

Q1.

a) $f(w, x, y, z) = \sum (1, 4, 5, 6, 7, 12)$

wx \ yz	00	01	11	10
00	m ₀ 1	m ₁ 1	m ₃	m ₂
01	m ₄ 1	m ₅ 1	m ₇ 1	m ₆ 1
11	m ₁₂	m ₁₃ 1	m ₁₅	m ₁₄
10	m ₈	m ₉	m ₁₁	m ₁₀

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

b) $F(w, x, y, z) = \sum (0, 1, 5, 7, 9)$

wx \ yz	00	01	11	10
00	m ₀ 1	m ₁ 1	m ₃	m ₂
01	m ₄	m ₅ 1	m ₇	m ₆
11	m ₁₂	m ₁₃	m ₁₅	m ₁₄
10	m ₈ 1	m ₉ 1	m ₁₁	m ₁₀

$F = x'y' + y'zw'$

Q2.

a) $wyz + w'x + wxz'$

wx \ yz	00	01	11	10
00	1	1	1	1
01	m ₄	m ₅	m ₇	m ₆
11	m ₁₂ 1	m ₁₃	m ₁₅ 1	m ₁₄ 1
10	m ₈	m ₉	m ₁₁ 1	m ₁₀

$F = m_0 + m_1 + m_2 + m_3 + m_{11} + m_{12} + m_{14} + m_{15}$

$F = \sum (0, 1, 2, 3, 11, 12, 14, 15)$

b) $A'B + A'CD + B'CD + BC'D$

AB \ CD	00	01	11	10
00	m ₀	m ₁	m ₃	m ₂
01	m ₄	m ₅	m ₇	m ₆
11	m ₁₂	m ₁₃	m ₁₅	m ₁₄
10	m ₈	m ₉	m ₁₁	m ₁₀

$F = \sum (3, 4, 5, 6, 7, 8, 11, 12)$

Q3.

a) $F(w, x, y, z) = \sum (0, 1, 2, 5, 8, 10, 12) = \pi (3, 4, 6, 7, 9, 11, 13, 15)$

wx \ yz	00	01	11	10
00	m ₀ 1	m ₁ 1	m ₃ 0	m ₂ 1
01	m ₄ 0	m ₅ 1	m ₇ 0	m ₆ 0
11	m ₁₂ 0	m ₁₃ 1	m ₁₅ 0	m ₁₄ 0
10	m ₈ 1	m ₉ 0	m ₁₁ 0	m ₁₀ 1

$F' = yz + wx'z + xz'$

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

b) $F(A, B, C, D) = \pi (1, 2, 6, 9, 11, 12, 14)$

AB \ CD	00	01	11	10
00	m ₀ 0	m ₁ 0	m ₃ 0	m ₂
01	m ₄	m ₅	m ₇	m ₆ 0
11	m ₁₂ 0	m ₁₃	m ₁₅	m ₁₄ 0
10	m ₈	m ₉ 0	m ₁₁ 0	m ₁₀

$F' = B'D + BCD' + ABD'$

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

Q4.

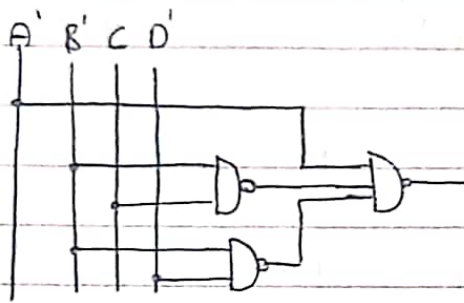
a) $F(A, B, C, D) = A'B'C + AC' + ACD + ACD' + A'B'D'$

AB \ CD	00	01	11	10
00	1		1	1
01				
11	1	1	1	1
10	1	1	1	1

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

Since we need to use NAND gate take two times complement.

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



b) $F(A, B, C) = (A' + B' + C') \cdot (A' + B') \cdot (A' + C')$

BC \ A	00	01	11	10
0	0	0	0	0
1	1	1	1	1

$$F' = A'B' + A'C'$$

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

$$F = (A'B')' \cdot (A'C')'$$

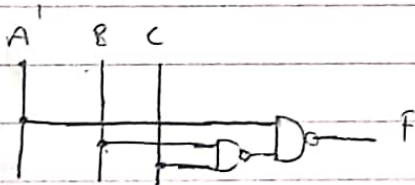
$$F = (A+B) \cdot (A+C)$$

$$F = A + AC + AB + BC$$

$$F = A(1+C) + AB + BC = A + AB + BC$$

$$F = A + BC = ((A + BC)')'$$

$$F = (A' \cdot (BC)')'$$



Q5. $F(A, B, C, D) = (A \oplus B)' (C \oplus D)$

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

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

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

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

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

$$= A'B'C'D + A'B'CD' + ABC'D + ABCD'$$

CD \ AB	00	01	11	10
00	0	1	0	1
01	0	0	0	0
11	0	1	0	1
10	0	1	0	0

$$F' = C'D' + CD + A'B + AB'$$

$$F = (C'D' + CD) \cdot (A'B + AB')$$

Since we asked for two-input NOR gate we take two times complement

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

$$F = \left\{ (C+D)' + (C'+D')' + (A+B)' + (A'+B')' \right\}'$$

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

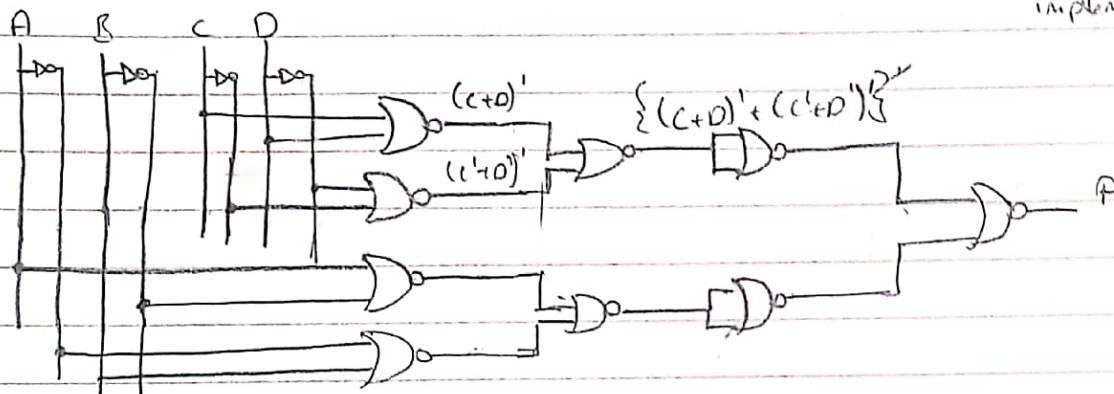
$$F = \left\{ \left\{ (C+D)' + (C'+D')' \right\}' \right\}' + \left\{ \left\{ (A+B)' + (A'+B')' \right\}' \right\}'$$

To get rid of

AND operation

take two times

implemented



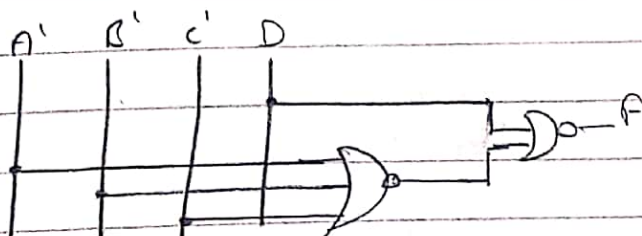
Q6. $F(A,B,C,D) = \sum (2,4,6,10,12)$
 $d(A,B,C,D) = \sum (0,8,9,13)$

AB \ CD	00	01	11	10
00	0 X	1 0	3 0	2 1
01	4 1	5 0	7 0	6 1
11	12 1	13 X	15 0	14 0
10	8 X	9 X	11 0	10 1

$$F' = D + ABC$$

$$F = (D + ABC)'$$

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



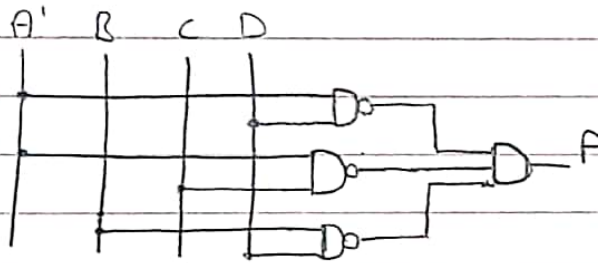
Q7. $F(A,B,C,D) = \sum(0,4,8,9,10,11,12,14)$

AB \ CD	00	01	11	10
00	1	0	0	0
01	1	0	0	0
11	1	0	0	1
10	1	1	1	1

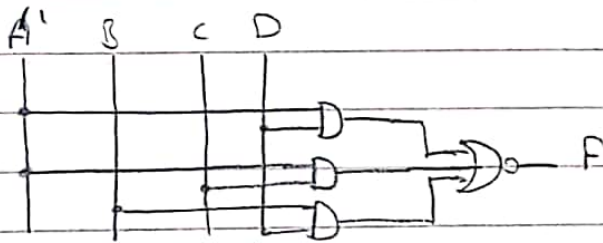
$$F' = A'D + A'C + BD$$

$$F = \{A'D + A'C + BD\}'$$

a) $F = (A'D)' \cdot (A'C)' \cdot (BD)'$ \rightarrow NAND and AND



b) $F = (A'D + A'C + BD)'$ \rightarrow AND, NOR

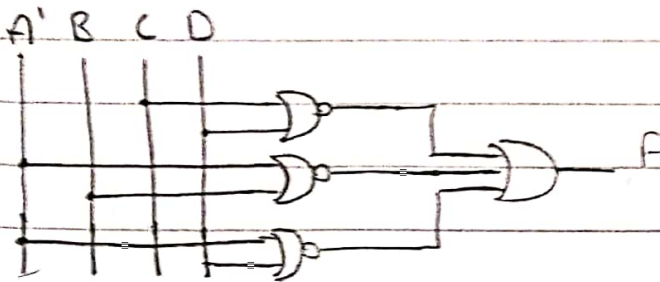


c) Or we can express the function as

$$F = [\{C'D' + AB' + AD\}]' = ((C+D) \cdot (A'+B) \cdot (A'+D))' \rightarrow \text{OR, NAND}$$



d) $F = C'D' + AB' + AD'$
 $= (C+D)' + (A'+B) + (A'+D)$ → NOR, OR



Q8. $D = A \oplus B \oplus C$

$F = ABC' + \underbrace{(A'+B')C}_{(AB)'} = ABC' + (AB)'C = (AB) \oplus C$

