Digital Logic Design:

Lecture 6

"Don't care" conditions,

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

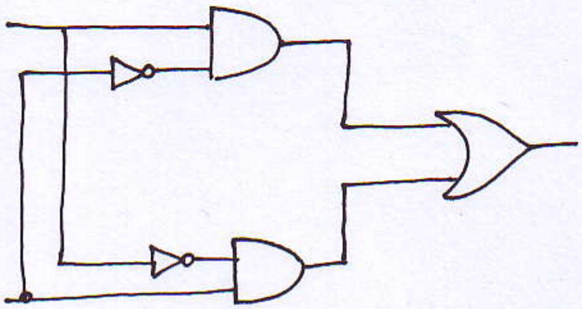
Without don't cares

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

with don't cares

$Y = A + BCD$

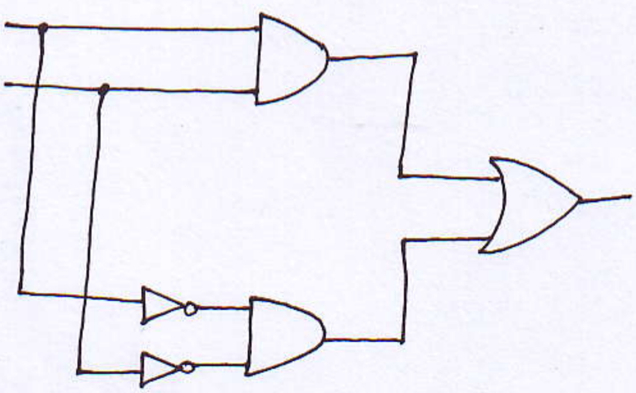
Combinational Logic Circuit



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

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

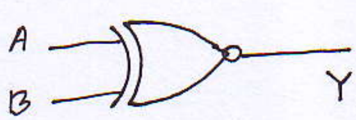
$$\therefore\ Y = A \oplus B$$



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

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

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



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)

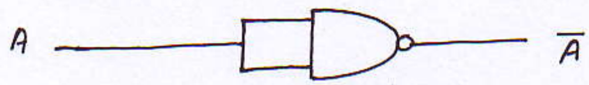


fig : A NAND gate used as an inverter

b)

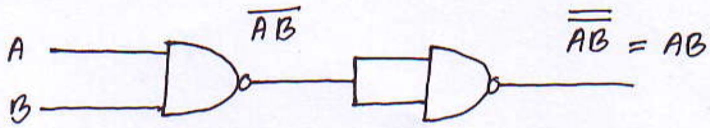
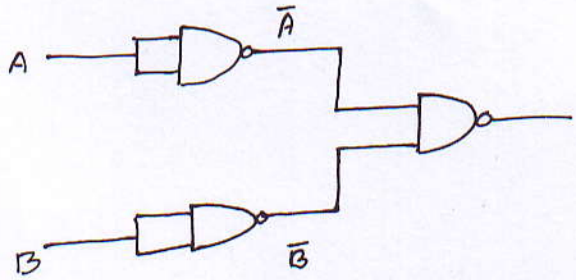


fig : Two NAND gates used as an AND gate

c)



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

fig : Three NAND gates used as an OR gate

d)

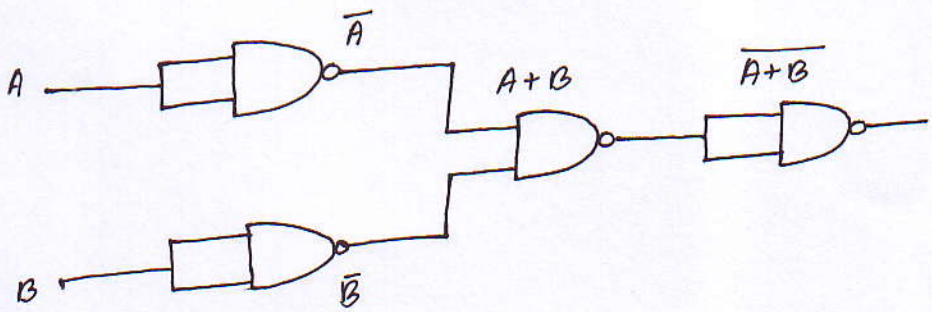


fig : Four NAND gates used as NOR gate

The NOR Gate as a universal Logic element

Truth table for 2 input NOR Gate

Fig : a NOR gate used as an inverter

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

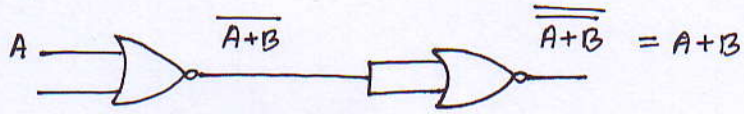


Fig : Two NOR gates used as an OR gate

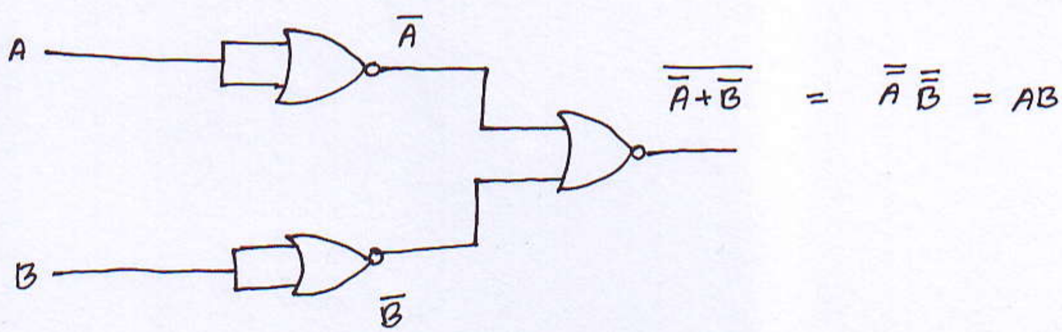


Fig : Three NOR gates used as an AND gate

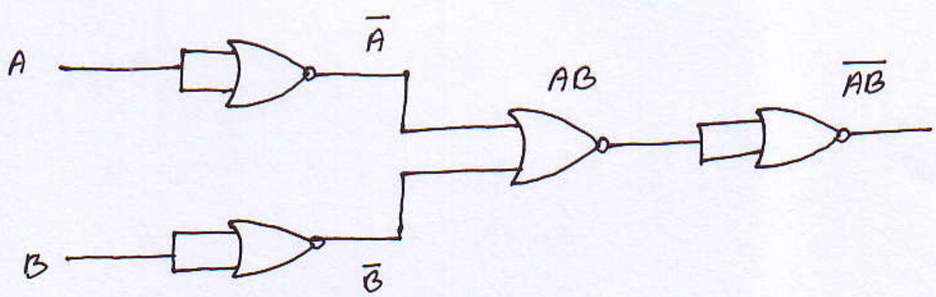


Fig : Four NOR gates used as a NAND gate

Simplify the Boolean Function in

a) Sum of products and

b) Product of sum form

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

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	

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

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

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

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

Exercise

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

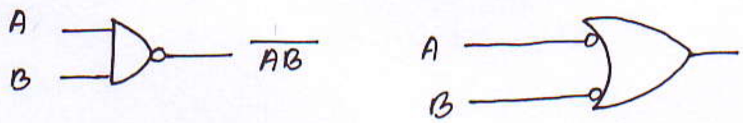
$$d = \sum(0,12,13)$$

Combinational Logic using NAND and NOR gates:

NAND gate:

Using De morgan's rule

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

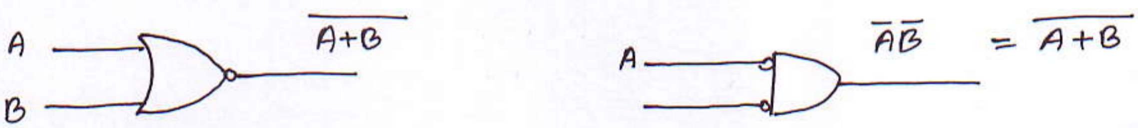


$\overline{A}+\overline{B} = \overline{AB}$

Fig : Tow graphic symbols for NAND gate

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

Negative AND



OR - invert

Fig : Two graphic symbols for NOR gate