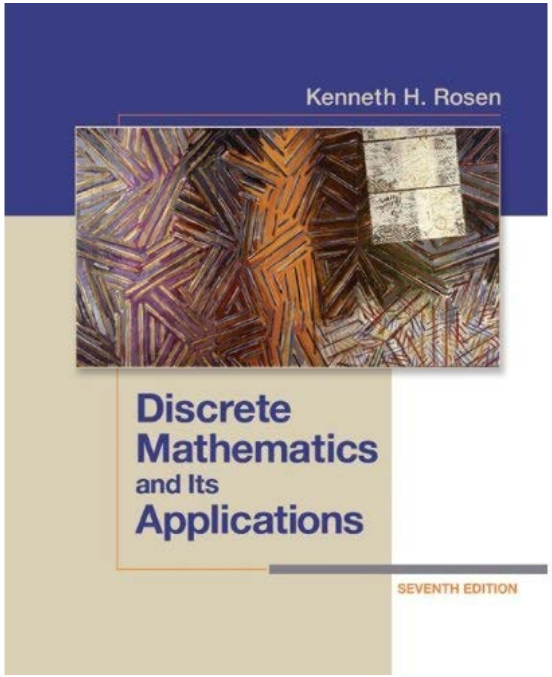
- Catcourses
  - Check regularly for announcements.
  - Homework Assignments will be posted and submitted there.
  - Grades for assignments will also be found there (secure).
- 2 Lectures and 1 Lab/Discussion per week
- 2 Mid-term exams: Oct 9 (T) and Nov 13 (T)
- Final exam (in the classroom, 3-6PM, Dec 11, Tuesday)
- About 11 homework assignments
- 4 quizzes (announced)

Course Objectives/Policies

- To think **logically** and **mathematically**
- Labs/homework assignments:
  - Attendance is required (5% of overall grade, zero point after 4 unexcused misses)
  - Homework is posted during lab. No programing assignments.
  - Giving help in finding errors and in understanding homework assignments is acceptable.
  - You should not show/share with any student any portion of your work (e.g., homework solutions, midterm/quiz/final exam)
  - No late submission is allowed after 1 day beyond the due date.

Course Material

- Text Book:
  - Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, McGraw Hill – 7th edition



Prerequisites

- Basic knowledge of calculus (MATH 21 and MATH 22).
- Basic knowledge of computer science.

Hints for success in the course

- Attend all lectures and pay attention
- Take notes while in the class
- Read the textbook
- Do all homeworks
- Do exercise problems at the end of chapters
- Ask questions

Grading Policy

- Homeworks: 15%
- 2 Mid-terms: 30%
- Final exam (comprehensive): 35%
- Quizzes: 15%
- Class participation: 5%

- Grades:
  - 90% of points at least an A- (90<= A- <=94)
  - 80% at least a B- (83<= B <=86)
  - 70% at least a C (73<= C <=76)

Policies

- Don’t copy someone else’s assignment/exam
- Don’t give your assignment away
- Don’t outsource your assignments
- Don’t use electronic devices in exams
- Turn off speakers/cellphone during class

No Cheating!

- Communicating information to another student during examination.
- Knowingly allowing another student to copy one's work.
- Offering another person's work as one's own.
- A very serious matter!

About me

- B.S., ECE, IIT Roorkee, India (1980)
- PhD, Computer Science, University of Maryland at College Park, MD (1986)
- Research interests: Cloud computing, cybersecurity, big data, AI, self-driving cars.
- University professor since Jan 1986.

What is Discrete Mathematics?

- A part of mathematics devoted to the study of **discrete** (as opposed to continuous) objects (e.g., numbers).
- Calculus deals with continuous objects and is not part of discrete mathematics.
- Examples of discrete objects: integers, Calif. license plates, number of votes each presidential candidate gets, a winning set of numbers in a lottery, your course-grades in Fall 2018.
- Examples of continuous objects: distance between home and work in miles, your weight/height, etc.
- Discrete vs. continuous: countable vs. infinitely many

Where Do We Use Discrete Mathematics?

- How many ways can a password be chosen following specific rules?
- How many valid Internet addresses are there?
- What is the probability of winning a particular lottery?
- How many distinct vehicle license plates are possible in California?
- How many ways can I choose courses in a semester?
- How can I encrypt a message so that no unintended recipient can read it?
- How many secret keys are possible?

Where Do We Use Discrete Mathematics?

- What is the shortest path between two cities using a transportation system?
- How can we prove that there are infinitely many prime numbers?
- How can a list of integers be sorted so that the integers are in increasing order?
- How many steps are required to do such a sorting?
- How can it be proved that a sorting algorithm always correctly sorts a list?

Goals

- **Mathematical Reasoning**: Ability to read, understand, and construct mathematical arguments and proofs.
- **Combinatorial Analysis**: Techniques for counting objects of different kinds.
- **Discrete Structures**: Abstract mathematical structures that represent objects and the relationships between them, e.g., sets, permutations, relations, graphs, trees, etc.

Algorithmic Thinking:

- An **algorithm** is a sequence of steps that can be followed to solve a particular problem.
- **Algorithmic thinking** involves specifying algorithms, analyzing the memory and time required by an execution of the algorithm, and verifying that the algorithm will produce the correct answer.

Discrete Mathematics is a Gateway Course

- Topics in discrete mathematics are important in many courses that you will take in the future:
  - **Computer Science**: Computer Architecture, Data Structures, Algorithms, Programming Languages, Compilers, Computer Security, Databases, Artificial Intelligence, Networking, Graphics, Game Design, Theory of Computation, ……
  - **Mathematics**: Logic, Set Theory, Probability, Number Theory, Abstract Algebra, Combinatorics, Graph Theory, Game Theory, Network Optimization, …
  - **Other Disciplines**: You may find concepts learned here useful in courses in philosophy, economics, linguistics, and other departments.

Propositional Logic (Ch. 1.1)

- Propositions
- Connectives
  - Negation
  - Conjunction
  - Disjunction
  - Implication; contrapositive, inverse, converse
  - Biconditional
- Truth Tables

Propositions

- A ***proposition***: a declarative sentence that is either true or false.
- Examples of propositions:
  a) The Moon is made of cheese.
  b) Trenton is the capital of New Jersey.
  c) Toronto is the capital of Canada.
  d) $1 + 0 = 1$
  e) $0 + 0 = 2$
- Examples that are not propositions:
  a) Sit down!
  b) What time is it?
  c) $x + 1 = 2$
  d) $x + y = z$

Propositional Logic

- Constructing Propositions
  - *Propositional Variables*: *p*, *q*, *r*, *s*, …
  - The proposition that is always true is denoted by **T** and the proposition that is always false is denoted by **F**.
  - *Compound Propositions*: constructed from logical connectives and other propositions

Logical connectives:

- Negation ¬
- Conjunction ∧
- Disjunction ∨
- Implication →
- Biconditional ↔

Compound Propositions: Negation

- The *negation* of a proposition p is denoted by $\neg p$ and has this truth table:

p	$\neg p$
T	F
F	T

- **Example**: If p denotes "The earth is round.", then $\neg p$ denotes "It is not the case that the earth is round," or more simply "The earth is not round."

Conjunction

- The *conjunction* of propositions p and q is denoted by $p \wedge q$ and has this truth table:

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

- **Example**: If p denotes "I am at home." and q denotes "It is raining." then $p \wedge q$ denotes
  - "I am at home and it is raining."

Disjunction

- The *disjunction* of propositions p and q is denoted by $p \vee q$ and has this truth table:

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

- **Example**: If p denotes "I am at home." and q denotes "I am driving." then $p \vee q$ denotes
  - "I am at home or I am driving."

The Connective Or in English

- In English "or" has two distinct meanings.
  - **"Inclusive Or"** - In the sentence "Students who have taken CSE20 or Math20 may take this class," we assume that students need to have taken one of the prerequisites, but may have taken both. This is the meaning of disjunction. For $p \vee q$ to be true, either one or both of p and q must be true.
  - **"Exclusive Or"** - When reading the sentence "Soup or salad comes with this entrée," we do not expect to be able to get both soup and salad. This is the meaning of Exclusive Or (Xor). In $p \oplus q$, one of p and q must be true, but not both. The truth table for $\oplus$ is:

p	q	$p \oplus q$
T	T	F
T	F	T
F	T	T
F	F	F

Reading assignment

- Chapter 1.1 – 1.3 of textbook