CSIE 2344, Spring 2025: Homework 1

Due March 10 (Monday) at Noon

There are 60 points in total. Points will be deducted if no appropriate intermediate step is provided.

0 Gradescope Page Selection (2pts)

- (2pts) When you submit your homework, select the corresponding page(s) of each question.

1 Base Determination (6pts)

Assume three digits are used to represent positive integers and also assume the following operation $024 + 043 + 013 + 033 = 201$ is correct. Determine all possible bases of the numbers.

2 8-4-(-2)-(-1) Code (12pts)

1. (6pts) It is possible to have negative weights in a weighted code for the decimal digits, *e.g.*, 8, 4, -2, and -1 can be used. Construct a table for this weighted code.

2. (6pts) If d is a decimal digit in this code, how can the code for $9 - d$ be obtained?

3 Logic Simplification (6pts)

Use only the DeMorgan's laws and the involution law to find the complement of the function: $F(A, B, C, D) = AB'C + (A' + B + D)(ABD' + B')$. You do not need to further simplify the function by other laws.

4 Switch Circuit (16pts)

Consider the switch circuit in Figure 1.

1. (4pts) Derive the switching algebra expression that corresponds one to one with the switch circuit.

2. (6pts) Derive an equivalent switch circuit with a structure consisting of a parallel connection of groups of switches connected in series (hint: use 9 switches).

3. (6pts) Derive an equivalent switch circuit with a structure consisting of a series connection of groups of switches connected in parallel (hint: use 6 switches).
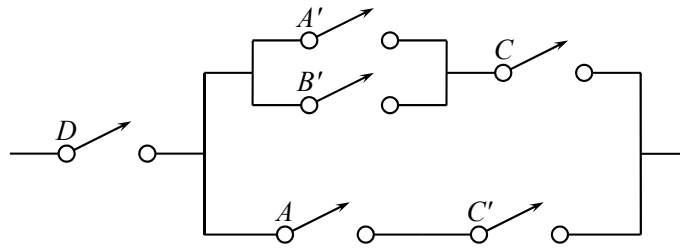
Figure 1: The given switch circuit.

5 Sum of Products (6pts)

Multiply out to obtain a sum of products: $(A+B+C+D)(A'+B'+C+D')(A'+C)(A+D)(B+C+D)$ (simplify where possible).

6 Product of Sums (6pts)

Factor to obtain a product of sums: $BCD + C'D' + B'C'D + CD$ (simplify where possible).

7 Majority Circuit (6pts)

The output of a majority circuit is 1 if a majority (more than half) of its inputs are equal to 1, and the output is 0 otherwise. Construct a truth table for a three-input majority circuit and derive a simplified sum-of-products expression for its output.