CS M51A, Fall 2022, Midterm
(Total Mark: 15 points)

Student Name: **Solution**   Student ID:

1. (2 Points) Using boolean algebra, Simplify the following expression as much as possible.

   (a) $F = (B.C) + (B.1) + (C.0) + (B.B.C)'$

   $$= B \cdot C + B + (B \cdot C)' = 1$$

   (b) $F = (C + A).(B + 1).(A + C)'.(B + C)$

   $$= (A+C) \cdot (A+C)' \cdot 1 \cdot (B+C) = \cancel{\$} \, 0$$

2. (2 Points) Present the following numbers in decimal.

   (a) 1100 is an unsigned number $(1100)_2 = (12)_{10}$

   (b) 1100 is a two's complement $(1100)_2 = (-4)_{10}$

3. (3 Points) Present the Sum of MINTEMRS and Product of MAXTEMRS for the following system, where A, B and C are inputs and F is the output. (Hint: you may first draw a truth table and then write the expressions)

   $F = (A.B) + C$

   $A'B'C + A'BC + AB'C + ABC' + AB$

   $\uparrow$

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

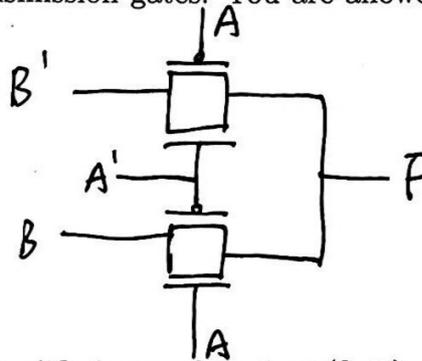   Sum of Minterms : $F = \sum m(1, 3, 5, 6,])$

   Product of Maxterm: $F = \prod M(0, 2, 4)$

   $\downarrow$

   $(A+B+C)(A+B'+C)(A'+B+C)$

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4. (3 Points) Implement F = A XNOR B using transmission gates. You are allowed to use 1, 0, A, A', B, and B' as your signals.

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

A	F
0	B'
1	B

5. (2 Points) Using the following K-Map, write the simplified sum of product (SoP) and product of sum (PoS) terms. (For your convenience, two same K-maps are provided. Use one for SoP and the other for PoS)

$$SoP = x_0' x_2' + x_2 x_3 + x_1' x_2' x_3'$$

$$PoS = (x_3 + x_2')(x_0' + x_3' + x_2) \cdot (x_2 + x_0' +$$

or

$$PoS = (x_3 + x_2') \cdot (x_0' + x_3 + x_1') \cdot (x_3' + x_2 +$$

6. (3 Points) Given the circuit below, complete the table below, determining the resistances for Q_1 to Q_6 and the final output F. The transistors Q_1 to Q_8 should be High or Low (show by 'H' or 'L') resistance. The output F may be 0, 1, float (show by −) or short (show by *). Remember short means the output is connected to both VDD and ground at the same time.
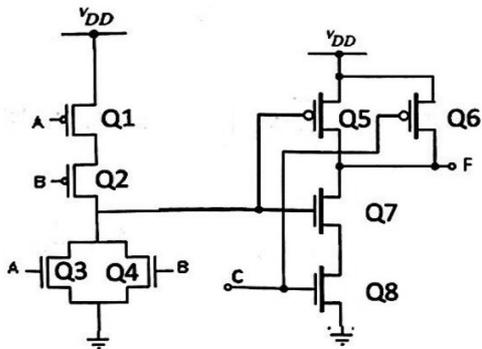
A B C	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	F
0 0 1	L	L	H	H	H	H	L	L	0
1 0 1	H	L	L	H	L	H	H	L	1
1 1 1	H	H	L	L	L	H	H	L	1

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