# Maths for Computing (CSL2040)

- Vimal Raj Sharma

# Lecture 1

Course Overview, Administrivia, Logic, Propositions

# Course Overview

**Goal of this course:** Learn mathematics that is useful and necessary for other CS courses.

**Tentative Plan:**

- **Logic and Set Theory:** Propositional logic, Predicates, and Quantification, Natural Deduction, Naive Set Theory.
- **Proof Techniques:** Introduction to Proofs, Well-Ordering Principle, Induction, Proof by contradiction.
- **Combinatorics:** Counting, Permutations, Combinations, Partitions, Pigeonhole Principle, Inclusion-exclusion, Binomial theorem.
- **Graph Theory:** Properties of graphs, Graph Matching and Coloring.
- **Models of Computation:** DFA, NFA, Equivalence of NFA and DFA, Regular Expressions, Pumping Lemma of Regular Languages, Context Free Grammar, Turing Machines, Undecidability.

# Administrivia

**Grading:**

- 40% - Assignments.
  - 5 assignments, one for each module of the course.
  - **Weightage Distribution**: 6-8-10-8-8.
- (15 + 15)% - Minors.
- 30% - Major.

**Books:**

- A Walk Through Combinatorics by Miklós Bóna.
- Discrete mathematics and its applications by Kenneth H. Rosen.

**Office Hours:** 3-5 PM on Thursday, in CSE 307.

**Course Site:** http://home.iitj.ac.in/~vimalraj/courses/csl2040.html (will be up soon)

**Attendance:** As per the institute policy.

# Administrivia

## More Rules/Advice:

- You are allowed to seek **hints** for the assignment.
  - Mention the source of help in the assignment.
  - Mindlessly **copying** will attract a **huge penalty**.
  - Exams will sometimes have questions based on assignments.
- Tutorials:
  - Will be held in **two batches**.
  - **Time:** Tuesday, 3-4 PM and 4-5 PM.
- Problems for tutorials and assignments will be given at the end of the lecture slides.
  - Deadline for an assignment will be four days after the completion of a module.
- If I am not here till **9:10 (Google time)**, then the class is cancelled and a compensatory class will be announced.

*Hopefully, it will never happen.*

# Logic

## What is logic?

Logic focuses on reasoning or how to reliably get from **assumptions** to **conclusions**.

### Example 1:

**Assumptions:**
1. All men are mortal.
2. Socrates is a man.

**Conclusion:** Socrates is mortal.

*Valid conclusion*

### Example 2:

**Assumptions:**
1. All cats are mortal.
2. Socrates is mortal.

**Conclusion:** Socrates is a cat.

*Invalid conclusion*

# Pitfalls of Natural Language in Reasoning

Natural language is sometimes **imprecise**:

**Assumption:**
1. Only married couples can book a room in hotel Moonlight.
2. Jay and Ella are married.

**Conclusion:** Jay and Ella can book a room in hotel Moonlight.

**Issue:** May be Jay and Ella are not married to each other?

Natural language is sometimes **ambiguous**:

**Assumptions:**
1. Nothing is better than eternal happiness.
2. McDonald’s burger is better than nothing.

**Conclusion:** McDonald’s burger is better than eternal happiness.

**Issue:** ‘Nothing’ has different meaning in both assumptions.

# Propositional Logic

**Definition:** A **proposition** is a sentence that is either true or false, but not both.

**Sentences that are propositions:**

1. New Delhi is the capital of India. ⟵ *True*
2. 45 is a prime number. ⟵ *False*
3. The current time is 9:00 PM IST. ⟵ *False*
4. $10 * 8 = 80.$ ⟵ *True*

**Sentences that are not propositions:**

1. What place is this? ⟵ *It's a question.*
2. Hold it carefully. ⟵ *It's an instruction*
3. This sentence is false. ⟵ *It can neither be true nor be false.*
4. $x + 1 = 2$ ⟵ *Whether it is true or false depends on value of x.*

# Tutorial Problems

1. Think of some sentences that are neither questions nor instructions, but still not propositions.