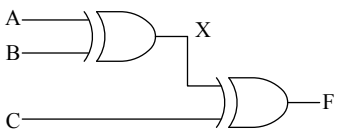
Problem 4 *(10 points)*

(a) *[5 pts.]* Complete the truth table for this circuit.



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

(b) *[5 pts.]* Assume $G = A_1 \oplus A_2 \oplus \ldots \oplus A_7$.

If five of the inputs (among $A_1, A_2, \ldots, A_7$) are equal to 1, then G is equal to ☐

Justify:

Problem 3 *(20 points)*

a) Convert the Boolean function $F = \overline{\overline{XY} \bullet \overline{\overline{X}\,\overline{Y}}}$ to a SOP form. State the identity or method you used in the conversion.

b) Complete the truth table for the Boolean function in part **3a)**.

X	Y	F
0	0	
0	1	
1	0	
1	1	

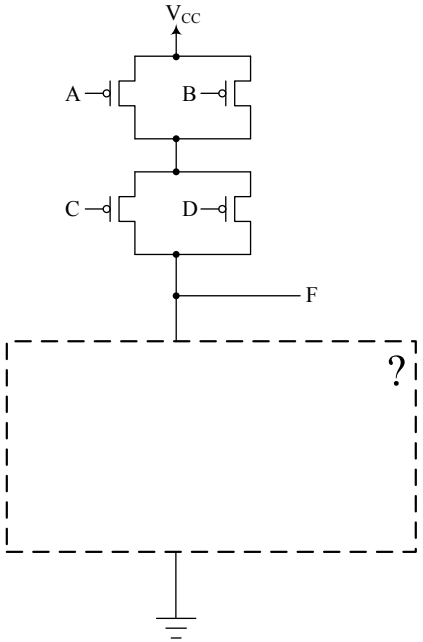
c) For the given truth table, write a Boolean function for it in canonical SOP form.

X	Y	Z	G
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

d) Find the optimal SOP Boolean function for the truth table in **3c)**.
HINT: The optimal corresponding circuit has 3 gates and 4 inputs. Show your work.

Problem 3 *(15 points)*

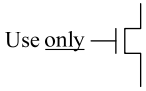
Only the p-mos transistors are shown:



a) *[5 pts.]* Write a Boolean expression for F. (**Hint:** Figure out when F = 1.)

b) *[5 pts.]* Deduce a Boolean expression for $\overline{F}$, then make it SOP form. Show work.

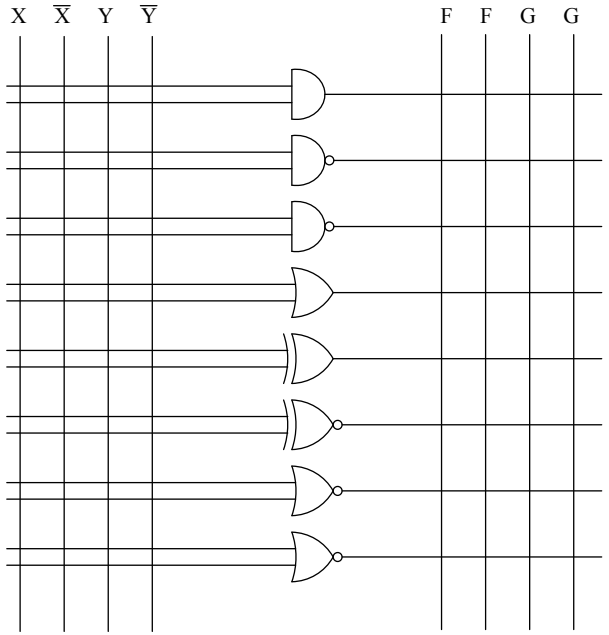
c) *[5 pts.]* Draw a diagram in the ? above, using all nmos transistors so that the output F is always connected to <u>either</u> V_{CC} <u>or</u> to GND but <u>not</u> <u>both</u>.

Use <u>only</u>  nMOS. Draw neatly.

Problem 4 *(10 points)*

Propose <u>two</u> ways of implementing the Boolean functions below, i.e., two <u>different</u> circuits for each of F and G. Each circuit consists of <u>one</u> gate (do not add gates; simple connect wires by drawing dots on the grid where connections should be). Draw neatly for credit, and show work.

X	Y	F	G
0	0	1	0
0	1	0	0
1	0	1	1
1	1	1	0



Problem 5 *(15 points)*

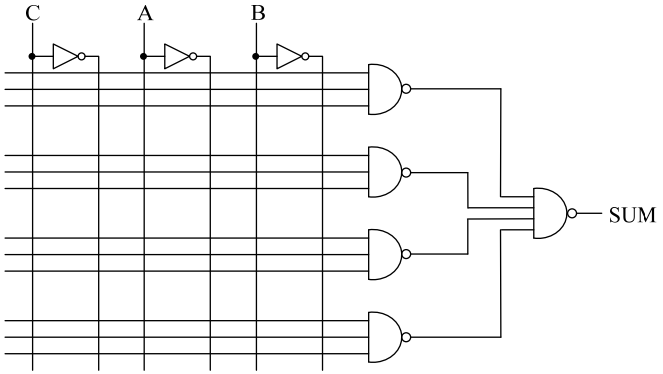
This is the truth table for a Full Adder:

C	A	B	SUM	CARRY
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

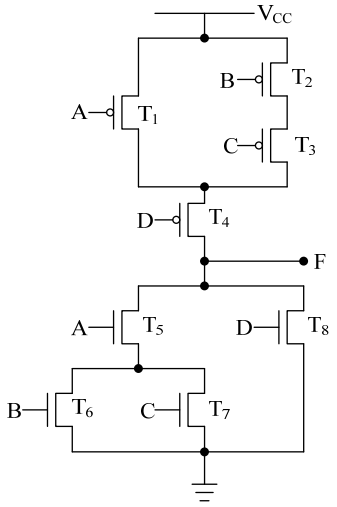
a) *[5 pts.]* Write the canonical SOP for SUM.

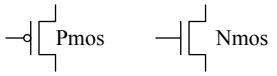
b) *[5 pts.]* Write the canonical SOP for CARRY, then minimize the SOP. Show work.
(**HINT:** In the resulting optimal AND-OR circuit all the AND gates have only two inputs.)

c) *[5 pts.]* Complete the following for SUM. Draw neatly to get credit. Draw dots on the grid where connections should be.



Problem 3 *(20 points)*





(a) *[5 pts.]* Give a Boolean expression with the transistors that must be conducting for F to be equal to 1 [e.g., T_1 and (T_6 or T_4)].

(b) *[5 pts.]* State a Boolean expression with the binary values for A, B, C, D so that F is equal to 1 [e.g., A = 0 and (B = 1 or C = 0)].

(c) *[5 pts.]* Give the Boolean expression for F corresponding to your statement found in (b).

F (A, B, C, D) =

(d) *[5 pts.]* Give an optimal SOP for F.

F (A, B, C, D) =