EE1005 – Digital Logic Design

Assignment 3 (Solution)

Spring 2023

Maximum Marks: 100	**Due Date:** 22 March 2023

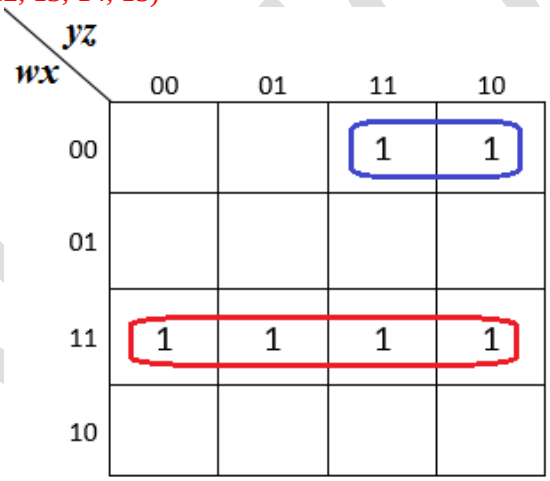
Instructions:

- Partially or fully **copied assignments** will be marked as **zero**.
- Only **handwritten** solution on **A4 page** will be accepted.
- Late submissions are not allowed.
- Clearly indicate all the calculations in your solution. No points will be awarded in case of missing calculations.
- You can submit your assignment **before 5:00 PM** on/before due date.

Question Number 1 **(20 marks)**

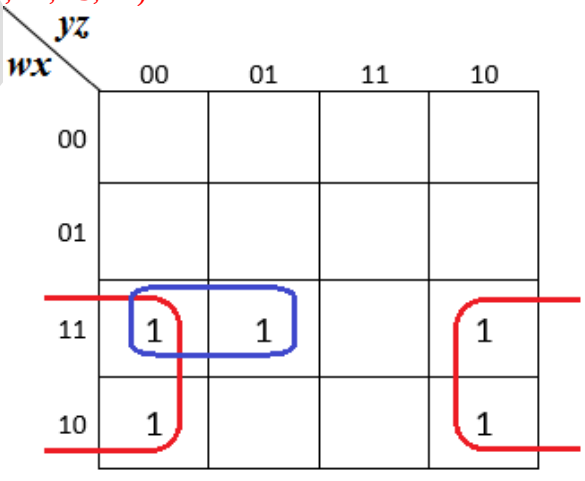
Simplify the following Boolean Functions by using K – Map

a) F(w, x, y, z) = Σ(2, 3, 12, 13, 14, 15)



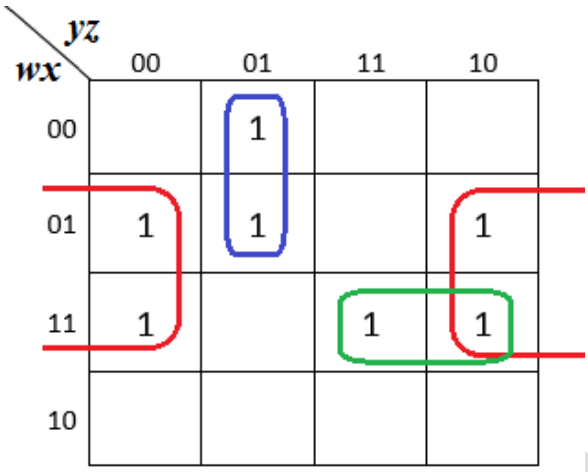
$F = wx + w'x'y$

b) F(w, x, y, z) = Σ(8, 10, 12, 13, 14)



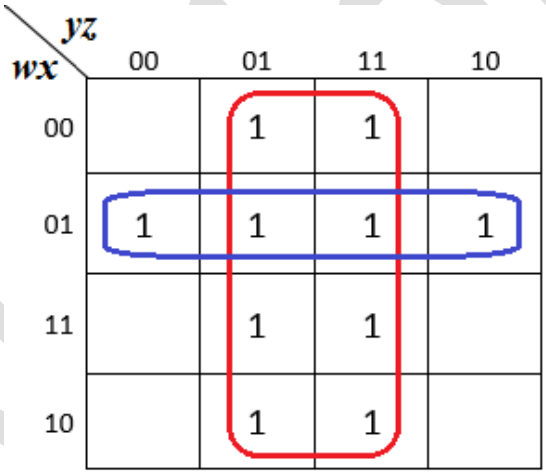
$F = wz' + wxy'$

c) F(w, x, y, z) = Σ(1, 4, 5, 6, 12, 14, 15)



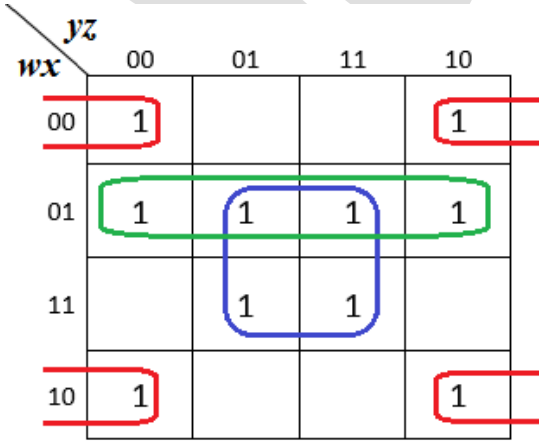
$F = xz' + w'y'z + wxy$

d) F(w, x, y, z) = Σ(1, 3, 4, 5, 6, 7, 9, 11, 13, 15)



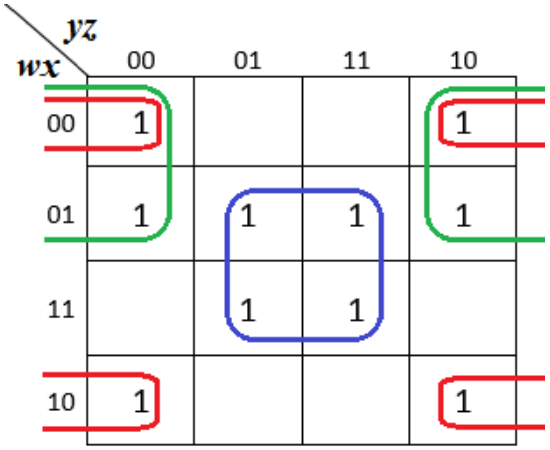
$F = z + w'x$

e) F(w, x, y, z) = Σ(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)



$F = x'z' + xz + w'x$

OR



$F = x'z' + xz + w'z'$

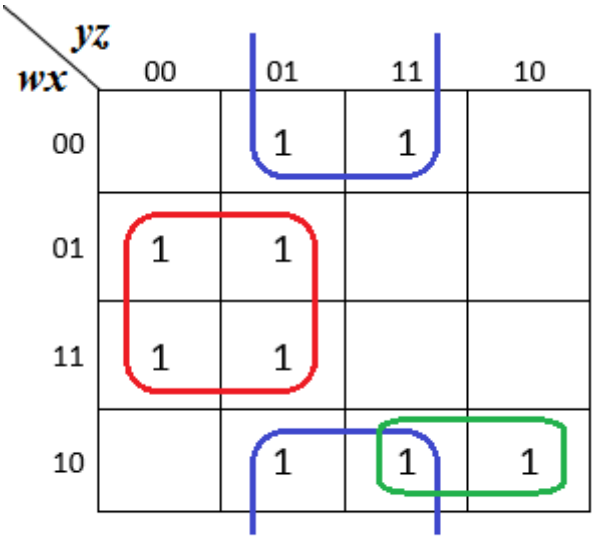
Question Number 2 **(20 marks)**

Simplify the following Boolean Functions by using K – Map

a) F(w, x, y, z) = x'z + w' xy' + w(x'y + xy')

After completing the minterms we will get

F(w, x, y, z) = Σ(1, 3, 4, 5, 9, 10, 11, 12, 13)

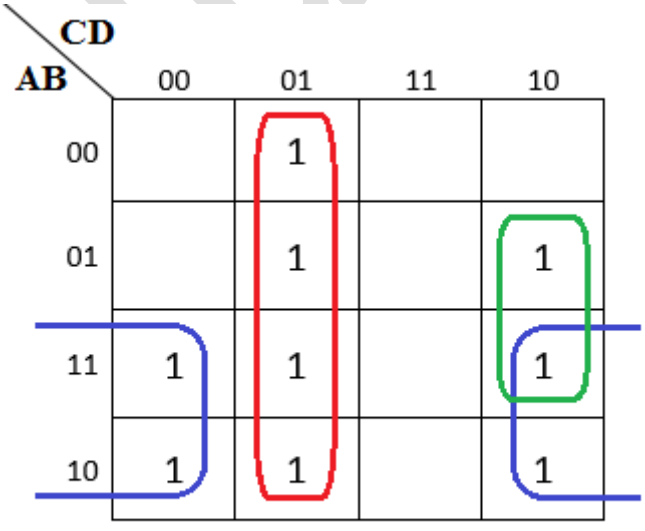


$$F = xy' + x'z + wx'y$$

b) F(A, B, C, D) = AD' + B'C'D + BCD' + BC'D

After completing the minterms we will get

F(A, B, C, D) = Σ(1, 5, 6, 8, 9, 10, 12, 13, 14)

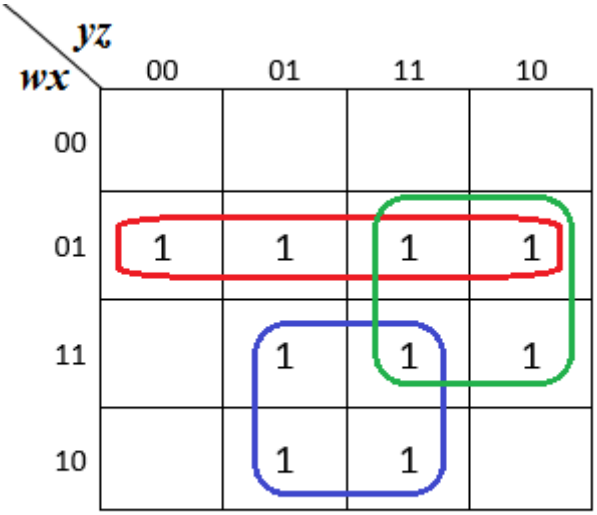


$$F = C'D + AD' + BCD'$$

c) F(w, x, y, z) = wxy + xz + wx'z + w'x

After completing the minterms we will get

F(w, x, y, z) = Σ(4, 5, 6, 7, 9, 11, 13, 14, 15)

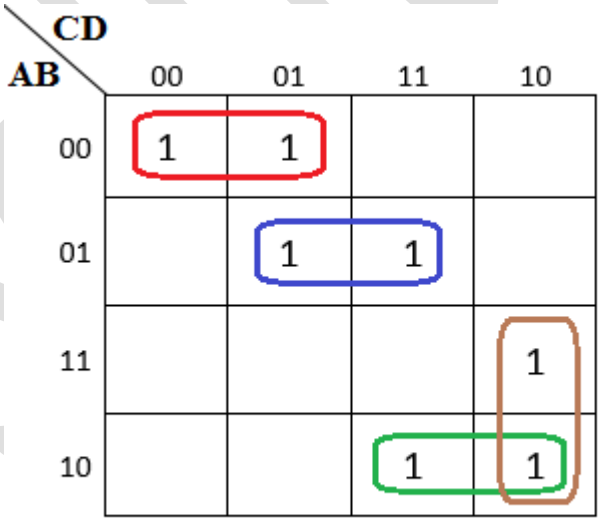


$$F = w'x + wz + wy$$

d) F(A, B, C, D) = A'B'C'D' + BC'D + A'C'D + A'BCD + ACD'

After completing the minterms we will get

F(A, B, C, D) = Σ(0, 1, 5, 7, 10, 11, 14)

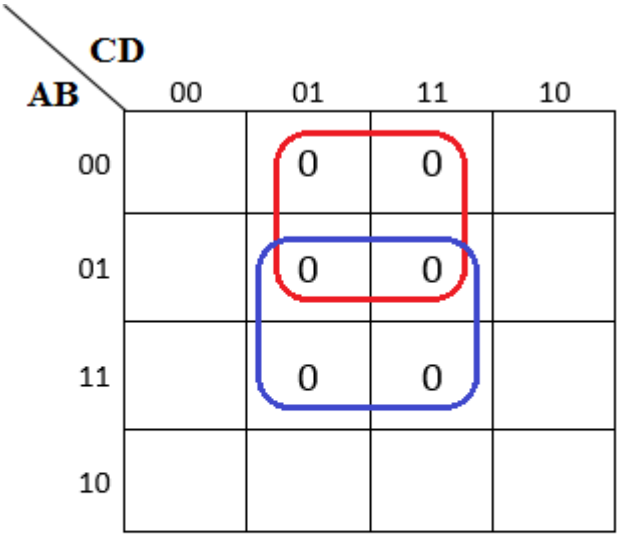


$$F = A'B'C' + A'BD + AB'C + ACD'$$

Question Number 3 **(10 marks)**

Simplify the following Boolean functions in product of Maxterms.

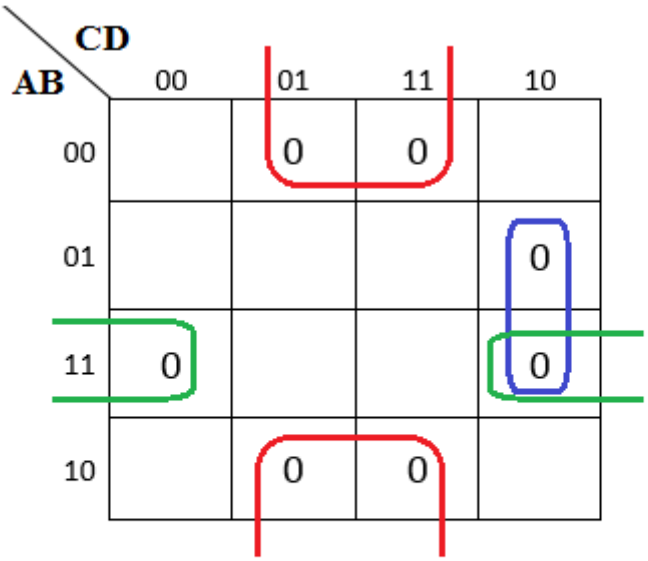
a) F(A, B, C, D) = Π (1, 3, 5, 7, 13, 15)



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

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

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



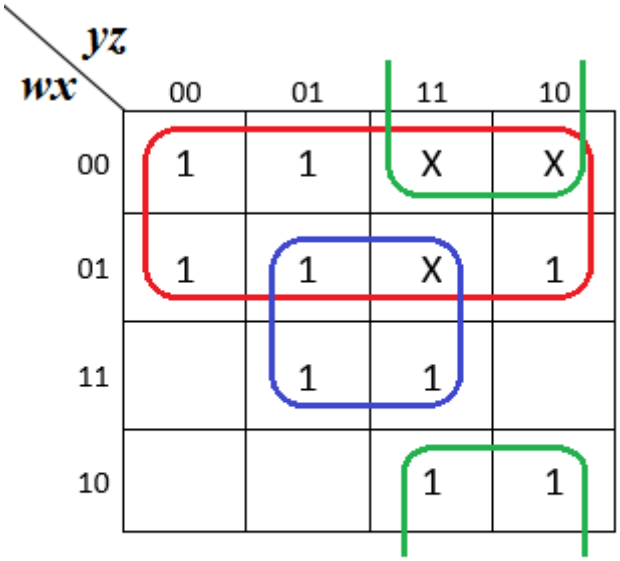
$$F' = B'D + BCD' + ABD'$$

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

Question Number 4 **(20 marks)**

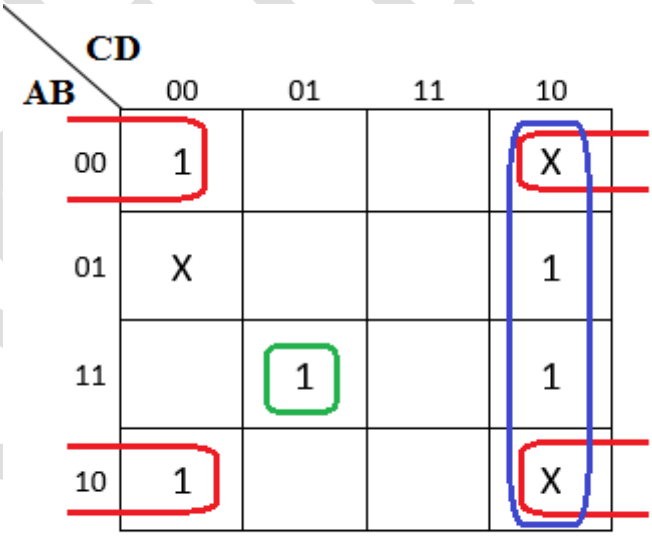
Simplify the following Boolean function F, together with the don't-care conditions d.

a) F(w, x, y, z) = Σ(0, 1, 4, 5, 6, 10, 11, 13, 15) d(w, x, y, z) = Σ(2, 3, 7)



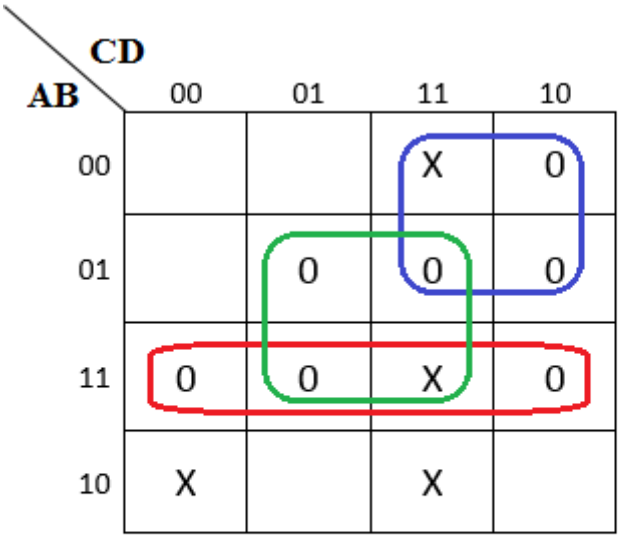
$$F = w' + xz + x'y$$

b) F(A, B, C, D) = Σ(0, 6, 8, 13, 14) d(A, B, C, D) = Σ(2, 4, 10)



$$F = B'D' + CD' + ABC'D$$

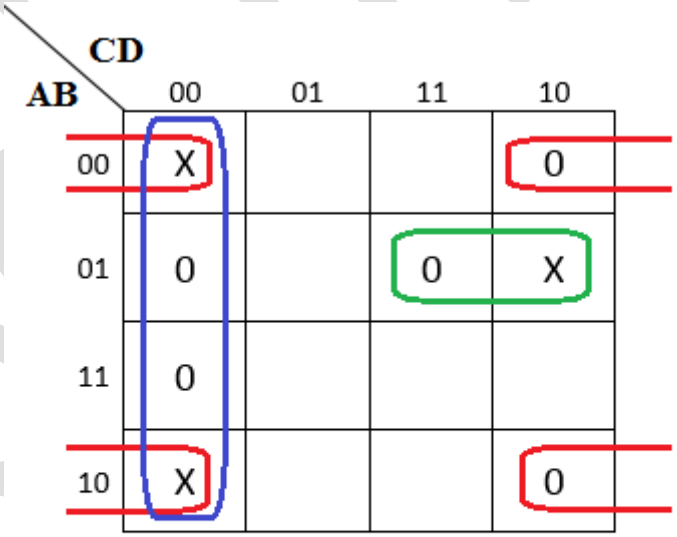
c) F(A, B, C, D) = Π(2,5, 6, 7, 12, 13,14) d(A, B, C, D) = Π (3, 9, 11, 15)



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

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

d) F(A, B, C, D) = Π (4, 12, 7, 2, 10) d(A, B, C, D) = Π (0, 6, 8)



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

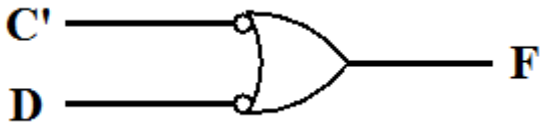
$$F' = (B + D)\,(C + D)\,(A + B' + C')$$

Question Number 5 **(10 marks)**

Simplify the following functions, and implement them with two-level NAND gate circuits:

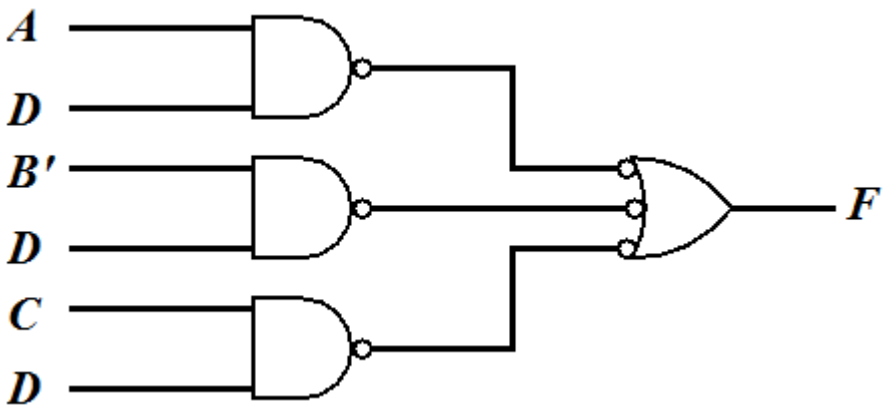
a) F(A, B, C, D) = AC'D' + A'C + ABC + AB'C + A'C'D'

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



b) F(A, B, C, D) = A'B'C'D + CD + AC'D

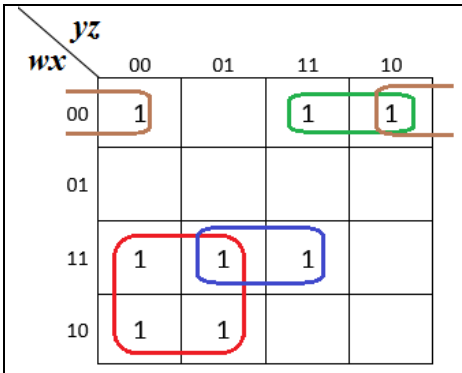
F(A, B, C, D) = C'D(A'B' + A) + CD
F(A, B, C, D) = C'D[(A + A')(A + B')] + CD
F(A, B, C, D) = C'D(A + B') + CD
F(A, B, C, D) = D[C'(A + B') + C]
F(A, B, C, D) = D[(C + C')(C + A + B')]
F(A, B, C, D) = D[C + A + B']
F(A, B, C, D) = AD + B'D + CD



Question Number 6 **(10 marks)**

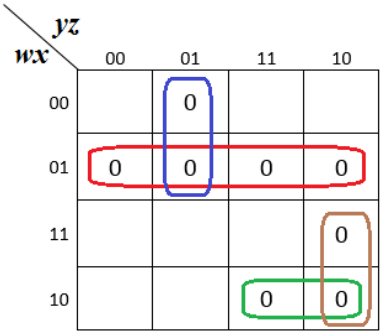
Simplify the following functions, and implement them with two-level NOR gate circuits:

a) F(w, x, y, z) = Σ(0, 2, 3, 8, 9, 12, 13, 15)



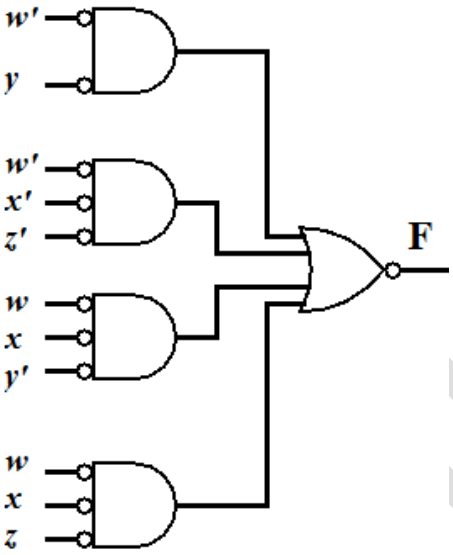
$F = wy' + wxz + w'x'y + w'x'z'$

OR



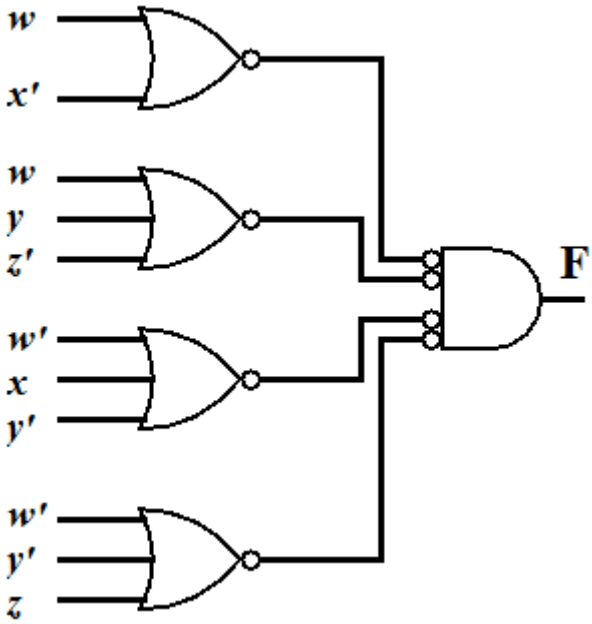
$F' = w'x + w'y'z + wx'y + wyz'$

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



Instead of w'x'z' we can also write x'y'z'

OR



Instead of (w' + y' + z) we can also write (x' + y' + z)

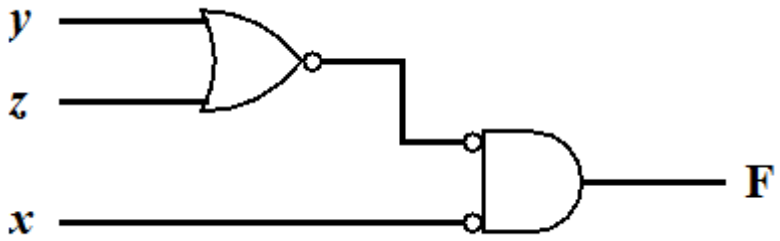
b) F(x, y, z) = [(x + y)(x + z)]'

F(x, y, z) = [x + xz + xy + yz]'

F(x, y, z) = [x(1 + y + z) + yz]'

F(x, y, z) = [x + yz]'

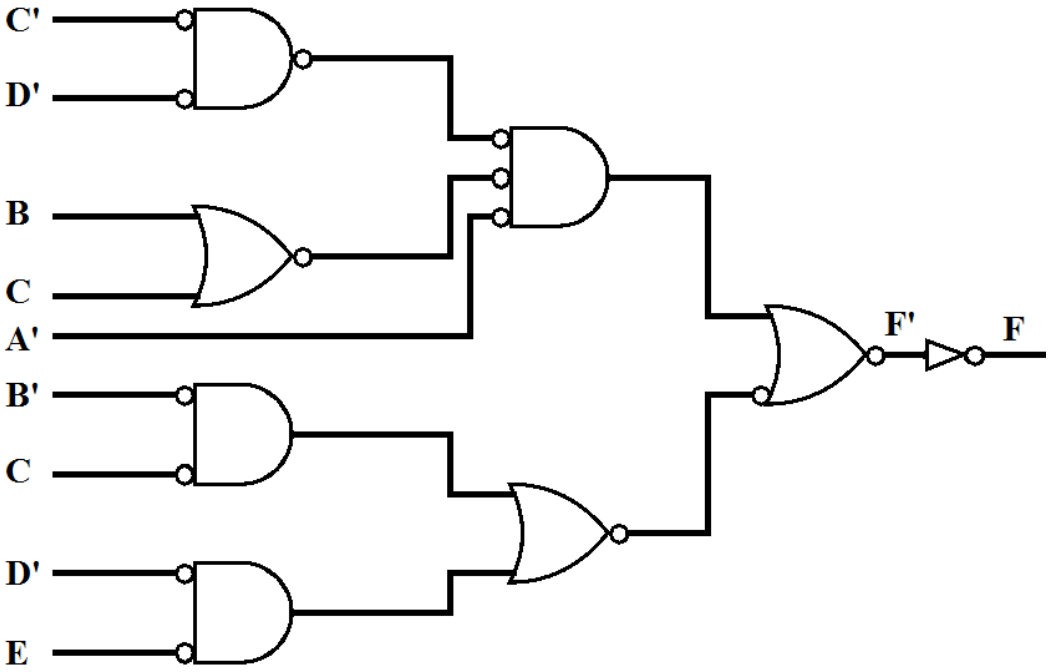
F(x, y, z) = (x')(y + z)



Question Number 7 **(05 marks)**

Draw the multi-level NOR circuit for the following expression:

$$CD(B + C)A + (BC' + DE')$$



Question Number 8 **(05 marks)**

Draw the multi-level NAND circuit for the following expression:

$$w(x + y + z) + xyz$$