Quiz 1 (Solutions)

Q1. $+49$ in binary : 00110001

$+29$ in binary : 00011101

Signed-2's-complement representation of -29 can be obtained by first taking signed-1's complement of -9 (which can be obtained by flipping the bits of $+29$) and then adding 1.

-29 in signed-2's complement is

$$
\begin{array}{r}
11100010 \\
+ \quad\quad\quad 1 \\
\hline
11100011
\end{array}
$$

Similarly, -49 is signed-2's complement is

$$
\begin{array}{r}
11001110 \\
+ \quad 1 \\
\hline
1100\,1111
\end{array}
$$

Thus,

$+29 + (-49)$ is

$$
\begin{array}{r}
00011101 \\
+\,11001111 \\
\hline
11101100
\end{array}
$$

How do we know this is correct (-20)?

2's complement of this is

$$
\begin{array}{r}
00010011 \\
+ \quad 1 \\
\hline
00010100
\end{array}
$$

which evaluates to 20.

Similarly,

$(-29) + (-49)$ is

$$
\begin{array}{r}
11100011 \\
+\,11001111 \\
\hline
1011\,0010
\end{array}
$$

We know this is -78 because 2's complement of this answer gives

$$
\begin{array}{r}
01001101 \\
+ \quad 1 \\
\hline
01001110
\end{array}
$$

which is 78.

Q2. a) $(w+xy')(x+y'z)$

$= wx + wy'z + xy' + xy'z$

$= wx + wy'z + xy'(1+z)$

$= wx + wy'z + xy'$ sum of products form

Let us use K-map to get a sum of products form for the complement.

$wx \backslash yz$	00	01	11	10
00	0	0	0	0
01	1	1	0	0
11	1	1	1	1
10	0	1	0	0

Complement of the function is $w'x' + w'y + x'y + wx'z'$

Taking its complement again, we get product of sums expression of the original function.

$$(w'x' + w'y + x'y + wx'z')'$$

$$= (w'x')' \cdot (w'y)' \cdot (x'y)' \cdot (wx'z')'$$

$$= (w+x) \cdot (w+y') \cdot (x+y') \cdot (w'+x+z)$$

Ans.

Similarly for part (b)

$$xy + (w'+y'z')(z'+x'y')$$

$$= xy + w'z' + w'x'y' + y'z' + x'y'z'$$

Sum of products form

We use K-map to get the complement is sum of products form.

wx \ yz	00	01	11	10
00	1	1	0	1
01	1	0	1	1
11	1	0	1	1
10	1	0	0	0

y

x

w

z

complement of the function is

$$wx'y + wy'z + xy'z + x'yz$$

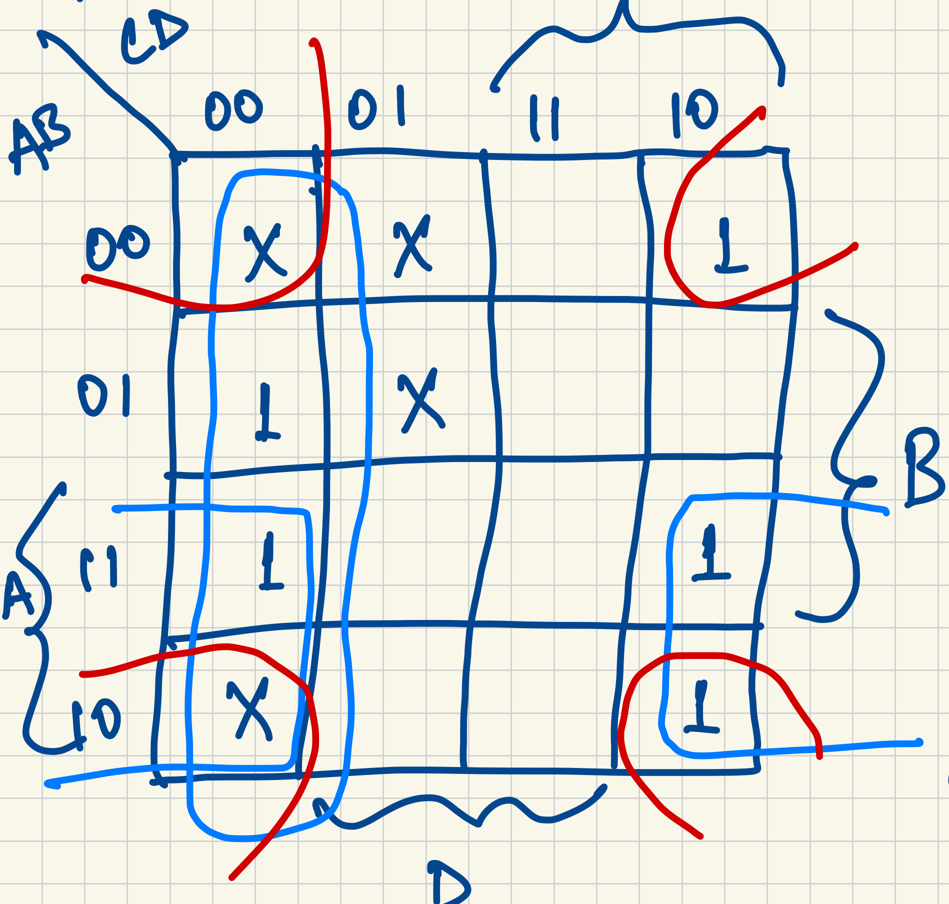
Taking the complement again, we get the desired form

$$(wx'y + wy'z + xy'z + x'yz)'$$

$$= (wx'y)' \cdot (wy'z)' \cdot (xy'z)' \cdot (x'yz)'$$

$$= (w'+x+y') \cdot (w'+y+z') \cdot (x'+y+z') \cdot (x+y'+z') \ \#$$

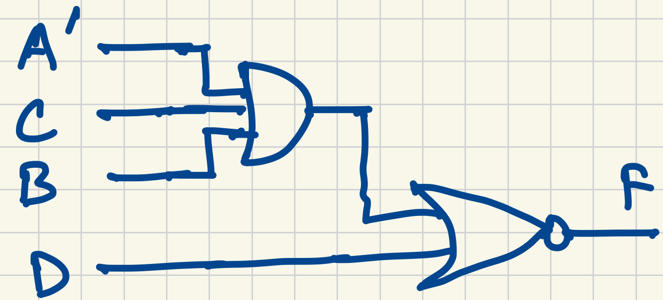
Q3.



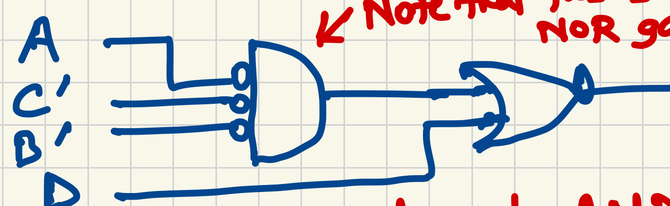
$$F = AD' + C'D' + B'D'$$

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

$$F' = D + A'CB$$



This can also be drawn as



Note that this is a NOR gate in invert-AND graphical representation.

Q4.

AB \ CD	00	01	11	10
00	m_0 1	m_1 0	m_3 0	m_2 0
01	m_4 1	m_5 0	m_7 0	m_6 0
11	m_{12} 1	m_{13} 0	m_{15} 0	m_{14} 1
10	m_8 1	m_9 1	m_{11} 1	m_{10} 1

C B A D

By looking at 1's in the K-map and merging them, we get,

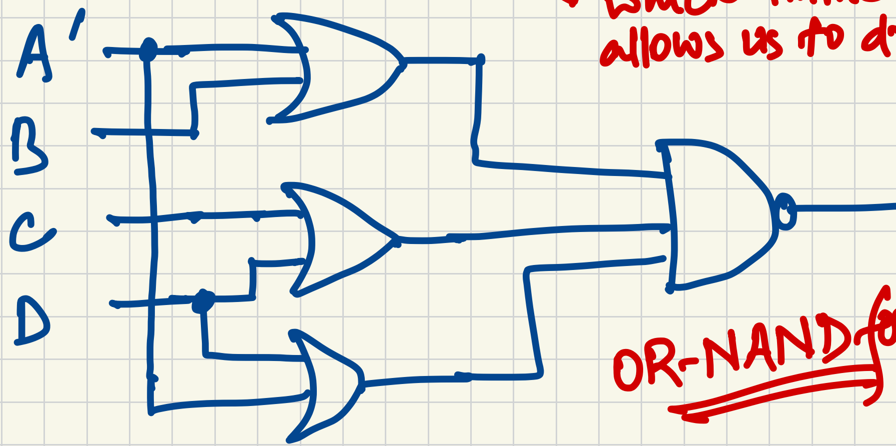
$$f = C'D' + AB' + AD'$$

$$f' = (C+D) \cdot (A'+B) \cdot (A'+D)$$

$$f = \underline{\left((C+D) \cdot (A'+B) \cdot (A'+D) \right)'}$$

OR-AND-Invert form

which immediately allows us to draw:



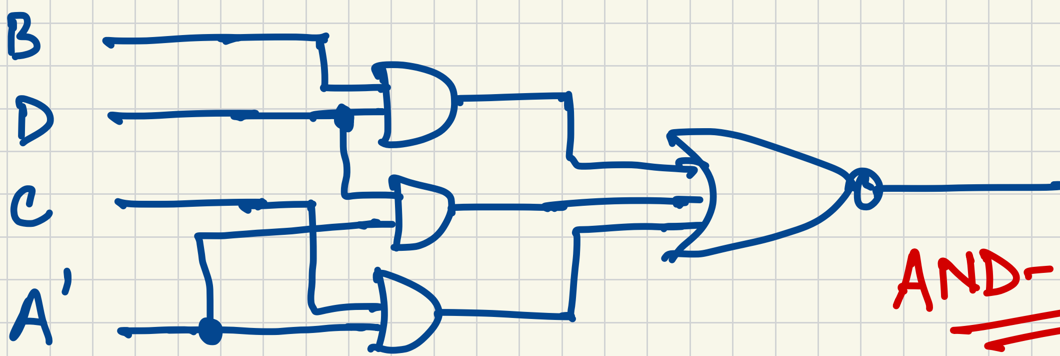
OR-NAND form

Also, by looking at 0's in the same K-map and merging them, we get

$$F' = (BD + DA' + CA')$$

$$F = \underline{(BD + DA' + CA')'}$$

AND-OR-Invert form which immediately allows us to draw



AND-NOR form