Engs 31 / CoSc 56

Homework 1: Boolean Algebra and Logic Design

Due electronically on Canvas on Friday, April 5, 2024

The following is a set of written exercises in Boolean algebra and combinational logic design (**50 total points**).

Problems

1. *Digital coding* — Express each of these decimal numbers in three ways: 8-bit binary, hexadecimal, and binary coded decimal (**9 points**):

(a) 173

(b) 127

(c) 68

2. *Digital coding* — Convert each of these 8-bit binary codes in two ways: to hexadecimal and to decimal. Also, for each of the binary numbers, determine whether it can be interpreted as binary coded decimal? If so, write down the decimal number encoded by the binary coded decimal (**9 points**).

(a) 01101001

(b) 01001000

(c) 01011110

3. *Logic design* **—** Consider a system with a three-bit input (W, X, Y) and three-bit output (A, B, C), described by the truth table below.

W	*X*	*Y*	*A*	*B*	*C*
0	0	0	1	0	0
0	0	1	1	1	0
0	1	0	1	0	1
0	1	1	0	1	1
1	0	0	1	0	1
1	0	1	1	1	1
1	1	0	1	1	0
1	1	1	0	0	0

(a) Write *unsimplified* logic equations and draw circuit diagrams for the three outputs (this can be done as three separate diagrams if you prefer) (**6 points**).

(b) Use *Boolean algebra* to find the minimized sum-of-products form (**9 points**).

(c) What single logic gate can be used to achieve the output *C (***2 points**)?

4. *Logic simplification — Logic minimization (**15 points**)*

Write the truth table for the following logic equation:

$$X = A'B'C'D' + A'B'C'D + A'B'CD' + A'B'CD + A'BC'D + AB'C'D + AB'CD' + AB'CD + ABC'D$$

Find the minimized sum of products form of this equation using a *Karnaugh map*. Compare the number of gates and transistors between the two functions (I'm not expecting you to draw out the logic diagram).