ASSIGNMENT-06

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Course : CSE231

Section : 10.

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Digital Logic Design

"Don't care" condition:

Use of "don't care" conditions to simplify an expression.

Inputs				Output
A	B	C	D	Y
0	0	0	0	X
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

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

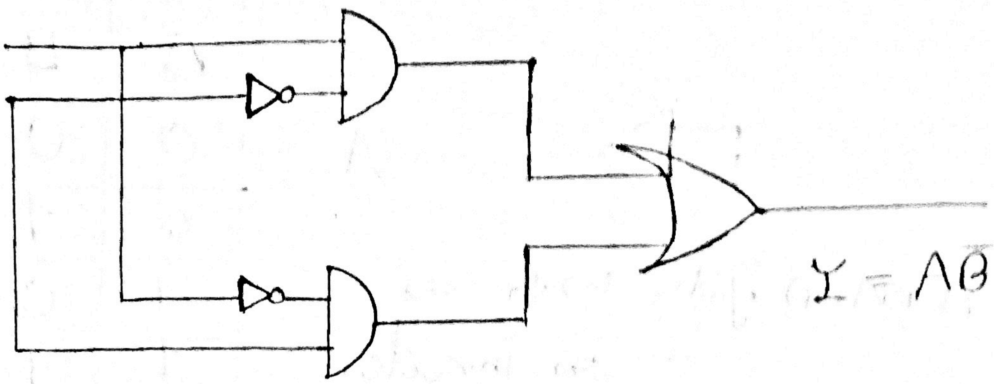
without don't cares:

$Y = A\bar{B}\bar{C} + \bar{A}BCD$.

with don't cares:

$Y = A + BCD$

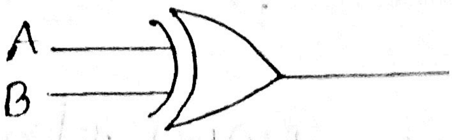
Combinational Logic Circuit :

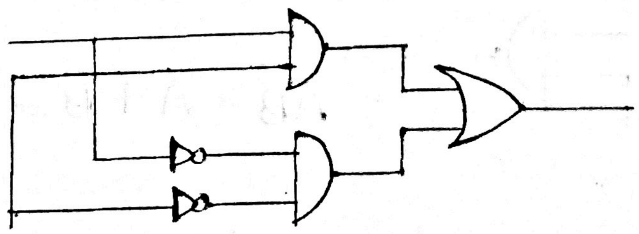


$Y = AB + AB.$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

$\therefore Y = A \oplus B.$

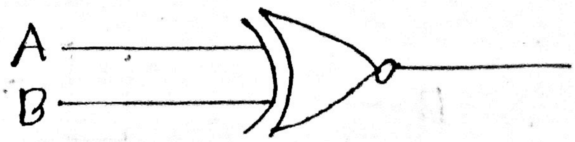




$Y = AB + \overline{A}\,\overline{B}$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

$\therefore Y = \overline{A \oplus B}$



The universal property of NAND and NOR gates.

Truth table for 2 input NAND gate.

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

(a)

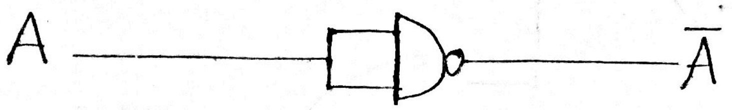
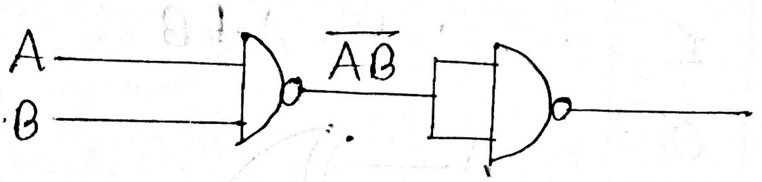


fig: A NAND gate used as an inverter.

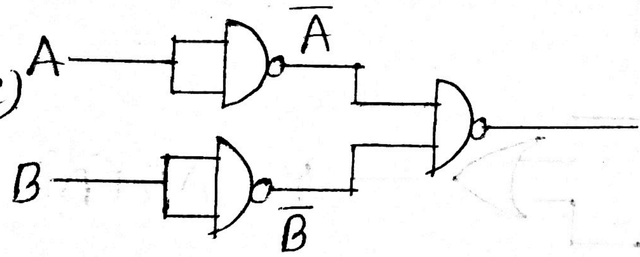
(b)



$\overline{\overline{AB}} = AB.$

fig: Two NAND gates used as an AND gate.

(c)



$\overline{\overline{A}\,\overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A+B$

fig: Three NAND gates used as an OR gate.

(d)

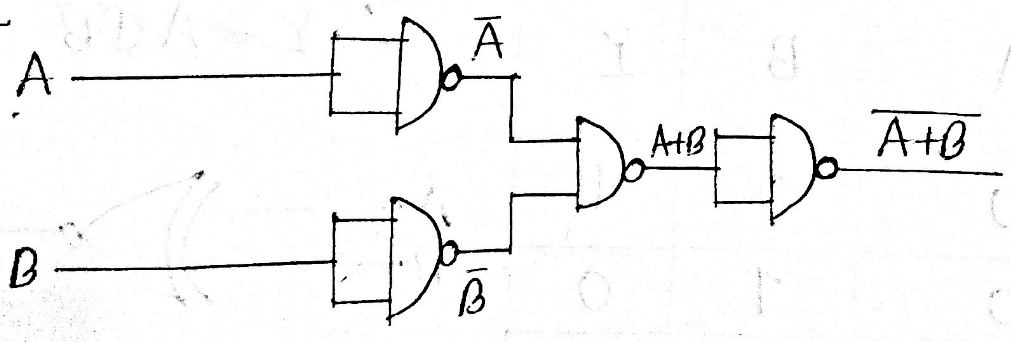


fig: Four NAND gates used as NOR gate.

The NOR Gate as a universal logic element.

Truth table for 2 input NOR Gate.

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

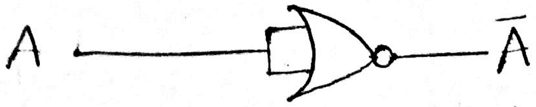


Fig: a NOR gate used as an inverter.

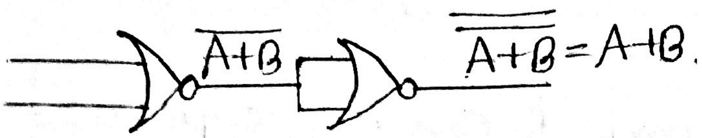


Fig: Two NOR gates used as an OR gate.

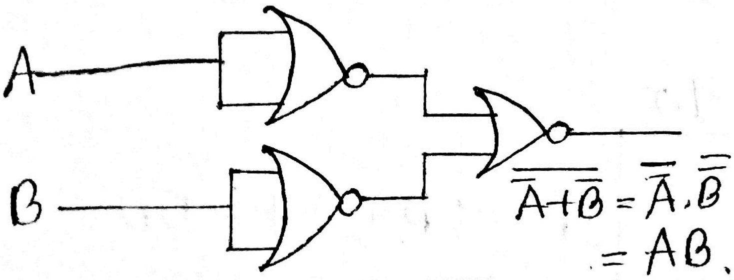


Fig: Three NOR gates used as an AND gate.

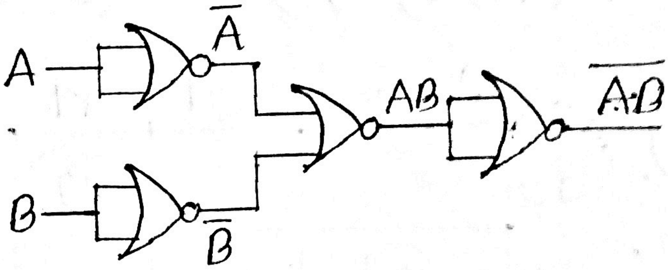


Fig: Four NOR gates used as a NAND gate

Simplify the Boolean Function in:

(a) Sum of products and

(b) Product of sum form.

$F(A,B,C,D) = \Sigma(0,1,2,5,8,9,10)$

(a)

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

$F = \bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}\bar{C}D$

In product of maxterms, F can be expressed as

$F(A,B,C,D) = \Pi(3,4,6,7,11,12,13,14,15)$

(b).

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

$\bar{F} = CD + AB + B\bar{D}$

$F = \overline{CD + AB + B\bar{D}}$

$= (\overline{CD}).(\overline{AB}).(\overline{B\bar{D}})$

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

Combinational Logic using NAND and NOR gates:

NAND gate:

using De Morgan's rule:

$$\overline{AB} = \underbrace{\overline{A}+\overline{B}}_{\text{Negative OR}}$$

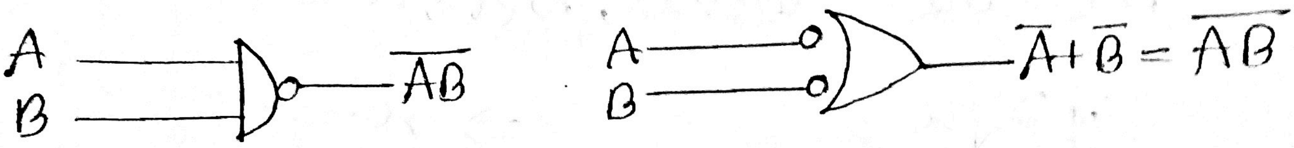
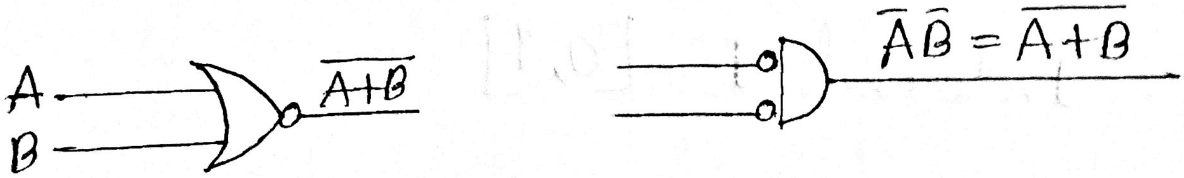


Fig: Two graphic symbols for NAND gate.

$$\overline{A+B} + \overline{A}\,\overline{B}$$

Negative AND.



OR-invert.

Fig: Two graphic symbols for NOR gate.

Exercise 01 :

$F(A,B,C,D) = \sum(5,7,8,10,11,14,15)$.

$d(A,B,C,D) = \sum(0,12,13)$.

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

C B A D

$F = A\bar{D} + BD + AC$

(Ans).

Exercise 02 :

$$F(w,x,y,z) = \Sigma(1,3,7,11,15)$$

$$d(w,x,y,z) = \Sigma(0,2,5)$$

wx \ yz	00	01	11	10
00	0: X	1: 1	3: 1	2: X
01	4: 0	5: X	7: 1	6: 0
11	12: 0	13: 0	15: 1	14: 0
10	8: 0	9: 0	11: 1	10: 0

$F = \overline{w}\,\overline{x} + yz$. (Ans).

Exercise 03 :

$$F(A,B,C,D) = \Pi(1,3,5,7,13,15).$$

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

$$\bar{F} = \bar{A}D + BD$$

$$\therefore F = \overline{\bar{A}D + BD}$$

$$= (\overline{\bar{A}D}).(\overline{BD})$$

$$= (\bar{\bar{A}}+\bar{D}).(\bar{B}+\bar{D})$$

$$= (A+\bar{D}).(\bar{B}+\bar{D})$$

Ans)

Exercise 04:

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

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

$$\bar{F} = \bar{B}D + AB + C\bar{D}$$

$$\therefore F = \overline{\bar{B}D + AB + C\bar{D}} = (\overline{\bar{B}D}).(\overline{AB}).(\overline{C\bar{D}})$$

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

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

Ans).

Exercise 3.15 :

(a) $F(x,y,z) = \Sigma(0,1,4,5,6)$.

$d(x,y,z) = \Sigma(2,3,7)$.

$x \backslash yz$	00	01	$\overbrace{11 \quad 10}^{y}$	
0	$_{0}\ 1$	$_{1}\ 1$	$_{3}\ \times$	$_{2}\ \times$
1	$_{4}\ 1$	$_{5}\ 1$	$_{7}\ \times$	$_{6}\ 1$
x'.		z	z	

$F = \bar{x} + x = 1$

(Ans).

(b). $F(A,B,C,D) = \sum(0,6,8,13,14)$.

$d(A,B,C,D) = \sum(2,4,10)$.

AB \ CD	00	01	11	10
00	0: 1	1: 0	3: 0	2: X
01	4: X	5: 0	7: 0	6: 1
11	12: 0	13: $\boxed{1}$	15: 0	14: 1
10	8: 1	9: 0	11: 0	10: X

$F = \bar{B}\bar{D} + C\bar{D} + AB\bar{C}D$.

(Ans)

(c) $F(A,B,C,D) = \Sigma(5,6,7,12,14,15)$.

$d(A,B,C,D) = \Sigma(3,9,11,15)$.

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

$F = AB\bar{D} + \bar{A}BD + BC$.

(Ans).

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

$d(A,B,C,D) = \Sigma(0, 6, 8)$.

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

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

(Ans).