L-16

* Logic gates

gate → It will allow or does not allow current to pass through it.

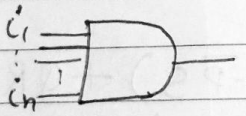
It is used to implement logic function using gates

* Types
  - Basic / fundamental
    - NOT
    - AND
    - OR
  - derived
    - NAND
    - NOR
    - XOR
    - XNOR

* AND gate

① n inputes and only '1' output

② Symbol



$$y = i_1 \cdot i_2 \cdots i_n$$

③ output of AND gate is '1' if all inputs are '1'

OR

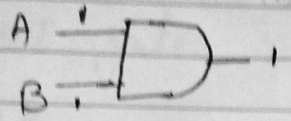
if atleast one input is '0' then out will be 0

4 Truth table

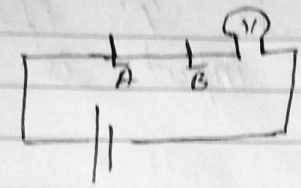
A	B	A·B
0	0	0
0	1	0
1	0	0
1	1	1

$f(A, B) = A \cdot B$

5 Circuit diagram



1 → Presence of current
0 → Absence " "



~~Ans~~ AND gate A·B Series circuit

6 How many minterms

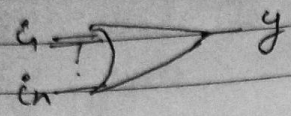
Q → Consider AND function of 'n' boolean variables how many minterms will be present

Ans One minterm

- OR function/gate

① n I/p & O/p is 1

② Symbol



$y = y\ i_1 + i_2 + i_3 \cdots i_n$

③ output of OR gate is '1' iff atleast one of its input is 1

④ Truth table

A	B	A+B
0	0	0
1	0	1
0	1	1
1	1	1

$f(A,B) = (A+B)$

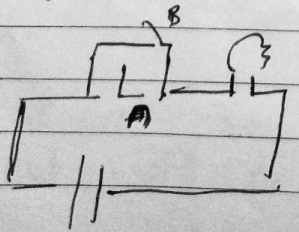
$\bar{A}B + A\bar{B} + AB$

$B + \bar{B}A$

↓ Absorption law

$A + B$

⑤ Circuit digram



OR AKA parallel circuit

6 How many minterms

n var OR function

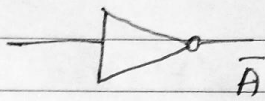
2^n $2^n - 1$ Ans

minterms

* NOT gate

① 1 I/P and 1 O/P

② Symbol



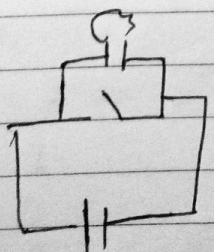
③ output not gate is '1' if input '0'

④

A	$\bar{A}$
0	1
1	0

$f(A) = \bar{A}$

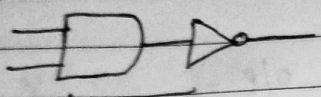
⑤ circuit diagram



6 How many minterms
→ Only one

* NAND gate

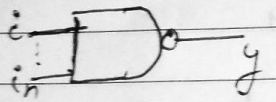
↳ Bubbled AND gate
Not



NAND gate

1) n inputes and one output

2) Symbol



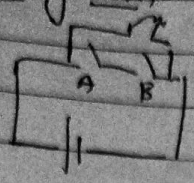
$y = \overline{i_1 \cdot i \cdot i \cdots in}$

③ output of NAND gate '1' if atleast one of its input is '0'

④ Truth table

A	B	y
0	0	1
0	1	1
1	0	1
1	1	0

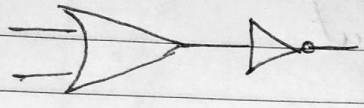
(5) Circuit diagram



(6) No of minterms

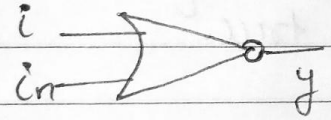
$$2^n - 1$$ Ans

* NOR gate
  ↳ Bubble OR gate



(1) n I/P and '1' output

(2) symbol



$$y = \overline{i_1 + i_2 + i_3 \cdots i_n}$$

(3) output is nor gate is '1' if all the inputs are '0'

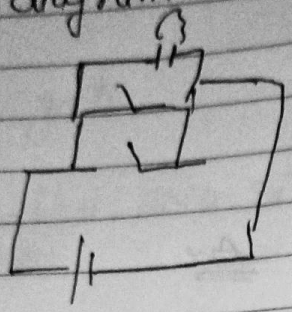
(4) Truth table:

A	B	y -> $\overline{A+B}$
0	0	1
0	1	0
1	0	0

A	B	y
1	1	0

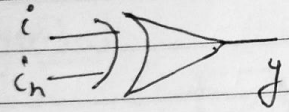
No. of minterms => 1

(5) circuit diagram



* XOR

(1) n input & 1 output

(2) 

$y = i_1 \oplus i_2 \oplus i_3 \cdots$

(3) o/p of XOR is 1 iff odd of literels (variables) are true.

(4) Truth table

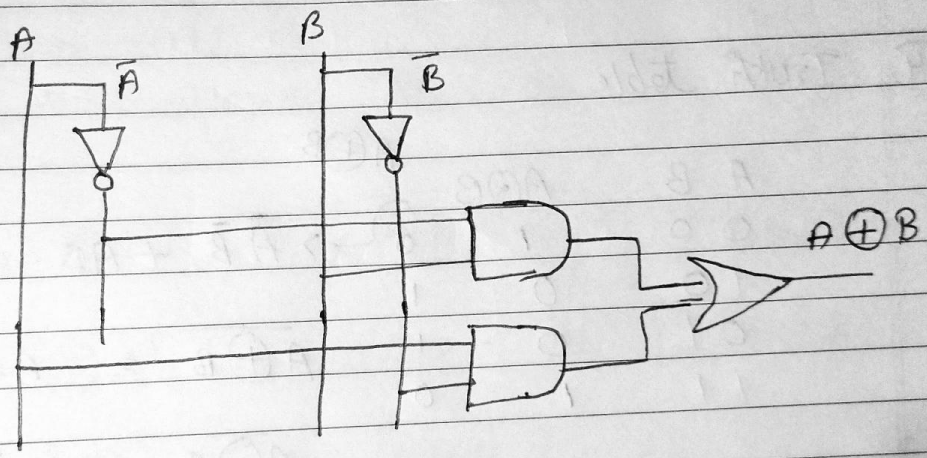
A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Minterms => $\bar{A}B + A\bar{B}$

A	B	C	f(A, B, C)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
0	1	1	0
1	1	1	1

$= \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$

5 Circuit diagram



6 How many minterms

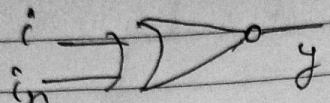
2^n

$\frac{2^n}{2}$ $\frac{2^n}{2}$ $\rightarrow$ 2^{n-1}

* XNOR gate

① input n, & o/p 1

② Symbol



$y = i_1 \odot i_2 \odot i_3 \cdots$

③ o/p of XNOR is 1 iff even no. of literals are false

④ Truth table

A	B	$A \odot B$	$A \oplus B$
0	0	1	0
1	0	0	1
0	1	0	1
1	1	1	0

$A \oplus B \rightarrow \bar{A}\bar{B} + AB$

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

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

A	B	C	$A \odot B \odot C$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
0	1	1	0
1	1	1	1

$101 = 0$

If we've f^n of even var then XOR and XNOR are opposite of each other

If we've f^n of odd var then XOR and XNOR are same

A	B	XOR $A \oplus B$	XNOR $A \odot B$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

XOR → diff
XNOR → similarities

$A' \oplus B \iff A \odot B$

$A \oplus B' \iff A \odot B$

$A' \oplus B' \iff A \oplus B$

$A' \odot B = A \oplus B$

$A \odot B' = A \oplus B$

$A' \odot B' = A \odot B$

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

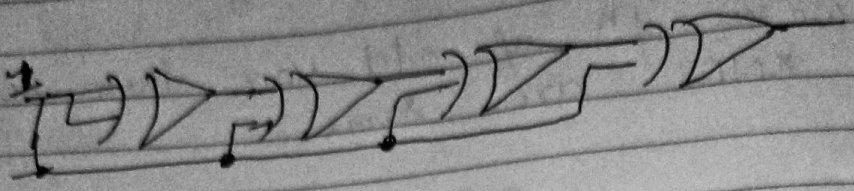
$\bar{A}\bar{B} + AB$

XOR

$1 \oplus 1 \oplus 1 \oplus 1 \oplus 1 \cdots = 0_{Ans}$ (1) → even times

$1 \oplus 1 \oplus 1 \oplus 1 \oplus 1 \cdots = 1_{Ans}$ (1) even times

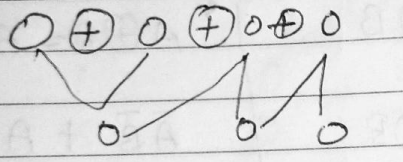
Gate question



if we have 20 XOR gates output will be ?

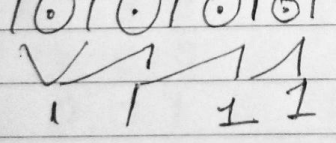
$1 \oplus 1 \oplus 1 \oplus 1 \oplus 1 \cdots$ Ans → 1

we have 20 XOR gate so no. of '1's will be '21' and '21' is odd so ans is '1'

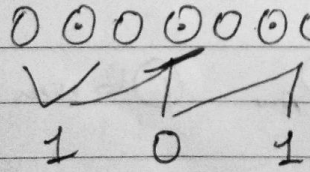


→ odd 0's
even 0's
Ans will 0 only

~~XOR~~ XNOR



→ odd 1
even 1



→ odd 0's ⇒ 0
even 1's ⇒ 1

XOR → odd literal true

→ odd 1's → 1
even 1's → 0

0 ← even / odd = 0

XNOR → even literal false

1 → odd / even = 1

0 — odd = 0
even = 1

$1 \oplus 0 \oplus 1 \oplus 0 \oplus 1 \oplus 1 \oplus 0 \oplus 1 \Rightarrow 5$

$1 \odot 0 \odot 1 \odot 0 \odot 1 \odot 1 \odot 0 \odot 1 \Rightarrow 0$

$A \oplus A \oplus A \oplus A \cdots$

even A → 0
even 0 → 0
even 1 → 0

odd A = 1
even 0 → 0
even 1 → 1

A ○ A ○ A ○ A

(1) ⇐ even A

even 0 ↓ 1

even 1 ↓ 1

add A => A

add 0 ↓ 0

odd 1 ↓ 1