CS1800 Discrete Structures *Out: October 4, 2026*

Problem Set 3

Strange & Varma *Due: October 11, 2026*

- This assignment is **due on October 11, 2026 at 11:59 PM** via Gradescope. You may submit up to 48 hours late with no penalty.
- Your solutions must be handwritten, with your name on the first page. All your work must be shown even if the problem doesn't specifically ask for it.
- Discussing problems with classmates is allowed but all solutions must be written by yourself, in your own words.
- Copying solutions from a classmate, an online source, or AI tools, is a violation of our academic integrity policy. Do *not* submit anything you cannot explain. Please list all your collaborators and online reference sources in your solution for each problem.
- If you get stuck on a homework problem, come by office hours or post on Campuswire! We recommend you spend about 30 minutes trying to figure out a problem, and then ask for help. We'll be happy to clarify material from class and algorithm concepts, but we will not give out solutions or confirm your answers are correct.

Problem 1 (Two's complement) 30

Part A: Convert the decimal numbers -34 and -21 to two's complement, assuming an eight bit two's complement representation. Show your work, including how you get from the positive integers to their negative counterparts.

Part B: Convert the following numbers to decimal assuming that negative numbers are in two's complement form; 11011101, 00011011, 10001110

Part C: We have the number[1] 10110000 and we are not sure what convention is being used: i) what is the number assuming signed magnitude representation, and ii) what is the number if we assume two's complement?

Part D: Sum the numbers you produced in **Part A** using binary addition, and verify that the result is equal to the binary for -55. Show your work.

Part E: What is the sum, in decimal, of the sixteen-bit numbers encoded in two's complement 1111111111111111 and 0000000000001111? Show your work or explain your reasoning.

[1] An earlier PDF had a typo and the last 0 was missing.

Problem 2 (Converting to Logic) 15+(4+6)+5

1. Show or describe in English the elements that make up the following set:
   - $A = \{x \in \mathbb{Z} \mid x^2 < 6x\}$
   - $B = \{x \in S \mid 3x \in S\}$ where $S = \{2, 3, 5, 9\}$
   - $C = \{(x, y) \mid (x + y)^2 > 100 \text{ and } x, y \in \mathbb{N}\}$
   - $D = \{n^2 \in \mathbb{R} \mid n < |n|\}$
   - Let $U = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ be the universe. Let $A = \{1, 4, 6\}$ and $B = \{1, 2, 3, 7, 9\}$ be two subsets of U. What are the elements of the set $\overline{\overline{A} \cap \overline{B}}$?
2. Write the following description of collections using set notation:
   - All positive numbers in which the absolute value of the square root of the number is less than or equal to 10.
   - All pairs of real numbers where their sum is 12.
3. For each of the following statements, state whether it is TRUE or FALSE. Show your work and explain your answer.
   - $-22 \in \{4x - 10 \ : \ x \in \mathbb{Z}\}$
   - $-22 \in \{4x - 10 \ : \ x \in \mathbb{N}\}$

Problem 3 (Venn Diagrams) **24**

Shade the regions for the following sets in the Venn diagram in Figure 1. *Note that the solution will require 6 separate Venn diagrams, one for each of the given expressions.*

1. $(A \cap B) \cup C$
2. $(B \setminus A) \cap C$
3. $(A \cup B) \cap \overline{C}$
4. $(A \cup C) \Delta B$
5. $(A \Delta B \Delta C) \cup \overline{A}$
6. $(A \cup \overline{A}) \setminus (A \cap B \cap C)$

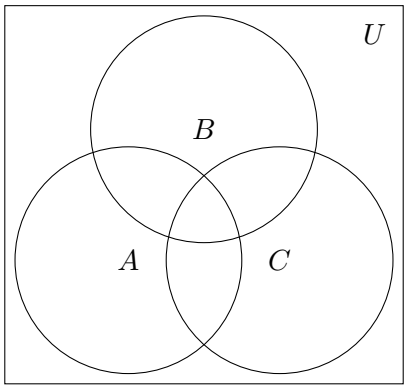


Figure 1: The Venn diagram to be shaded in according to the sets expressed above.

Problem 4 (Simplifying Sets) 2+4+6+8

Simplify each of the following expressions where U is the universal set which contains all elements. Your final simplification should only use unions, intersections and complements and in particular it should not use the Δ operator.

1. $A \cap A$
2. $\overline{\overline{A} \cap \overline{B}} \cap U$
3. $(A \cup A) \cap (B \cup \overline{A})$
4. $\overline{\overline{A \cap \overline{A} \cap A} \cap B \cap \overline{\overline{C}} \cap \overline{A}}$