Q1.

a) $f(w,x,y,z) = \Sigma(1,4,5,6,7,13)$

wx \ yz	00	01	11	10
00	M_0 $w'x'y'z'$	M_1 1	M_3	M_2
01	M_4 1	M_5 1	M_7 1	M_6 1 → $w'x$
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) $F(w,x,y,z) = \Sigma(0,1,5,7,9)$

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}

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

Q2.

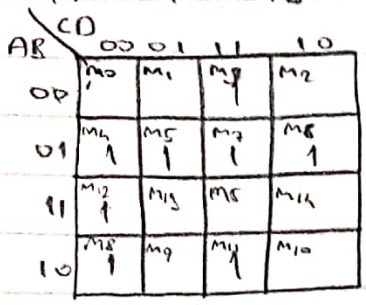
a) $wyz + w'x' + wxz'$

wx \ yz	00	01	11	10
00	M_0 1	M_1 1	M_3 1	M_2 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}

$F = M_0 + M_1 + M_2 + M_3 + M_{11} + M_{12} + M_{14} + M_{15}$

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

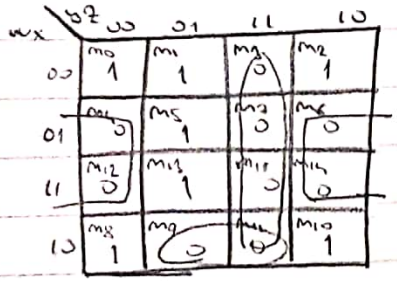
b) $A'B + A'CD + B'CD + BC'D'$



$f = \Sigma(3,4,5,6,7,8,11,12)$

Q3.

a) $F(w,x,y,z) = \Sigma(0,1,2,5,8,10,12) = \pi(3,4,6,7,9,11,12,14,15)$



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

$F = (y'+z').(w'+x+z').(y'+z)$

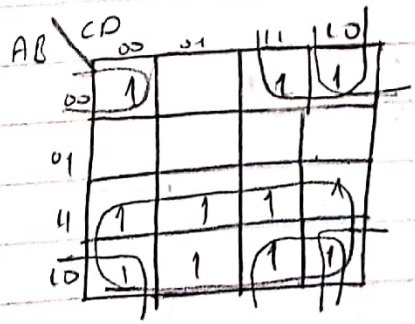
b) $F(A,B,C,D) = \pi(1,3,6,9,11,12,14)$

$f' = B'D + BCD' + AB'D'$

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

Q4.

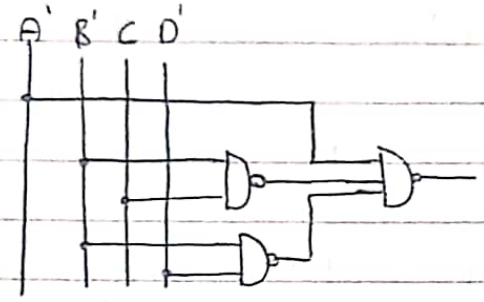
a) $f(A,B,C,D) = A'B'C' + AC' + ACD + ACD' + A'B'D'$



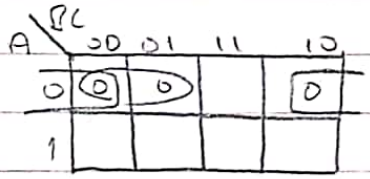
$f = A + B'C + B'D'$

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

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



b) $f(A,B,C) = (A'+B'+C').(A'+B').(A'+C')$



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

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

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

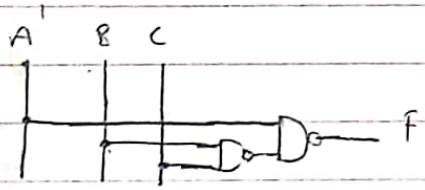
$f = (A+B).(A+C)$

$f = A + AC + AB + BC$

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

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

$f = (A'.(BC)')'$



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

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

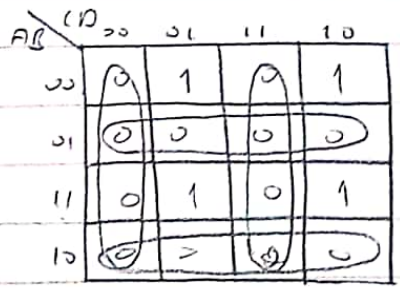
$= (AB)'.(A'B)'(CD' + C'D)$

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

$= (A'A' + A'B' + AB + BB').(C'D + CD')$

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

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



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

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

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

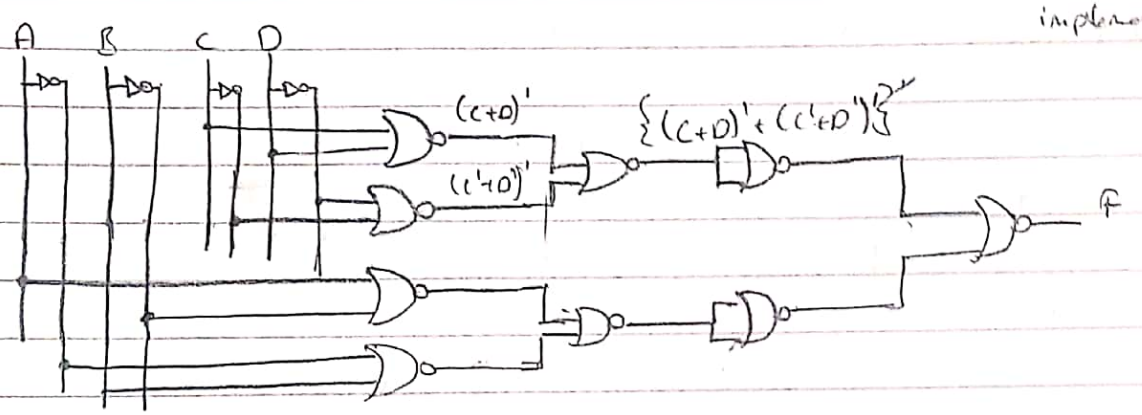
$$F = \{(C+D).(C'+D')(A+B').(A'+B)\}''$$

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

$$f = \{[\{(C+D)' + (C'+D)'\}'] \cdot \{(A+B)' + (A'+B)'\}\}'$$

$$f = [\{(C+D)' + (C'+D)'\}' + [\{(A+B)' + (A'+B)'\}']]'$$

To get rid of AND operation take two times implement



Q6. $f(A,B,C,D) = \Sigma(2,4,6,10,12)$

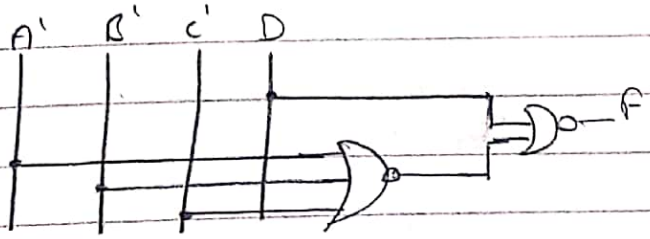
$d(A,B,C,D) = \Sigma(0,8,9,13)$

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

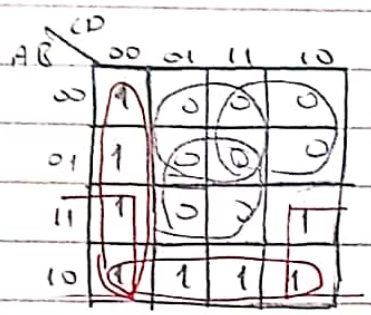
$f' = D + AB'C$

$f = (D + AB'C)'$

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



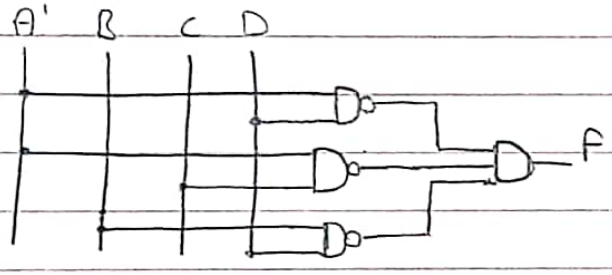
Q7. $F(A,B,C,D) = \Sigma(0,4,8,9,10,11,12,14)$



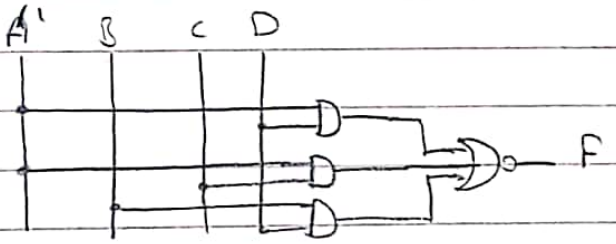
$F' = A'D + A'C + BD$

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

a) $F = (A'D)'.(A'C)'.(BD)'$ → NAND and AND

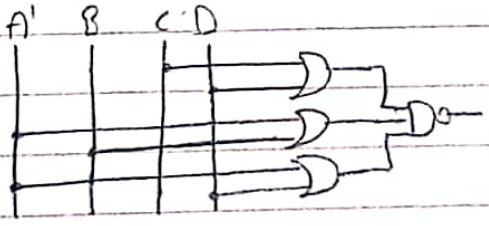


b) $F = (A'D + A'C + BD)'$ → AND, NOR



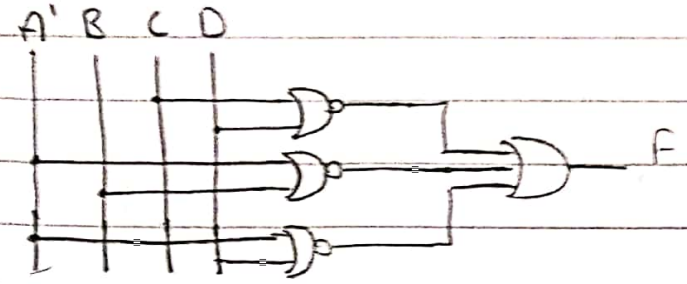
c) Or we can express the function as

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



d) $F = C'D' + AB' + AD'$

$= (C+D)' + (A'+B)' + (A'+D)'$ → NOR , OR



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

$f = ABC' + (A'+B')C = ABC' + (AB)'C = (AB) \oplus C$

$(AB)'C$