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A6 Batch

COA Assignment I

COA

assignment 1

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1) Simplify the following expressions using Boolean algebra.

a) $A + AB$

sol^n,

$= A \cdot (1 + B)$

$= A \cdot (1)$

$= A$ (absorption law)

Truthtable

A	B	AB	A+BA
0	0	0	0
0	1	0	0
1	0	0	1
1	1	1	1

$\because (A = A + BA)$

b) $AB + AB'$

sol^n,

$= A(B + B')$

$= A \cdot 1$

$= A$

Truth table

A	B	AB	AB'	AB+AB'
0	0	0	0	0
0	1	0	0	0
1	0	0	1	1
1	1	1	0	1

$\therefore A = AB + AB'$

c) $A'BC + AC$

sol^n,

$= A'BC + AC$

$= C(A'B + A)$

$= C(A + B)$

$= CA + CB$

d) $A'B + ABC' + ABC$

sol^n,

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

$= A'B + AB \cdot 1$

$= B(A' + A)$

$= B$

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2) Simplify using Boolean algebra.

a) $AB + A(CD + CD')$

Sol^n,

$= AB + AC(D + D')$ (distributive law)

$= AB + AC \cdot 1$

$= AB + AC$

$= A(B + C)$

Truth table

A	B	C	D	AB	CD	CD'	A(B+C)	Z
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	1	0	0
0	0	1	1	0	1	0	0	0
0	1	0	0	0	0	0	0	0
0	1	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0
0	1	1	1	0	1	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0
1	0	1	0	0	0	1	1	1
1	0	1	1	0	1	0	1	1
1	1	0	0	1	0	0	1	1
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	1	1
1	1	1	1	1	1	0	1	1

equivalent so proved

b) $(BC' + A'D)(AB' + CD')$

Sol^n,

$= BC'(AB' + CD') + A'D(AB' + CD')$

$= ABB'C' + BC'CD' + AA'B'D + A'DD'C$

$= 0 + 0 + 0 + 0 + 0$ $[\because A \cdot A' = 0]$

3) Using Demorgan's theorem, show that:

a) $(A+B)'(A'+B')' = 0$

Sol^n,

using demorgan's theorem,

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

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

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

$= 0 \cdot 0$

$= 0$

b) $A + A'B + A'B' = 1$

Sol^n,

$= (A+B) + (A+B)'$ $[\because A + A'B = A+B]$

$= 1$ $[\because A + A' = 1]$

4) Simplify using 3-variable K-map.

a) $F(x,y,z) = \Sigma(0,1,5,7)$

note: $\Sigma \rightarrow$ SOP form $0 \rightarrow \bar{A}$

$1 \rightarrow A$

$2^3 = 8$ cells in the K-map

11

$x \backslash yz$	00	01	11	10
0	1 $_0$	1 $_1$	$_3$	$_2$
1	$_4$	1 $_5$	1 $_7$	$_6$

v_I

$F = \mathrm{I} + \mathrm{II}$

$= A'B' + AC$

Thus, $F = A'B' + AC \longrightarrow \boxed{F = X'Y' + XZ}$

ps: got confused and wrote ABC instead of xyz, sorry

b) $F(x, y, z) = \Sigma(1, 2, 3, 6, 7)$

soln.

II pairing of 2

x \ yz	00	01	11	10
0	$_{0}$	$1\;_{1}$	$1\;_{3}$	$1\;_{2}$
1	$_{4}$	$_{5}$	$1\;_{7}$	$1\;_{6}$

pairing of 4
I

$F = \mathrm{I} + \mathrm{II}$

$\therefore F = B + A'C \longrightarrow \boxed{F = Y + X'Z}$

c) $F(x, y, z) = \Sigma(3, 5, 6, 7)$

soln.

I

x \ yz	00	01	11	10
0	$_{0}$		$1\;_{3}$	$_{2}$
1	$_{4}$	$1\;_{5}$	$1\;_{7}$	$1\;_{6}$

III II

$F = \mathrm{I} + \mathrm{II} + \mathrm{III}$

$= BC + AB + AC$

$\therefore F = BC + AB + AC$

$\boxed{\therefore F = YZ + XY + XZ}$

d) $F(A, B, C) = \Sigma(0, 2, 3, 4, 6)$

Sol^n

a \ bc	00	01	11	10
0	1 (0)	(1)	1 (3)	1 (2)
1	1 (4)	(5)	(7)	1 (6)

$\rightarrow$ I, $\rightarrow$ II

$F = I + II$

$= C' + A'B$

Simplify the following Boolean functions using four-variable maps

@ $F(A B C, D) = \Sigma(4, 6, 7, 15)$

Sol^n

$2^4 = 16$ cells

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

$\rightarrow$ I, $\rightarrow$ II

$F = I + II$

$= A'BD' + BCD$

b) $F(A,B,C,D) = \Sigma(3, 7, 11, 13, 14, 15)$

Sol^n

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

I, II, III

$F = I + II + III$

$= B'CD + CAB + ABD$

c) $F(A,B,C,D) = \Sigma(0,1,2,4,5,7,11,15)$

Sol^n

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

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

d) $F(A,B,C,D) = \Sigma(0,2,4,5,6,7,8,10,13,15)$

Sol^n

AB \ CD	00	01	11	10
00	1			1
01	1	1	1	1
14		1	1	
10	1			1

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

6) Simplify the ~~problems~~ expressions in
1) sum of products form
2) product of sums form

(a) $x'z' + y'z' + yz' + xy$
soln,

note: replace z by $(A+\bar{A})$
$A \cdot 1 = A$
$A + 1 = 1$

$m_1 : x'z'$
$m_2 : y'z'$
$m_3 : yz'$
$m_4 : xy$

x \ yz	00	01	11	10
0	1			1
1	1		1	1

x \ yz	00	01	11	10
0		0	0	
1		0		

for SOP
$F = z + yx$

for POS
$F' = x'z + y'z$
$\therefore F = (x+z')(y+z')$

Thus, required SOP form is $F = z + xy$ and
POS form is $F = (x+z')(y+z')$

(b) $AC' + B'D + A'CD + ABCD$
soln,

required $2^4 = 16$ cells

PTO →

for SOP form

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

$F = AC' + CD$

for POS form

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

$F' = A'C' + CD'$

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

Q7) Simplify the following Boolean function in sum of products form by means of 4 variable map. Draw the logic diagram with a) AND - OR gates b) NAND gates

$F(A,B,C,D) = \Sigma(0,2,8,9,10,11,14,15)$

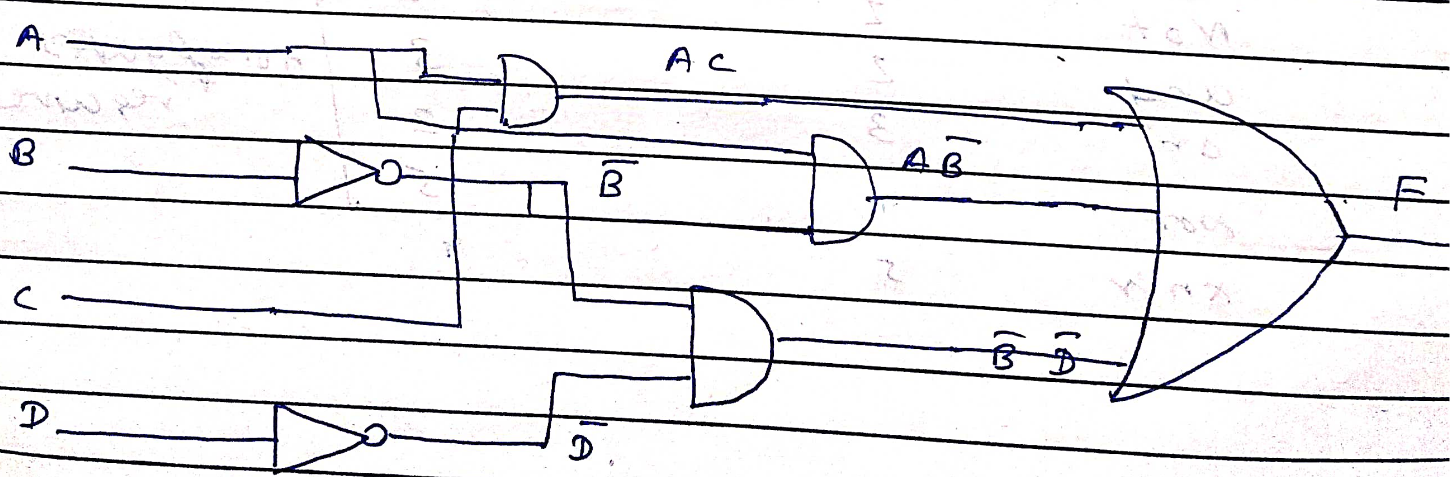
Sol^n,

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

$F = \cancel{BC}\ AC + \cancel{A}\ A\bar{B} + \bar{B}\bar{D}$

$\therefore F = AC + A\bar{B} + \bar{B}\bar{D}$ which is required SOP form.

ⓐ Logic digram using AND - OR gates

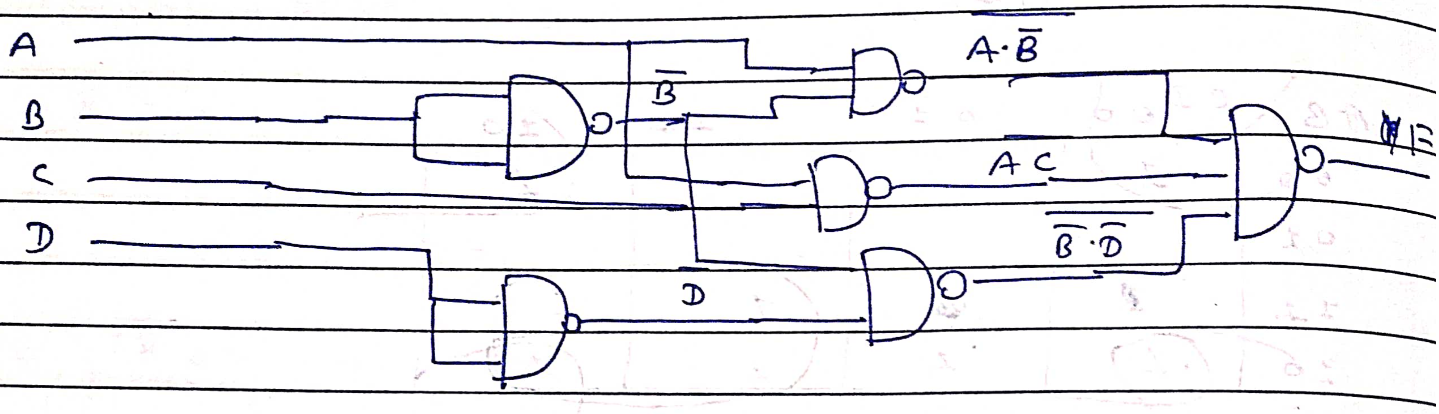


(3) using NAND gate

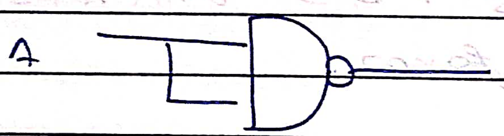
$F = AC + A\overline{B} + \overline{B}\,\overline{D}$

$\overline{\overline{F}} = (\overline{\overline{AC + A\overline{B} + \overline{B}\,\overline{D}}})$

$= (\overline{\overline{AC} \cdot \overline{A\overline{B}} \cdot \overline{\overline{B}\,\overline{D}}})$



Notes:



$\Rightarrow$ NOT gate

	NAND	NOR
Not	1	1
and	2	3
or	3	2
xor	4	5
xnor	5	4

no. of gates required

Q) Simplify the following Boolean function in product of sums form by means of a 4 variable maps. Draw logic diagram with a) OR-AND gates, b) NOR gates

$F(w,x,y,z) = \Sigma(2,3,4,5,6,7,11,14,15)$

Soln,

wx \ yz	00	01	10	11
00			1	1
01	1	1	1	1
11			1	1
10			1	

$F = \bar{A}C + CD + \bar{A}B + BC$ → SOP form

wx \ yz	00	01	10	10
00	0	0		
01				
11	0	0		
10	0	0		0

$\bar{F} = \cancel{\bar{w}\bar{x}\bar{y}}\ \bar{x}\bar{y} + w\bar{y} + w\bar{x}\bar{z}$

$\therefore F = (x+y)(\bar{w}+y)(\bar{w}+x+z)$

which is required POS form.

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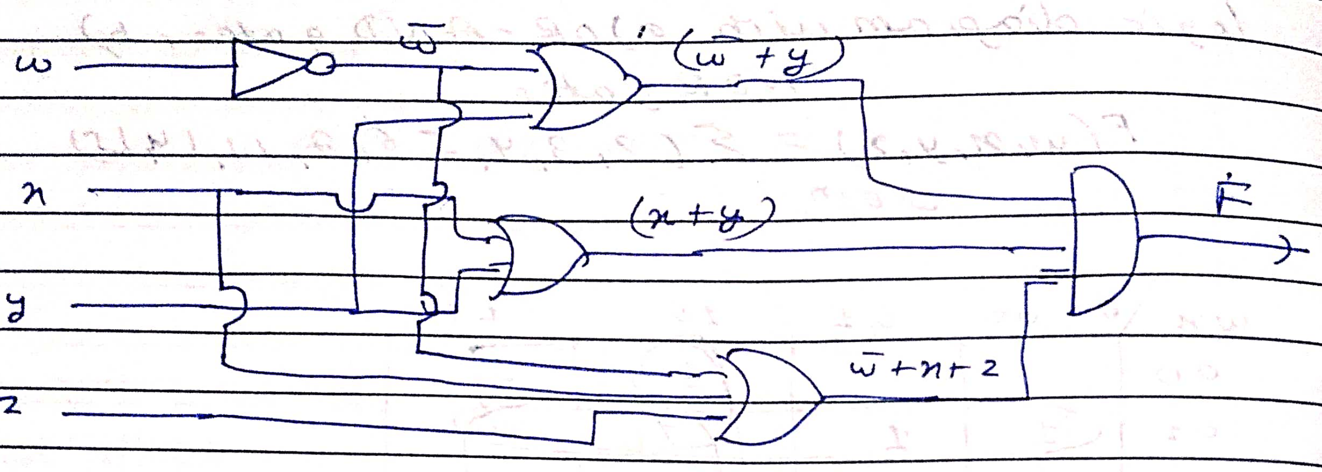
ⓐ using OR - AND gates

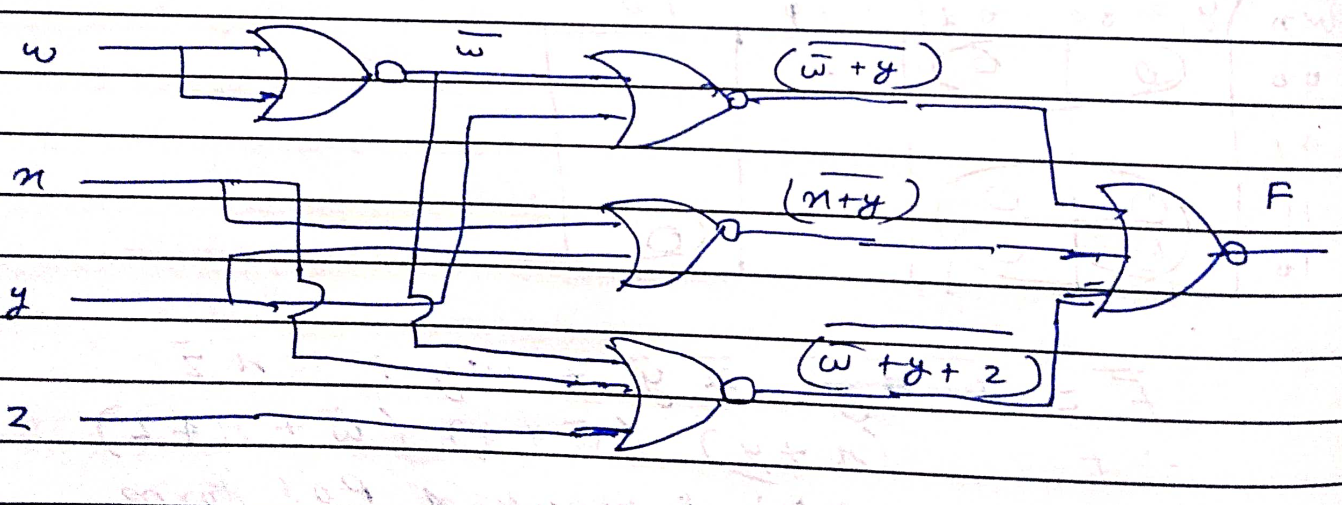


ⓑ Using NOR gate

NOR ⇒ $Y = \overline{A+B}$

$F = (x+y)(\bar{w}+y)(\bar{w}+x+z)$

$\bar{F} = \overline{(x+y)} + \overline{(\bar{w}+y)} + \overline{(\bar{w}+x+z)}$



29) Simplify Boolean function F together with the don't care conditions d in 1) SOP 2) POS form

$$F(w,x,y,z) = \Sigma(0,1,2,3,7,8,10)$$
$$d(w,x,y,z) = \Sigma(5,6,11,15)$$

Sol^n,

Q_1

wx \ yz	00	01	11	10
00	1	1	1	1
01		X	1	X
11			X	
10	1		X	1

Q_2

$F = Q_1 + Q_2$

$= \overline{w}z + \overline{x}\,\overline{z}$ which is required SOP form.

wx \ yz	00	01	11	10
00				
01	0	X		X
11	0	0	X	0
10		0	X	

Q_1

Q_2

$\overline{F} = Q_1 + Q_2$

$= wz + x\overline{z}$

$\therefore F = (\overline{w}+\overline{z})(\overline{x}+z)$ which is required POS form.