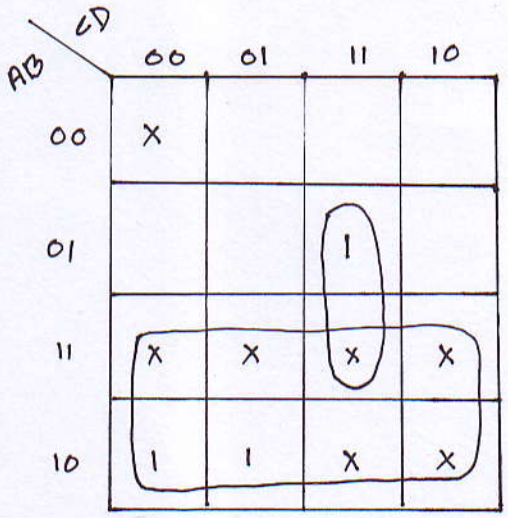
# Digital Logic Design :

## 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 |



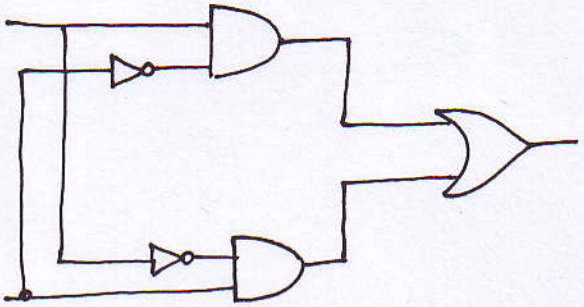

Without don't cares

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

with don't cares

$$Y = A + BCD$$

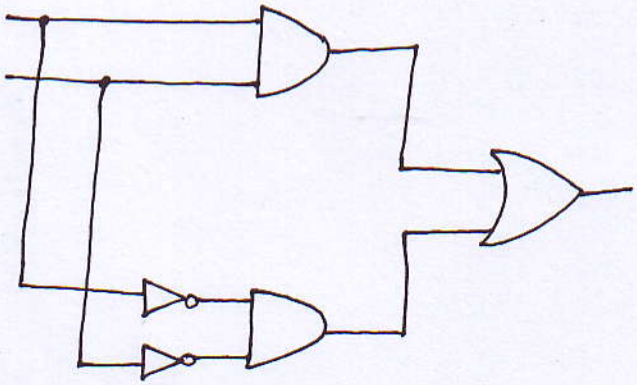
# Combinational Logic Circuit



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

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

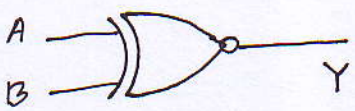
$\therefore Y = A \oplus B$

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

| 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)

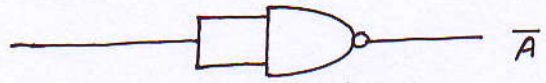



fig : A NAND gate used as an inverter

b)

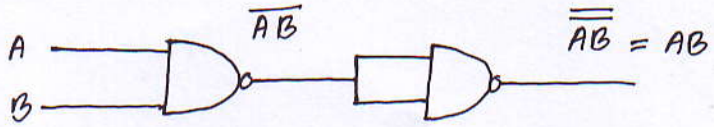
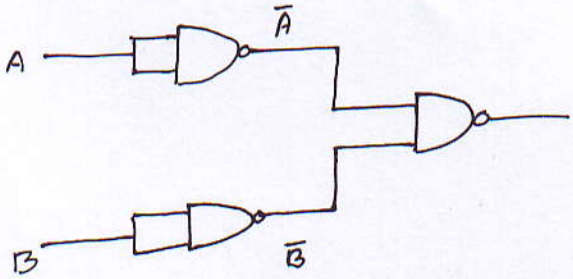



fig : Two NAND gates used as an AND gate

c)




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

fig : Three NAND gates used as an OR gate

d)

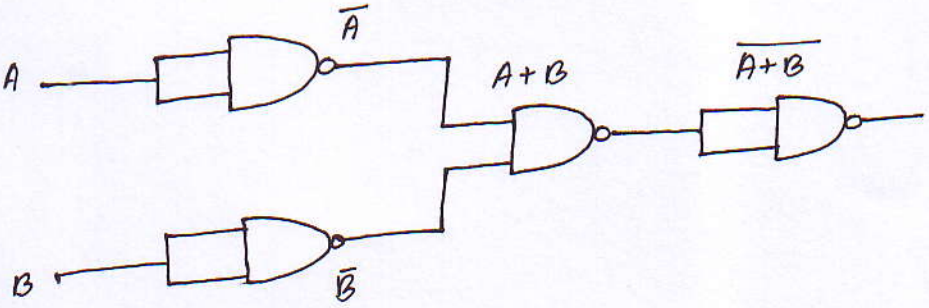



fig : Four NAND gates used as NOR gate

# The NOR Gate as a universal Logic element

Truth table for 2 input NOR Gate

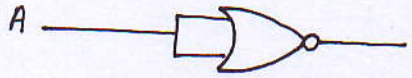



Fig : a NOR gate used as an inverter

| A | B | X |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

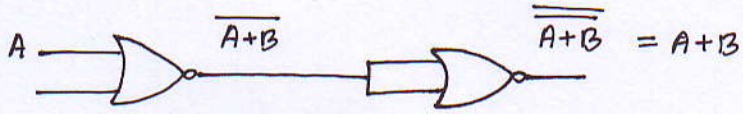



Fig : Two NOR gates used as an OR gate

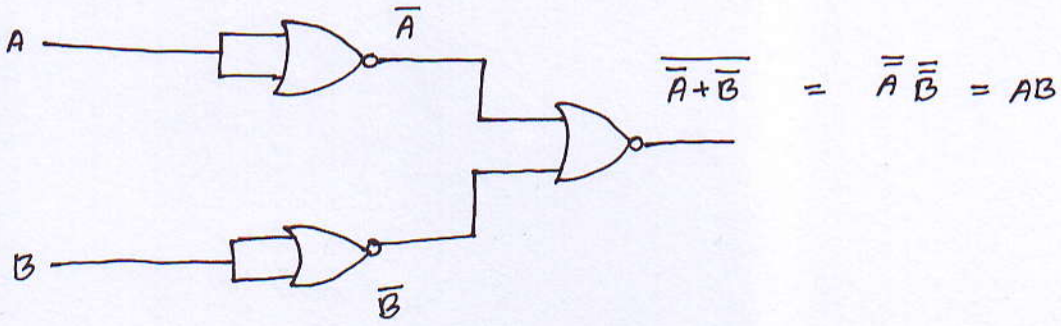



Fig : Three NOR gates used as an AND gate

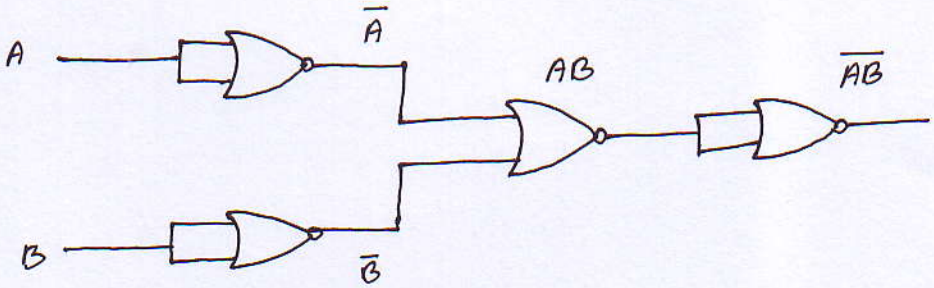



Fig : Four NOR gates used as a NANO gate

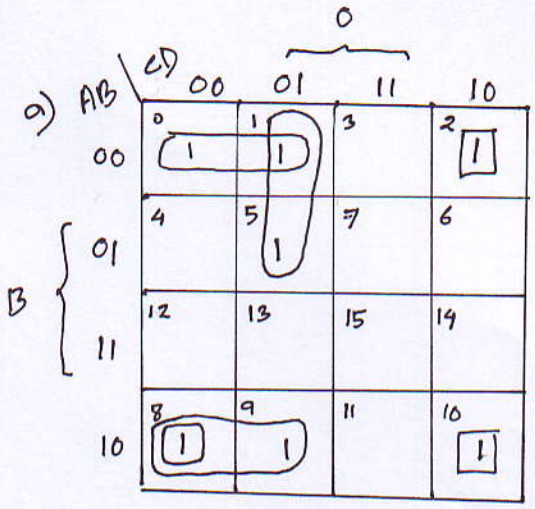
Simplify the Boolean Function in

a) Sum of products and

b) Product of sum form

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

a)

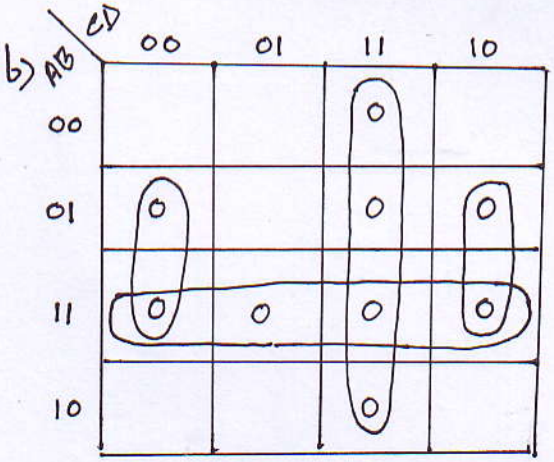



$F = \bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}\bar{C}D$

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)




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

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

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

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

Exercise

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

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

# Combinational Logic using NAND and NOR gates :

## NAND gate :

Using De morgan's rule

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

Negative OR

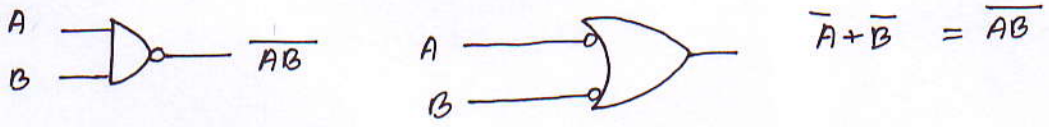
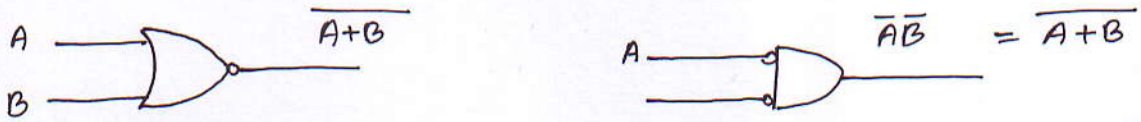



Fig : Tow graphic symbols for NAND gate

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

Negative AND




OR - invert

Fig : Two graphic symbols for NOR gate