CS 207 Digital Logic - Spring 2019
Assignment 1

Deadline: Friday, Mar. 22, 2019

Digital Logic Theory

Write down your answer to the questions on a new sheet with detailed procedures.

1. (0.3 points) List the octal and hexadecimal numbers from 10 to 32. With A and B as the last two digits, list the numbers from 10 to 32 in base-12.

2. (0.3 points) What is the largest binary number that can be expressed with 12 bits? What are the equivalent decimal and hexadecimal numbers?

3. (0.5 points) Perform subtraction on the given unsigned numbers using the 10's complement of the subtrahend. Where the result should be negative, find its 10's complement and affix a minus sign. Verify your answers.
   (a) $4637 - 2579$
   (b) $125 - 1800$
   (c) $2043 - 4361$
   (d) $1631 - 745$

4. (0.3 points) Write the expression "G. Boole" without quotes in ASCII, using an eight-bit code. Include the period and the space. Treat the leftmost bit of each character as a parity bit. Each eight-bit code should have odd parity.

5. (0.5 points) The following is a string of ASCII characters whose bit patterns have been converted into hexadecimal for compactness: 73 F4 E5 76 E5 4A EF 62 73. Of the eight bits in each pair of digits, the leftmost is a parity bit. The remaining bits are the ASCII code.
   (a) Convert the string to bit form and decode the ASCII.
   (b) Determine the parity used: odd or even?

6. (0.3 points) Find the complement of $F = wx + yz$; then show that $FF' = 0$ and $F + F' = 1$.

7. (0.5 points) Draw logic diagrams to implement the following Boolean expressions:
   (a) $y = [(u + x')(y' + z)]$
   (b) $y = (u \oplus y)' + x$
   (c) $y = u(x \oplus z) + y'$
   (d) $y = u + x + x'(u + y')$

8. (0.5 points) The logical product of all maxterms of a Boolean function of n variables is 0.
   (a) Prove the previous statement for $n = 3$.

(b) Suggest a procedure for a general proof of n.

9. (0.5 points) Obtain the truth table of the following functions, and express each function in sum-of-minterms and product-of-maxterms form:
   (a) $(c' + d)(b + c')$
   (b) $bd' + acd' + ab'c + a'c'$

10. (0.3 points) Show that a positive logic NAND gate is a negative logic NOR gate and vice versa.

11. (0.3 points) Write the Boolean equations and draw the logic diagram of the circuit whose outputs are defined by the following truth table:

f_1	f_2	a	b	c	f_1	f_2	a	b	c
1	1	0	0	0	1	0	1	0	0
0	1	0	0	1	0	1	1	0	1
1	0	0	1	0	1	0	1	1	1
1	1	0	1	1					

12. (0.3 points) Write the following Boolean expressions in sum of products form: $(b + d)(a' + b' + c)$.

13. (0.5 points) Simplify the following Boolean functions, using three-variable maps:
   (a) $F(x, y, z) = \sum(1, 2, 3, 6, 7)$
   (b) $F(x, y, z) = \sum(3, 4, 5, 6, 7)$

14. (0.5 points) Simplify the following Boolean expressions, using four-variable maps:
   (a) $A'B'C'D + AB'D + A'BC' + ABCD + AB'C$
   (b) $A'B'C'D' + BC'D + A'C'D + A'BCD + ACD'$

15. (0.5 points) Simplify the following Boolean functions by first finding the essential prime implicants:
   (a) $F(w, x, y, z) = \sum(0, 2, 5, 7, 8, 10, 12, 13, 14, 15)$
   (b) $F(A, B, C, D) = \sum(0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$

16. (0.3 points) Give three possible ways to express the following Boolean function with eight or fewer literals: $F = A'BC'D + AB'CD + A'B'C' + ACD'$.

17. (0.6 points) Implement the following Boolean function F, together with the don't-care conditions d, using no more than two NOR gates:

$$F(A, B, C, D) = \sum(2, 4, 10, 12, 14)$$
$$d(A, B, C, D) = \sum(10, 1, 5, 8)$$

Assume that only the normal (non-complemented) inputs are available.

Digital Logic Experiment

Pack (`tarball`, `zip`, `7z`, etc.) the source and output files as indicated in the respective sections in lab sheets.

1. (0.3 points) Section 5.4 of Lab 1 (a component that has AND, OR, and NOT gates).

2. (0.4 points) Section 2.1 of Lab 2 (sum-of-products and productof-sums transformation).

3. (0.3 points) Section 3.1 of Lab 2 (two-input XOR with only AND, OR, and NOT gates).
4. (0.4 points) Section 1 of Lab 3 (textual output of all operators)
5. (0.4 points) Section 2.2 of Lab 3 (UDP implementation of Boolean expression).
6. (0.3 points) Section 1 of Lab 4 (textual output of `begin-end` and `fork-join`).
7. (0.3 points) Section 2 of Lab 4 (textual output of blocking and nonblocking assignment).
8. (0.3 points) Section 3.1 of Lab 4 (textual output of nested `if-else` example).
9. (0.3 points) Section 3.2 of Lab 4 (textual output of nested `casez` example).