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SUBJECT : ECE 2002

1 Obtain 1's and 2's complement

(i) 0010000

1's ⇒ 1101111

2's ⇒ 1110000

(ii) 11011010

1's ⇒ 00100101

2's ⇒ 00100110

(iii) 10101010

1's ⇒ 01010101

2's ⇒ 01010110

(iv) 10000101

1's ⇒ 01111010

2's ⇒ 01111011

(v) 11111111

1's ⇒ 00000000

2's ⇒ 00000001

2 9's and 10's complement of the following

(i) 25,478,036 $= (10^8 - 1) - 25,478,036$

9's $= 74521963$

10's = 74521964

(ii) 63,325,600

9's = 99,999,999 − 63,325,600 = 36674399

10's = 36674400

(iii) 25,000,000

9's = 99,999,999 − 25,000,000 = 74999999

10's = 75000000

(iv) 00,000,000

9's = 99,999,999

10's = 100,000,000

3) i) 2's comp of $(10010)_2$ ⇒

$$\begin{array}{r} 01101 \\ +1 \\ \hline 01110 \end{array}$$

$$\begin{array}{r} 10011 \\ +01110 \\ \hline ①\ 00001 \end{array}$$

⇒ 00001

(ii) 2's comp of $(100110)_2$ =

$$\begin{array}{r} 011001 \\ +1 \\ \hline 011010 \end{array}$$

STEP 1:

$$\begin{array}{r} 100010 \\ 011010 \\ \hline 111100 \end{array}$$

STEP 2: Subtract 1 (binary subtraction)

$$\begin{array}{r} 111100 \\ -\quad 1 \\ \hline 111011 \end{array}$$

STEP 3: Recomplement = 000100

= -100 (ans)

(iii) 2's comp of $(110101)_2$ = 001010 → 1's comp

$$\begin{array}{r} 001010 \\ +1 \\ \hline 1011 \end{array}$$ → 2's comp

STEP 1:

$$\begin{array}{r} 1001 \\ 1011 \\ \hline ①\ 0100 \end{array}$$

⇒ 0100 (ans)

(iv) 2's comp of $(10101)_2$ = 01010 → 1's comp

$$\begin{array}{r} 01010 \\ +1 \\ \hline 1011 \end{array}$$ → 1' comp

STEP 1:

$$\begin{array}{r} 101000 \\ 001011 \\ \hline 110011 \end{array}$$

no carry

STEP 2: Subtract 1

$$\begin{array}{r} 110011 \\ -\quad 1 \\ \hline 110010 \end{array}$$

⇒ Recomplement ⇒ 001101 ; Final solution = -1101

4 (i) 4637 − 2579

10's comp of 2579 = 9999
2579
7420 → 9's comp
+1
7421 → 10's comp

STEP 1: 4637
7421
① 2058

⇒ Final ans = 2058

VERIFY: 4037 − 2579 = 2058

(ii) 10's comp of 1800 = 9999
−1800
8199 → 9's comp
+1
8200 → 10's comp

STEP 1: 0125
8200
8325

STEP 2: 9999
−8325
1674 → 9's comp
+1
1675 → 10's comp ⇒ Final ans = −1675

(iii) 10's comp of 4361 = 9999
−4361
5638 → 9's comp
+1
5639 → 10's comp

STEP 1: 2043
5639
7682 → 9's comp

no carry

9999
7682
2318 → 10's comp

Final answer = −2318

(iv) 10's comp →

$$\begin{array}{r} 9\,9\,9\,9 \\ -\ 7\,4\,5 \\ \hline 9\,2\,5\,4 \end{array} \rightarrow 9\text{'s comp}$$

$$\begin{array}{r} +\ 1 \\ \hline 9\,2\,5\,5 \end{array} \rightarrow 10\text{'s comp}$$

$$\begin{array}{r} 1\,6\,3\,1 \\ 9\,2\,5\,5 \\ \hline ①\ 8\,8\,6 \end{array}$$

Final answer = 886

5 Rules

1) Compliment : $(A')' = A$

AND: $A.A = A$

$A \cdot 0 = 0$

$A \cdot 1 = A$

$A \cdot A' = 0$

OR: $A + A = A$

$A + 0 = 0$

$A + 1 = 1$

$A + A' = 1$

DISTRIBUTIVE: $A + BC = (A+B) \cdot (A+C)$

$A \cdot (B + C) = AB + AC$

* $A + A'B = A + B$

$A' + AB = A' + B$

DE MORGAN's LAW: $(A+B)' = A'B'$

$(A \cdot B)' = A' + B'$

6 (a) $A'C' + ABC + AC'$

$A'C' + AC' + ABC$

$= C'(A' + A) + ABC$

$= C' . 1 + ABC$

$= C' + ABC$

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

$= AB + C'$

(b) $(x'y' + z)' + z + xy + wz$

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

$(x'y' + z)' + z(1 + w) + xy$

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

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

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

$(z + (x + y)) . 1 + xy$

$x + y + z + xy$

$x + y + z$

(c) $A'B(D' + C'D) + B(A + A'CD)$

$= A'BD' + A'BC'D + AB + A'BCD$

$= A'BD(C + C') + A'BD' + AB$

$= A'BD + A'BD' + AB$

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

$= A'B + AB$

$= B(A' + A)$

$= B$

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

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

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

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

$AA' + A'B + A'C'D$

$A'B + A'C'D$

$A'(B + C'D)$

(e) $ABC'D + A'BD + ABCD$

$ABD(C' + C) + A'BD$

$ABD + A'BD$

$BD(A + A')$

$= \underline{\underline{BD}}$

7 Obtain truth table and express SOP and POS Forms:

(i) $(b+cd)(c+bd)$

| | b | c | d | cd | b+cd | bd | c+bd | (b+cd)(c+bd) |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 4 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 5 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 6 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Sum of minterms $\Rightarrow (\bar{b}\cdot c\cdot d)+(b\cdot\bar{c}\cdot d)+(b\cdot c\cdot\bar{d})+(b\cdot c\cdot d)=\Sigma(3,5,6,7)$

Product of maxterms $\Rightarrow (b+c+d)\cdot(b+c+\bar{d})\cdot(b+\bar{c}+d)\cdot(\bar{b}+c+d)=\Pi(0,1,2,4)$

(ii) $(cd+b'c+bd')(b+d)$

| | b | c | d | cd | b' | b'c | d' | bd' | (b'c+bd'+cd) | (b+d) | (b'c+bd'+cd)(b+d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 4 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 3 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 5 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 6 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

Sum of minterms $= (b\cdot\bar{c}\cdot\bar{d})+(\bar{b}\cdot c\cdot d)+(b\cdot c\cdot\bar{d})+(b\cdot c\cdot d)=\Sigma(3,4,6,7)$

Product of maxterms $=(b+c+d)\cdot(b+c+\bar{d})\cdot(b+\bar{c}+d)\cdot(\bar{b}+c+\bar{d})=\Pi(0,1,2,5)$

(iii) $(c' + d)(b + c')$

| | b | c | d | $c'+d$ | $c'+b$ | $(c'+d)(c'+b)$ | $c'$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 4 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 3 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 5 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 6 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

sum of minterms = $(\bar{b}.\bar{c}.\bar{d}) + (\bar{b}.\bar{c}.d) + (b.\bar{c}.\bar{d}) + (b.\bar{c}.d) + (b.c.d) = \Sigma(0,1,4,5)$

Product of maxterms $= (b+\bar{c}+d).(\bar{b}+\bar{c}+\bar{d}).(\bar{b}+\bar{c}+d) = \Pi(2,3,6,7)$

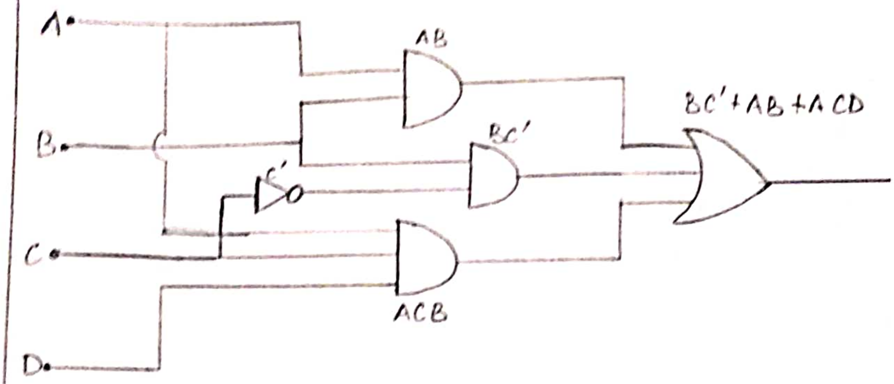
(iv) $bd' + acd' + ab'c + a'c'$

| | a | b | c | d | $bd'$ | $acd'$ | $d'$ | $ab'c$ | $a'c'$ | $bd'+acd'+ab'c+a'c'$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 4 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 12 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 9 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 13 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 7 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |

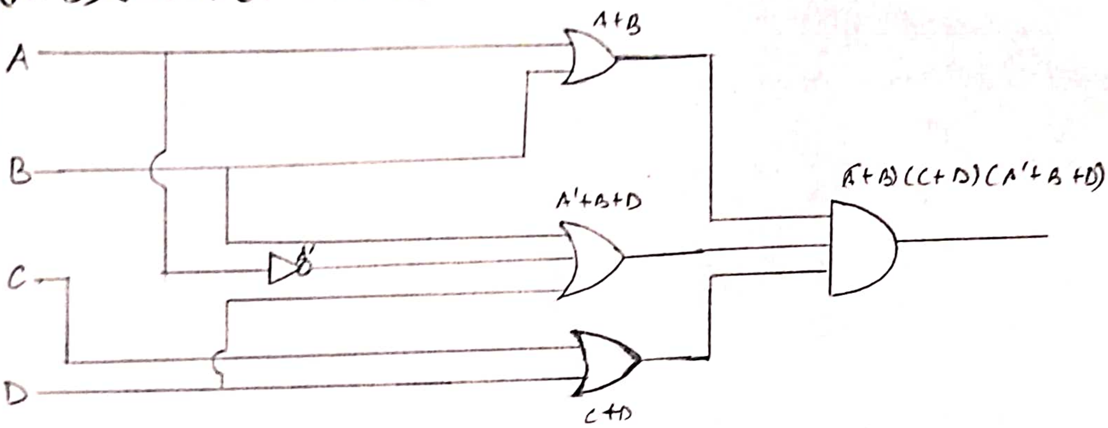
sum of minterms = $(\bar{a}.\bar{b}.\bar{c}.\bar{d}) + (\bar{a}.\bar{b}.\bar{c}.d) + \cancel{(a.\bar{b}.\bar{c}.\bar{d}) + (\bar{a}.b.\bar{c}.\bar{d})}$
$+ (\bar{a}.b.\bar{c}.\bar{d}) + (a.b.\bar{c}.\bar{d}) + (a.\bar{b}.c.\bar{d}) + (\bar{a}.b.c.\bar{d}) + (a.b.c.\bar{d})$
$+ (a.\bar{b}.c.d) + (\bar{a}.b.\bar{c}.d) = \Sigma(0,1,4,12,10,6,14,11,5)$

Product of sums(max) = $(a+b+\bar{c}+d).(\bar{a}+b+c+d).(\bar{a}+b+c+\bar{d}).(a+b+\bar{c}+\bar{d}).(\bar{a}+\bar{b}+c+\bar{d})$
$+ (a+\bar{b}+\bar{c}+\bar{d}).(a+\bar{b}+c+\bar{d}) = \Pi(2,8,9,3,13,7,15)$

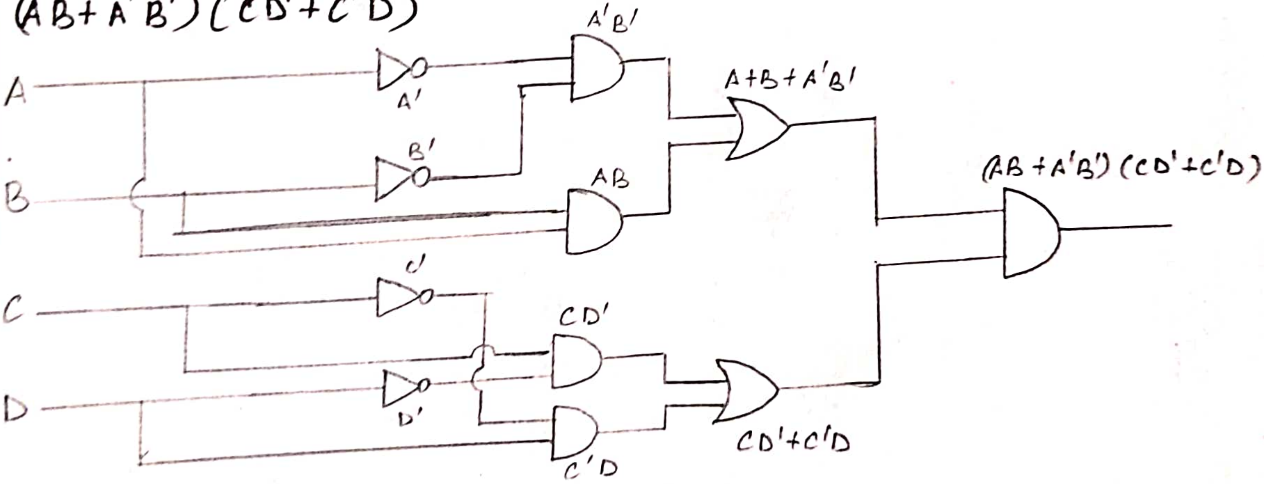
9(i) BC' + AB + ACD



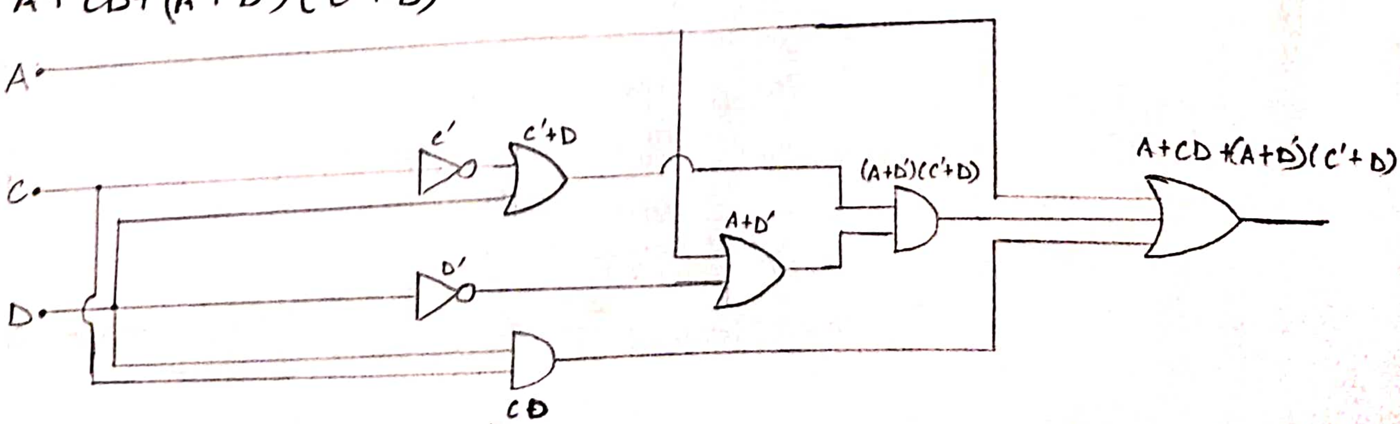

(ii) (A+B)(C+D)(A'+B+D)



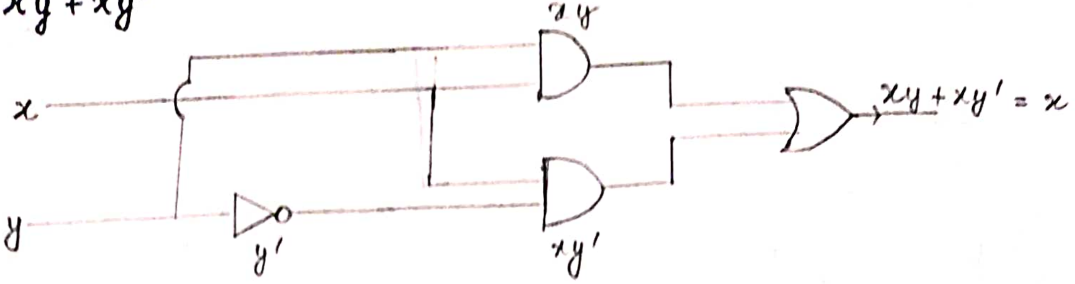

(iii) (AB+A'B')(CD'+C'D)




(iv) A + CD + (A + D')(C' + D)



10(i) $xy + xy'$

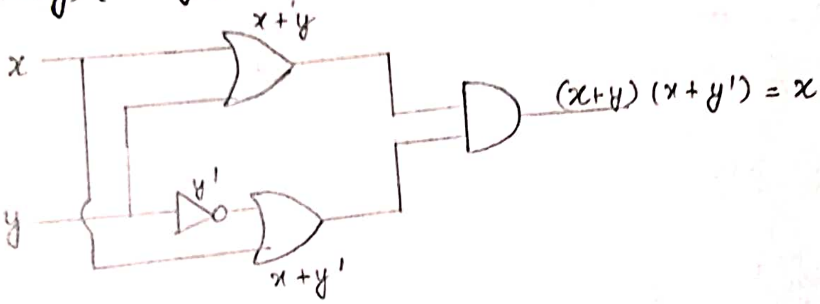



$x.(y + y')$

$x . 1$ $\quad \because y + y' = 1$

$= x$

(ii) $(x+y)(x+y')$




$(x+y)(x+y')$

$x.x + x.y' + y.x + y.y'$ $\quad (\because x.x = x \text{ and } x.x' = 0)$

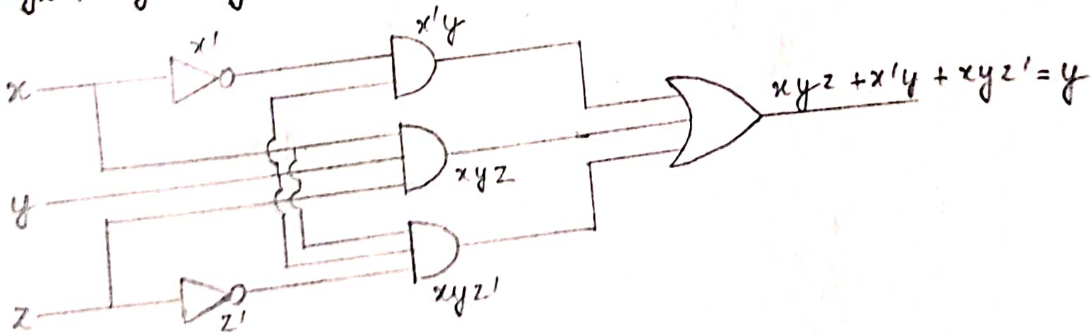
$x + x.y' + y.x + 0$

$x + x.(y'+y) + 0$ $\quad (y + y' = 1)$

$x + x.1$

$x + x = x$

(iii) $xyz + x'y + xyz'$




$xyz + x'y + xyz'$

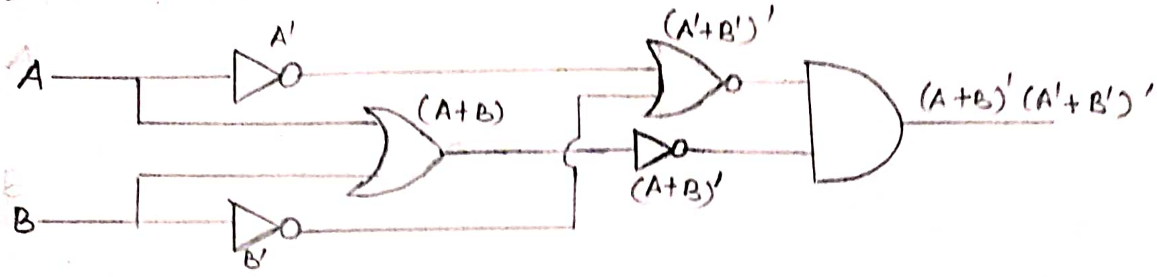
$xy(z + z') + x'y$ $\quad (z + z' = 1)$

$xy.1 + x'y$

$y(x + x')$

$y.1 = y$

(iv) $(A+B)'(A'+B')'$




$(A+B)'(A'+B')'$

$(A'B')'((AB)')'$

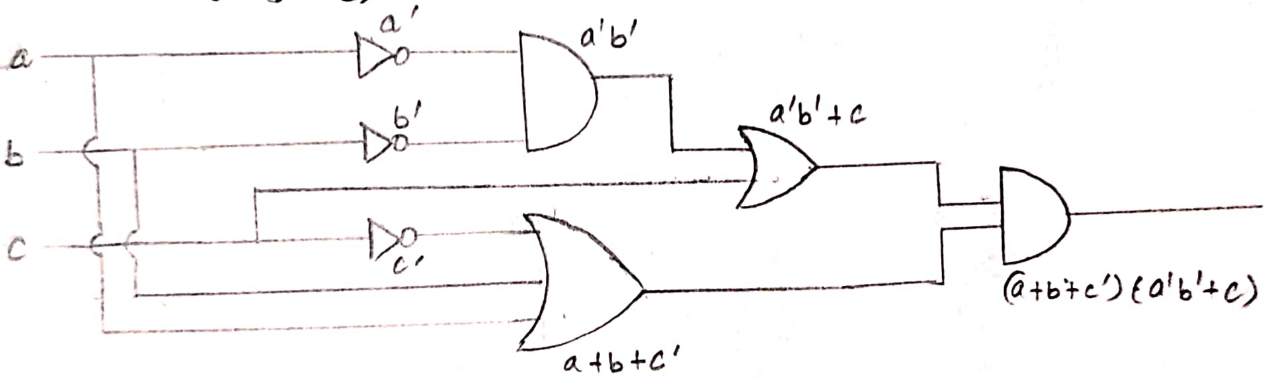
$(A'B')(AB)$

$(A.A')(A'B)(B'A)(B'.B')$

$0.(A'B)(B'A).0$

$=0$

(v) $(a+b+c')(a'b'+c)$

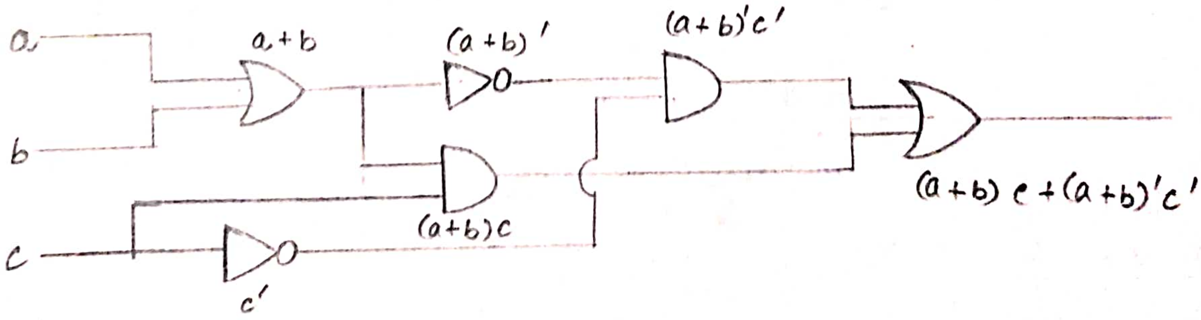



$(a+b+c')(a'b'+c)$

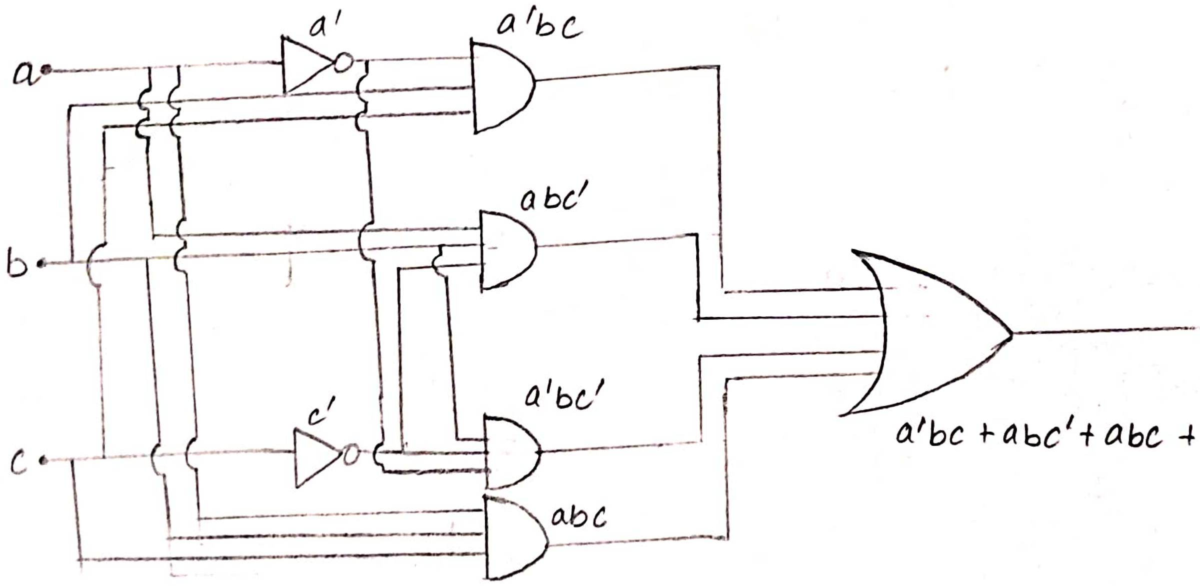
$((a+b)+c')((a+b)'+c)$

$=(a+b)(a+b)'+(a+b)c+(a+b)'c'+c.c'$

$=(a+b)c+(a+b)'c'$



(vi) $a'bc + abc' + abc + a'bc'$




$a'bc + abc' + abc + a'bc' = b$

$a'bc + abc' + abc + a'bc'$

$= bc(a' + a) + bc'(a + a')$

$= bc + bc'$

$= b(c + c')$

$= b \cdot 1 = \underline{\underline{b}}$