CprE 281: Digital Logic
Midterm 1: Friday Sep 21, 2018

Student Name: __________________________ **Student ID Number: _____________**

Lab Section:	**Mon 12-3(P)**	**Tue 11-2(U)**	**Wed 8-11(J)**	**Thur 11-2(Q)**	**Fri 11-2(G)**
(circle one)		**Tue 2-5(M)**	**Wed 11-2(W)**	**Thur 11-2(V)**	
		Tue 2-5(Z)	**Wed 6-9(T)**	**Thur 2-5(L)**	
				Thur 5-8(K)	

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

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

(b) A NOR gat can be built using one AND gate and two NOT gates. TRUE / FALSE

(c) It is possible to build an AND gate with a 4-to-1 multiplexer. TRUE / FALSE

(d) A two-input AND requires more transistors than a three-input OR. TRUE / FALSE

(e) An XOR can be implemented with a 2-to-1 multiplexer and one NOT. TRUE / FALSE

(f) $\overline{x+y} + \overline{x}\,y + x\,\overline{y} + x\,y = 1.$ TRUE / FALSE

(g) $\text{XOR}(x, 1) = \overline{x}$ TRUE / FALSE

(h) $\text{XOR}(\text{XOR}(x, 0), 1) = x$ TRUE / FALSE

(i) A NAND can be implemented with fewer transistors than a NOR. TRUE / FALSE

(j) Tatooine, Alderaan, and Jedha are all planets in the Star Wars universe. TRUE / FALSE

2. **Three-Variable K-map (5p)**

Draw the K-map and derive the minimum **POS** expression for **$f(a,b,c)=\Sigma m(0,4,7)+D(6)$.**

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

(a) Draw the truth table for the Boolean function F that has the following K-Map:

X \ YZ	00	01	11	10
0	0	1	0	0
1	0	1	1	1

(b) Prove that $(x + y) \bullet (x + \bar{y}) = x$ using truth tables.

(c) Draw the truth table for the function $f(a,b,c) = \bar{a}\,b + a\,\bar{c} + \bar{a}\,\bar{b}\,c$.

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

(a) Convert 219_{10} to binary

(b) Convert 1101_4 to decimal

(c) Find the values of the digits x and y in the equation: $XY_5 = 1101_2$

(d) Convert 851304_9 to ternary (base 3)

(e) Compute the following sums where all numbers are in base 5:

$$\begin{array}{r} 43 \\ +\quad 4 \\ \hline \end{array} \qquad\qquad \begin{array}{r} 142 \\ +\quad 13 \\ \hline \end{array}$$

5. Minimization (2 x 5p each = 10p)

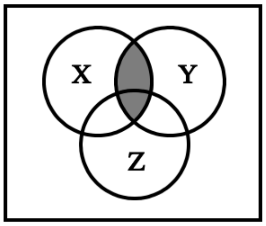
Consider the Boolean function f(X, Y, Z) = $\overline{\overline{(\,\overline{(\,\overline{(Z + Z)} + Y)} + X)} + \overline{(X + Y)}}$

(a) Draw the circuit diagram for this expression using <u>only NOR</u> gates.

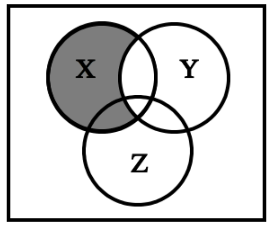
(b) Use the theorems of Boolean algebra to simplify the expression from part (a).

6. Venn Diagrams (3 x 5p each = 15p)

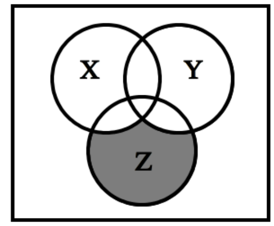
(a) Write the expression that is represented by each of the three Venn diagrams:



(A)



(B)



(C)

A =　　　　**B =**　　　　**C =**

(b) Let F(X, Y, Z) = A + B + C. Use the expressions that you derived in part (a) to draw the K-map for the Boolean function F. Then use the K-map to derive the minimum-cost <u>SOP</u> expression for F.

(c) Draw the circuit for your expression from part (b). Label all inputs and outputs.

7. Derive the minimum SOP expression using a K-map (3 x 5p each = 15p)

(a) Draw the K-map for the following function

$$F(a,b,c,d)=\Sigma m(0, 1, 7, 10, 11) + D(2, 4, 6, 8, 9, 14)$$

(b) Use the K-map to derive the minimum-cost SOP expression for the function F.

(c) Draw the circuit diagram for the minimum expression from part (b).

8. NAND/NOR Logic (2 x 5p each = 10p)
(a) Using <u>only NOR gates</u>, draw the logic circuit that corresponds to this K-map:

B \ A	0	1
0	0	1
1	1	0

(b) Draw the circuit for F(X, Y, Z) = Π M (1, 2, 4, 6, 7) using <u>only NAND gates</u>.

9. **Seven-Segment Display (3 x 5p each = 15p). The truth table for a Boolean function that convers its 4 binary inputs into a 7-segment display code is given below.**

	x_3	x_2	x_1	x_0	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1

(a) Derive a minimum-cost SOP expression for the output b.

(b) Derive a minimum-cost POS expression for the output f.

(c) Derive a minimum-cost POS expression for the output g.

10. Minimization with Theorems (15p)

Use the theorems of Boolean algebra to simplify the following Boolean function

$$f(x, y, z) = x\,y\,\overline{z}\,(x + y) + \overline{z}\,(\overline{x + \overline{y}}) + x\,(\overline{\overline{x} + yz}) + 1\,(z + x\,\overline{y}) + \overline{\overline{x} + z}$$

Question	Max	Score
1. True/False	10	
2. Three-variable K-map	5	
3. Truth Tables	15	
4. Number Conversions	20	
5. Minimization	10	
6. Venn Diagrams	15	
7. SOP with K-Map	15	
8. NAND/NOR Logic	10	
9. Seven-Segment Display	15	
10. Minimization	15	
TOTAL:	130	