CprE 281: Digital Logic
Midterm 1: Friday Sep 18, 2020

Name: ________________________________ **ID Number:_______________**

Lab Section:	**Tue 11-2 (#16)**	**Wed 8-11 (#8)**	**Thur 11-2 (#14)**	**Fri 11-2 (#7)**
(circle one)	**Tue 2-5 (#11)**	**Wed 11-2 (#18)**	**Thur 11-2 (#17)**	
			Thur 2-5 (#10)	

1. True/False Questions (10 x 1p each = 10p)

(a) I forgot to write down my name, student ID number, and lab section. TRUE / FALSE

(b) Any Boolean function can be implemented using only AND gates. TRUE / FALSE

(c) There are at least 4 different ways to draw a 3-variable K-Map. TRUE / FALSE

(d) Wampas and tauntauns are native to the ice planet Hoth. TRUE / FALSE

(e) The axioms of Boolean algebra can be proven with the theorems. TRUE / FALSE

(f) $\text{XOR}(x, x) = x$. TRUE / FALSE

(g) $\text{NAND}(x, 0) = \overline{x}$. TRUE / FALSE

(h) $\overline{x}(x + \overline{y})y = 0$. TRUE / FALSE

(i) $\overline{x} + xy = x + y$. TRUE / FALSE

(j) An SOP expression easily maps to a NOR-NOR implementation. TRUE / FALSE

2. Three-Variable K-Map (5p)

Use a K-map to derive the minimum SOP expression for $f(x, y, z) = \Pi M(1, 4, 5)$.

3. Multiplexer (5p + 5p = 10p)

(a) Draw the circuit diagram for a 2-to-1 multiplexer, which has a Boolean expression $F = \overline{S}\,A + S\,B$

(b) Redraw your circuit form a) using only NAND gates. Clearly label all inputs and outputs of the circuit.

4. Number Conversions (4 x 5p each = 20p)

(a) Convert 10101101_2 to decimal

(b) Convert 123_{10} to binary

(c) Convert 227_{10} to hexadecimal

(d) Convert $\mathtt{C0FFEE}_{16}$ to octal.

5. From Verilog Code to Circuit (10p)

Draw the circuit diagram that corresponds to the Verilog module shown below. Clearly label all inputs, outputs and wires of your circuit.

```
module mystery (A,B,C,F);
     input A,B,C;
     output F;

     nand(X, C, C)

      nand(Y, A, B);

      nand(Z, Y, X);

      nand(F, Z, Z);

endmodule
```

6. Truth Tables (3 x 5p = 15p)

(a) Draw the truth table for the Boolean function $F(X, Y) = (X + \overline{Y}) (\overline{X} + \overline{Y})$
Show partial results for each of the two terms.

(b) Use a truth table to determine if the following Boolean equation is true:

$$\overline{A}\,\overline{C} + \overline{A}\,\overline{B} + \overline{A}\,B\,C = \overline{A}$$

(c) Draw the truth tables for the following 5 logic gates: AND, OR, XOR, NAND, NOR.
Clearly label which table corresponds to which gate.

7. Derive the minimum POS expression using a K-map (10p + 5p = 15p)

(a) Use a K-map to derive the minimum-cost POS expression for the following function

$$f(w, x, y, z) = \Sigma\, m(4, 5, 6, 14, 15) + D(7, 9)$$

(b) Draw the circuit diagram for the expression derived in (a) using only NOR gates. Clearly label all inputs and outputs.

8. Circuit Simplification (3 x 5p = 15p)

(a) Draw the circuit diagram for this Boolean expression (don't simplify it yet)

$$F(A, B, C) = (A + B + C)\ (A + \overline{B} + C)\ (B + C)$$

(b) Use the theorems of Boolean algebra to find a minimum-cost <u>SOP</u> expression for F.

(c) Draw the circuit for the minimum-cost <u>SOP</u> expression. Label all inputs and outputs.

9. Minimization (3 x 5p = 15p)

(a) Draw the K-map that corresponds to the following Boolean function:

$$f = w\,\overline{x}\,z + w\,x\,\overline{y}\,\overline{z} + x\,y\,\overline{z} + \overline{w}\,\overline{x}\,z$$

(b) Redraw the K-map from (a) and derive the minimum-cost <u>SOP</u> expression for f.

(c) Draw the circuit for the minimum-cost <u>SOP</u> expression using only NAND gates. Clearly label all inputs and outputs.

10. Boolean Algebra (10p + 5p = 15p)

(a) Use the theorems of Boolean algebra to simplify the formula given below into a minimum-cost expression.
(b) Draw the circuit diagram for the simplified expression using only NOR gates.

$$F(X, Y, Z) = \overline{(X + \overline{X}\,\overline{Y})}\,(X + Y + \overline{Z}) + \overline{(X + \overline{Y} + X\overline{Y})}\,(\overline{X}\,\overline{Y}\,Z)$$

Question	Max	Score
1. True/False	10	
2. Three-Variable K-map	5	
3. Multiplexer	10	
4. Number Conversions	20	
5. Verilog Module	10	
6. Truth Tables	15	
7. POS with K-Map	15	
8. Circuit Simplification	15	
9. Minimization	15	
10. Boolean Algebra	15	
TOTAL:	130	