ASSIGNMENT

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Q) Reduce the following Boolean expressions to the indicated number of literals:

(a) $A'C' + ABC + AC'$ to three literals
(b) $(x'y' + z)' + z + xy + wz$ to three literals
(c) $A'B(D' + CD) + B(A + A'CD)$ to one literal
(d) $(A' + C)(A' + C')(A + B + C'D)$ to four literals
(e) $ABC'D + A'BD + ABCD$ to two literals

Draw the logic diagrams that implement the original and simplified expressions.

A) (a) $A'C' + ABC + AC'$ to three literals

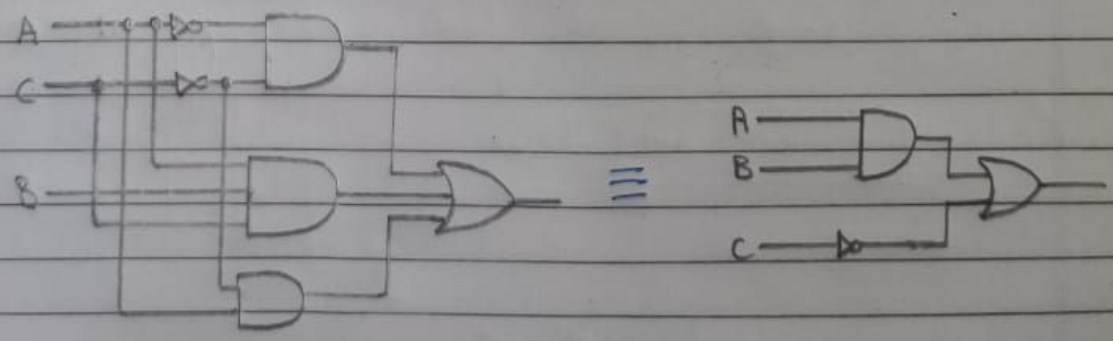
$= C'(A' + A) + ABC$

$= C' + ABC$

$= (C' + AB)(C' + C)$ [distributive law]

$= \boxed{AB + C'}$

$A'C' + ABC + AC' \equiv AB + C'$



(b) $(x'y'+z)' + z + xy + wz$ to three literals

$= (x+y)z' + z + wz + xy$ [DeMorgan]

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

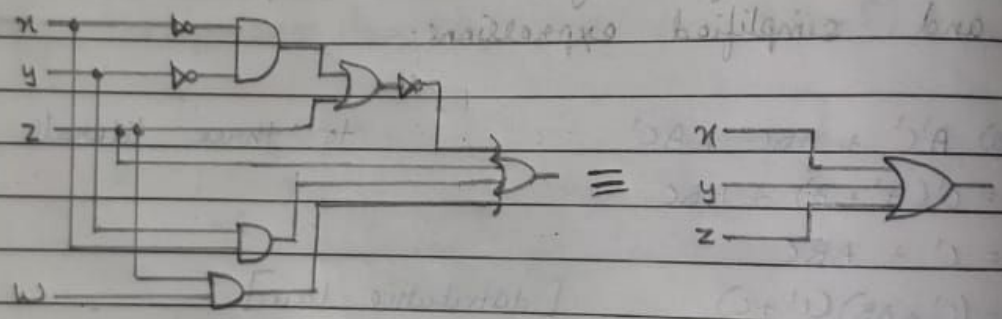
$= (x+y)z' + z + xy$

$= (x+y+z)\cdot(z'+z) + xy$ [distributive]

$= x+y+z + xy$

$= \boxed{x+y+z}$ [absorption]

$\therefore (x'y'+z)' + z + xy + wz \equiv x+y+z$



(c) $A'B(D'+C'D) + B(A+A'CD)$ to one literal

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

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

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

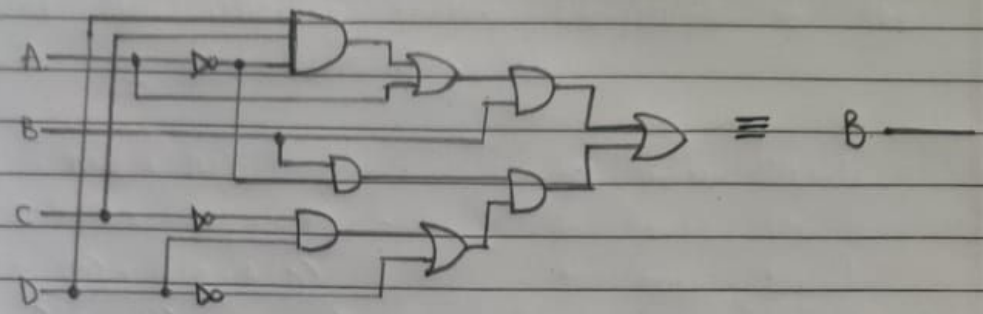
$= A'B(D'+D) + AB$

$= A'B + AB$

$= B(A'+A)$

$= \boxed{B}$

$A'B(D' + C'D) + B(A + A'CD) \equiv B$



(d) $(A'+C)(A'+C')(A+B+C'D)$ to four literals

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

$= (A' + A'C' + A'C + 0)(A+B+C'D)$

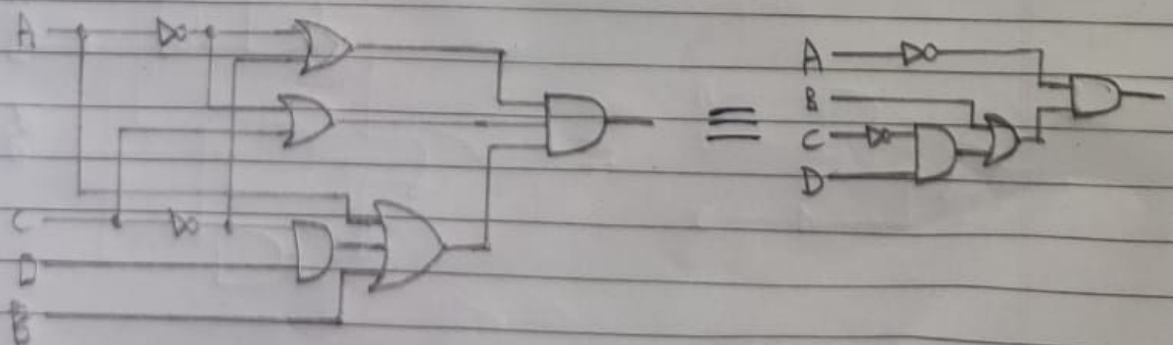
$= (A'(1 + C' + C))(A+B+C'D)$

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

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

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

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



(e) $ABC'D + A'BD + ABCD$ to two literals

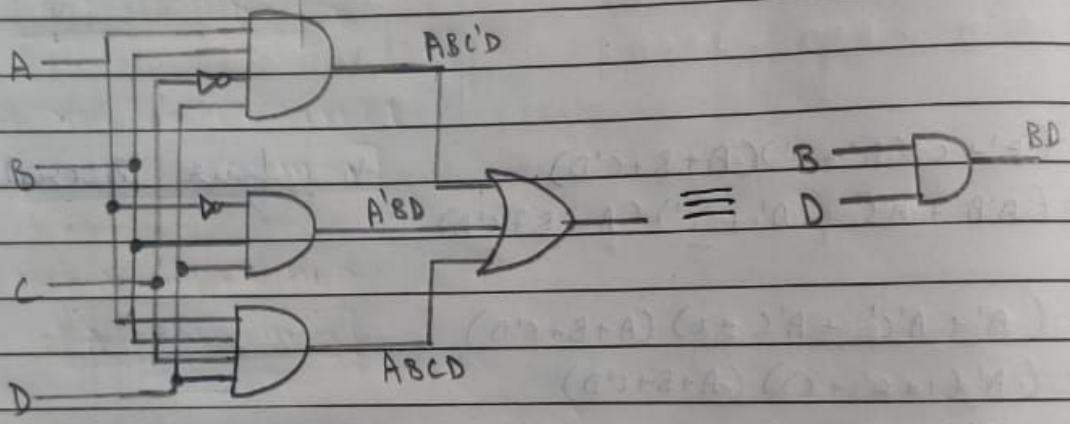
$= ABD(C' + C) + A'BD$

$= ABD + A'BD$

$= (A + A')BD$

$= \boxed{BD}$

$ABC'D + A'BD + ABCD \equiv BD$



Q2) List the truth table of the function:

1. $F = xy + xy' + yz'$
2. $F = bc + a'c'$

A2) 1. $F = xy + xy' + yz'$

x	y	z	xy	xy'	yz'	xy + xy' + yz'
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	1	1
0	1	1	0	0	0	0
1	0	0	0	1	0	1
1	0	1	0	1	0	1
1	1	0	1	0	1	1
1	1	1	1	0	0	1

~~2. F = bc + a'c'~~

$\therefore F(x,y,z) = \Sigma(2,4,5,6,7) = \Pi(0,1,3)$

2. $F = bc + a'c'$

a	b	c	bc	a'c'	bc + a'c'
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	1	0	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1

$F(a,b,c) = \Sigma(0,2,3,7) = \Pi(1,4,5,6)$

Q3) We can perform logical operations on strings of bits by considering each pair of corresponding bits separately (called bitwise operation).
Given two eight-bit strings A = 10110001 and B = 10101100, evaluate the eight-bit result after the following logical operations:

(a) AND
(b) OR
(c) XOR
(d) NOT A
(e) NOT B

Ans) A = 10110001
B = 10101100

(a) A AND B = 10100000
$A \cdot B = 10100000$

(b) A OR B = 10111101
$A + B = 10111101$

(c) A XOR B = 00011101
$A \oplus B = 00011101$

(d) NOT A = 01001110
$\bar{A} = 01001110$

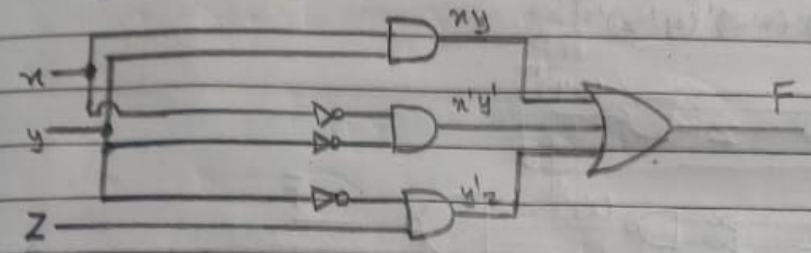
(e) NOT B = 01010011
$\bar{B} = 01010011$

Q4) Implement the boolean function
$F = xy + x'y' + y'z$

(a) with AND, OR and INVERTER GATES.
(b) with OR and INVERTER GATES.
(c) with AND and INVERTER GATES.
(d) with NAND and INVERTER GATES.
(e) with NOR and INVERTER GATES.

A4) (a) with AND, OR and INVERTER gates.

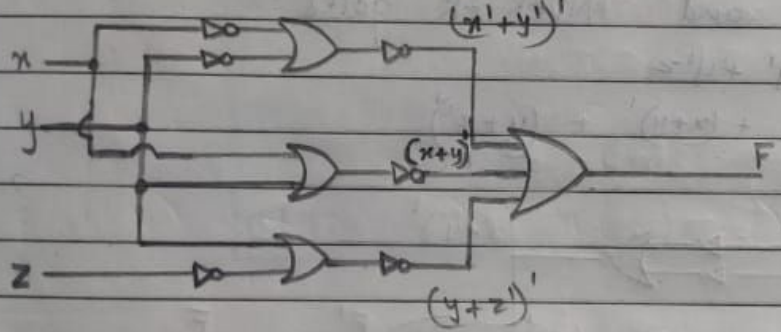
$F = xy + x'y' + y'z$



(b) with OR and INVERTER gates.

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

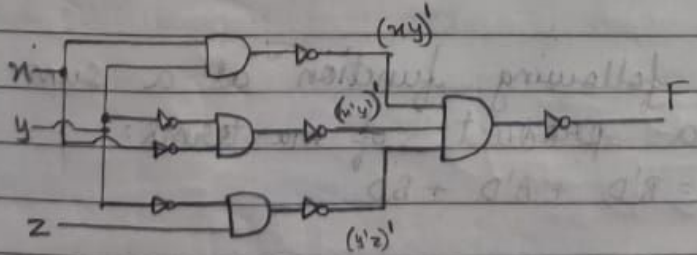
$F = (x'+y')' + (x+y)' + (y+z')'$



(c) with AND and INVERTER gates.

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

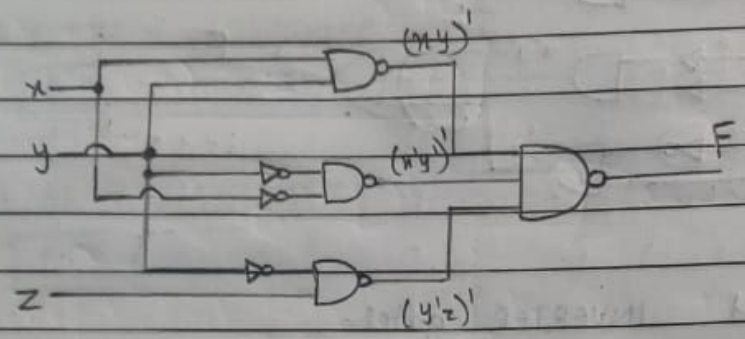
$F = [(xy)'(x'y')'(y'z)']'$



(d) with NAND and INVERTER gates:

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

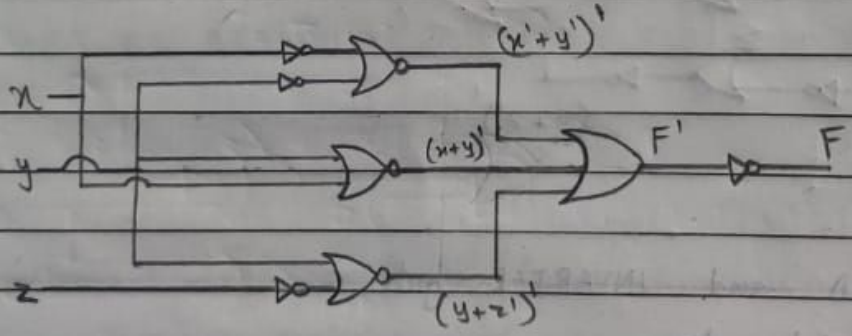
$F = [(xy)'(x'y')'(y'z)']'$



(e) with NOR and INVERTER gates:

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

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



Q5) Express the following function as a sum of minterms and as a product of maxterms:

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

→

A5) $F(A,B,C,D) = B'D + A'D + BD$

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

$= B'CD + B'C'D + A'BD + A'B'D + ABD + A'BD$

$= B'CD(A+A') + B'C'D(A+A') + A'BD(C+C') + A'B'D(C+C') + ABD(C+C')$

$= AB'CD + A'B'CD + AB'C'D + A'B'C'D + A'BCD + A'BC'D + A'B'CD + A'B'C'D + ABCD + ABC'D$

$= AB'CD + A'B'CD + AB'C'D + A'B'C'D + A'BCD + A'BC'D + ABCD + ABC'D$

$= \Sigma(11, 3, 9, 1, 7, 5, 15, 13)$

$= \boxed{\Sigma(1,3,5,7,9,11,13,15)}$ sum of minterms

$= \boxed{\Pi(0,2,4,6,8,10,12,14)}$ product of maxterms.

Q6) Express the ~~following~~ complement of the following function in sum-of-minterms form:

(a) $F(A,B,C,D) = \Sigma(2,4,7,10,12,14)$

(b) $F(x,y,z) = \Pi(3,5,7)$

A6) (a) $F(A,B,C,D) = \Sigma(2,4,7,10,12,14)$

$\boxed{F'(A,B,C,D) = \Sigma(0,1,3,5,6,8,9,11,13,15)}$

(b) $F(x,y,z) = \Pi(3,5,7)$

$F'(x,y,z) = \Pi(0,1,2,4,6)$

$\boxed{F'(x,y,z) = \Sigma(3,5,7)}$

Q7) Convert each of the following to the other canonical form:

(a) $F(x,y,z) = \Sigma(1,3,5)$
(b) $F(A,B,C,D) = \Pi(3,5,8,11)$

A7) (a) $F(x,y,z) = \Sigma(1,3,5)$
$= \Pi(0,2,4,6,7)$

(b) $F(A,B,C,D) = \Pi(3,5,8,11)$
$= \Sigma(0,1,2,4,6,7,9,10,12,13,14,15)$

Q8) Convert each of the following expressions into sum of products and product of sums:

(a) $(v + xw)(x + v'v)$
(b) $x' + x(x+y')(y+z')$

→

A8) (a) $(v + xw)(x + v'v)$

$= vx + vv'v + x \cdot x \cdot w + xwv'v$

$= vx + 0 + xw + xwv'v$

$= vx + wx(1 + v'v)$

$= \boxed{vx + wx}$ ⟶ Sum of products.

$= \boxed{x(v + w)}$ ⟶ Product of sums.

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

$= x' + x(xy + yy' + xz' + y'z')$

$= x' + x.xy + x.xz' + xy'z'$

$= x' + xy + xz' + xy'z'$

$= x' + xy + xz'(1 + y')$

$= x' + xy + xz'$

$= (x' + x)(y + x') + xz'$ [distributive]

$= y + x' + xz'$

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

$= \boxed{(y + x' + z')}$ ⟶ Sum of products and Product of Sums. (BOTH)

Q9) Draw the logic diagram corresponding to the following Boolean expressions without simplifying them:

(a) $Bc' + AB + ACD$

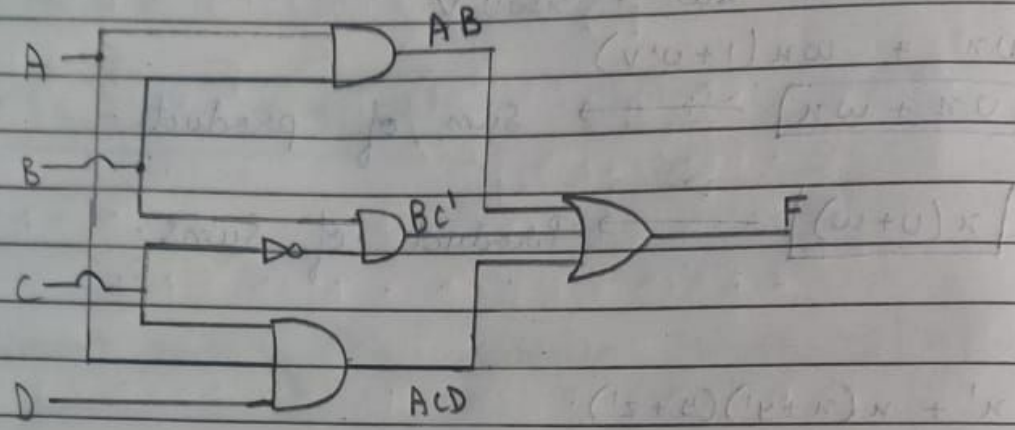
(b) $(A + B)(c + D)(A' + B + D)$

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

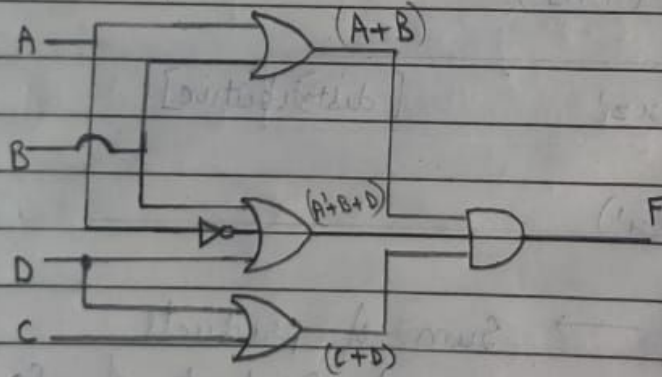
(d) $A + CD + (A + D')(c' + D)$

A9)

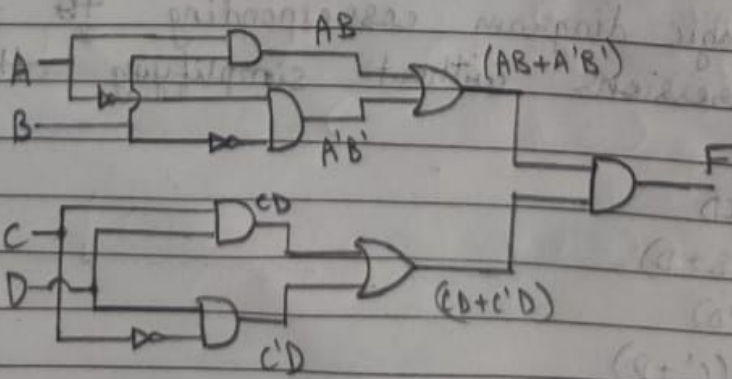
(a) $BC' + AB + ACD = F$



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



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



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