ECE255 – Introduction to Digital Logic Design
Homework Assignment 3
Due September 22

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1. You are given the function $f(a, b, c, d) = \sum(m_5, m_{15}) + \sum d(m_1, m_9, m_{13})$ with 2 minterms and 3 *don't cares*.

(a) Use the don't cares to find the most minimal MSOP Boolean expression for f using a K-map.

equation $\bar{c}d + abd$

Simplest expression. d

ab \ cd	00	01	11	10
00		1		
01		1		
11		1	1	
10		1		

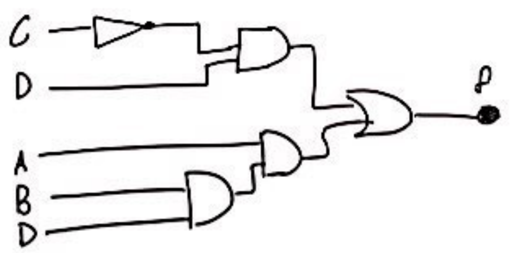
1101 and 1111

We can turn the don't cares to ones and get a group of 4 and 1 2 group for the MSOP.

(b) Using the MSOP form from (a), use the Boolean Algebra rules to further minimize f in terms of fewer gates required and fewer inputs per logic gate. **Show your work.**

my boolean algebra solution is the simplest it can go.

$\boxed{\bar{C}d + ABD.}$



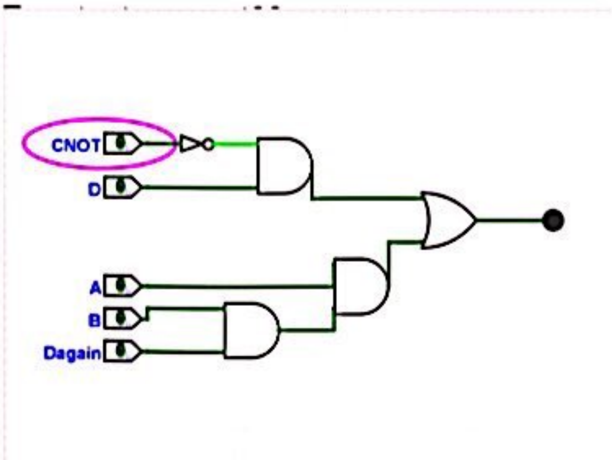
1 inverter

3 AND gates

1 OR gate

1 Led output.

(c) Sketch (or use Logisim) a schematic of the digital circuit that implements your Boolean function from (b).



2. Consider the application of De Morgan's Laws to **implement a digital circuit consisting of only NAND gates**. You may assume complemented inputs to the function are already available.

You are given the function $f(a, b, c) = \sum(m_3, m_4, m_6, m_7)$.

(a) Determine a Boolean expression for f in terms of NAND gates only. Hint: Start with a K-map to find the MSOP and then convert to a NAND based solution by applying De Morgan's Theorem.

C \ AB	00	01	11	10
0	0	1	3: 1	2
1	4: 1	5	7: 1	6: 1

Can really only do groups of two.

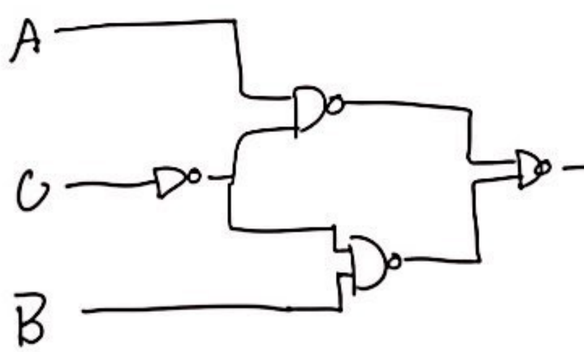
$f = AB + \bar{B}C$ (Inverse the expression) Now apply demorgan's law.

applying demorgan's law.

$(A \cdot B)' + (B' \cdot C)'$ Double negation.

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

(b) Sketch (or use Logisim) a schematic of the digital circuit that implements your NAND-based Boolean function from (a).



$f = \overline{B\bar{C}} \quad \overline{a\bar{c}}$

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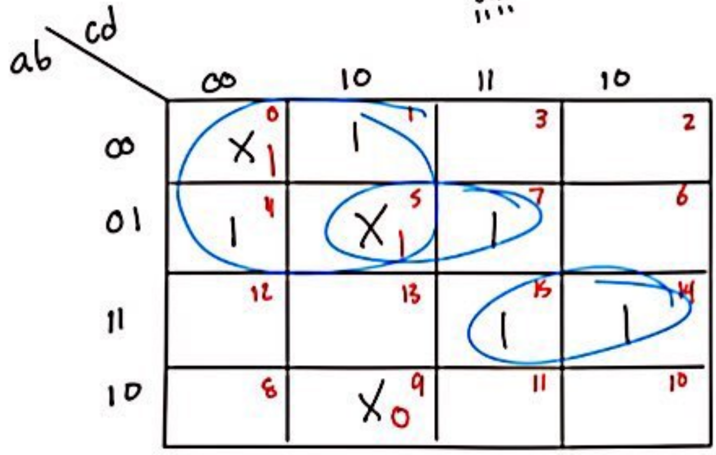
3. You are given the function $f(a, b, c, d) = \sum(m_1, m_4, m_7, m_{14}, m_{15}) + \sum d(m_0, m_5, m_9)$.

(a) Use a K-map to determine the MSOP form for f.

0111
1111



we can form m_0 and m_5 to simplify a group of 4; but m_9 is useless.

group m_5 m_7 and overlap $m_{15} m_{14}$ as that's the simplest.

1111
1110

$f = \bar{a}\bar{c} + ABC + \bar{A}BD$ now simplify.

(b) Sketch (or use Logisim) a schematic of the digital circuit that implements your NAND-based Boolean function from (a).

NAND Based

$f = \overline{\overline{(ABC + BCD + \bar{A}\bar{C})}}$

$= \overline{ABC} + \overline{BCD} + \overline{\bar{A}\bar{C}}$