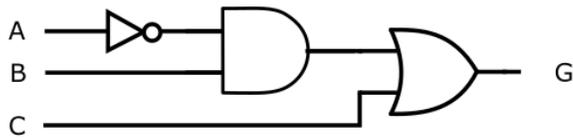
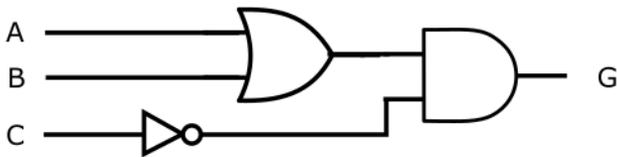


Problem 1: (20 points)

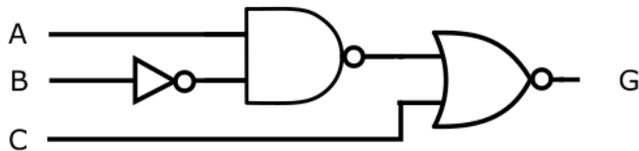
Write a Boolean expression for each of these gate schematics.



G = $\bar{A} \cdot B + C$



G = $(A + B) \cdot \bar{C}$



G = $\overline{A \cdot \bar{B}} + C$

Problem 2: (10 points)

A design team created the following logic expression for a project:

$$X = \overline{\overline{A + B \cdot C}} + A \cdot D \cdot \overline{\overline{E}} + F \cdot G$$

That logic is correct, but at the last minute, the customer added a new requirement:

“Add a new input H. If H is low, output X must be low, otherwise use the same logic as before”

Make the simplest change possible to add the required behavior. You’re welcome to either write a new expression, or just describe what you would do.

AND the whole thing with H

Problem 3: (25 points)

Implement the following Boolean expression in proper CMOS (N-FETs and P-FETs). Assume that inputs and their complements are available (i.e. you may use something like \bar{C} as an input to a FET if needed).

$$F = \overline{(\bar{A} \cdot (\bar{B} + C))} + D$$

Derive expressions for the pull-up and pull-down switch networks (p.u. and p.d.) here:

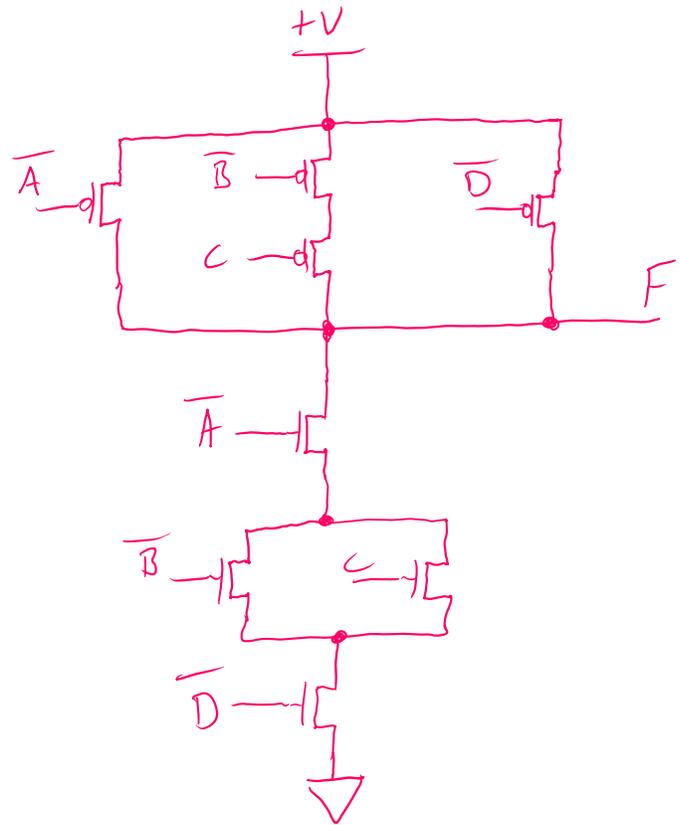
$$p.u. = F = A + B \cdot \bar{C} + D$$

$$p.u. = \underline{A + B \cdot \bar{C} + D}$$

$$p.d. = \bar{F} = \bar{A} \cdot (\bar{B} + C) \cdot \bar{D}$$

$$p.d. = \underline{\bar{A} \cdot (\bar{B} + C) \cdot \bar{D}}$$

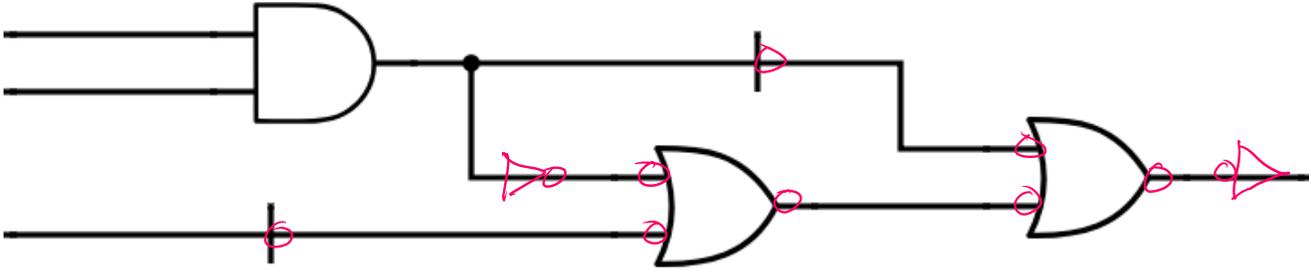
Draw CMOS here:



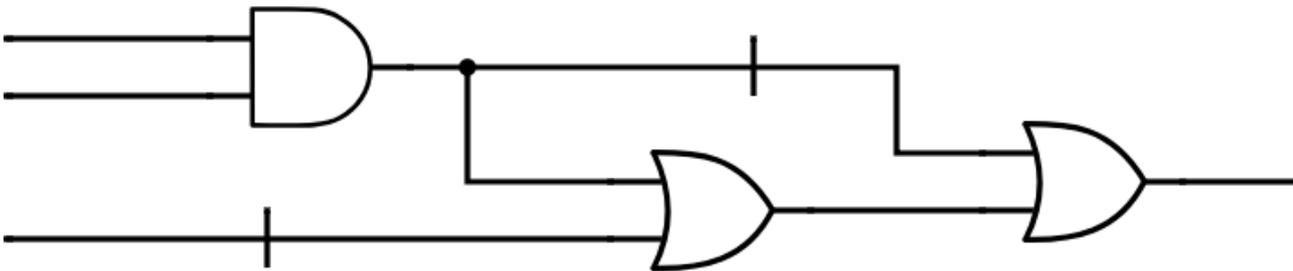
Problem 4: (20 points)

Manipulate the following mixed-logic schematic to implement it using only **ANDs** and **inverters**.

The same circuit is repeated here twice in case you ruin one. Please mark the one that you want graded.



 Mark here if you want this one graded.



 Mark here if you want this one graded.

Problem 5: (25 points)

Using the truth table below, create a K-map and solve for a minimal sum-of-products expression.

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Label the rows and columns of the K-map appropriately.

CP

AB \ CD 00 01 11 10

00	0	0	0	1
01	1	0	0	1
11	1	1	1	1
10	1	0	0	1

All essential

Y = $A \cdot B + C \cdot \bar{D} + B \cdot \bar{D} + A \cdot \bar{D}$