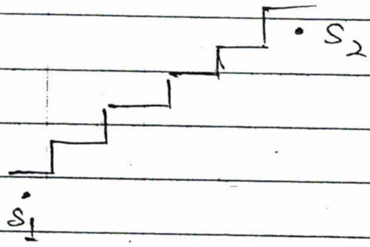
IES/GATE

Electrical Engineering

VOLUME-V

DIGITAL-ELECTRONICS

CONTENT



S_2 S_1	Bulb
0 0	0
0 1	1
1 0	1
1 1	0

$f = S_1 \oplus S_2$

→ $f_7 = x+y$ OR
$x \cup y$

→ $f_8 = \overline{x+y}$ NOR
$x \downarrow y$

→ $f_9 = x \odot y$ Ex-NOR
$= x'y' + xy$

Ex-NOR is also known as coincidence Logic or equivalence Logic Gate

→ $f_{10} = \bar{y}$ NOT
→ $f_{11} = x+\bar{y}$ Implication
$x < y$ [if y then x]

→ $f_{12} = \bar{x}$ NOT (compliment)

→ $f_{13} = \bar{x} + y$ Implication

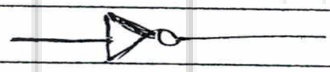
if $x \to y$ [if x then y]

→ $f_{14} = \overline{x \cdot y}$ NAND

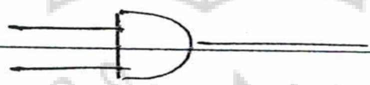
$x \uparrow y$

→ $f_{15} = 1$ Identity

Symbols for the Logic Gate

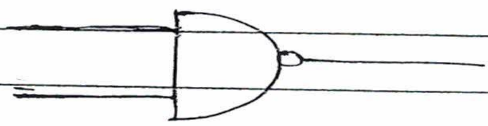


NOT

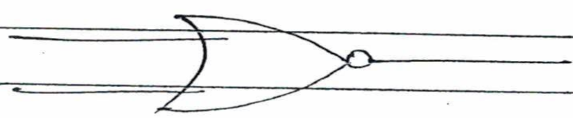


AND

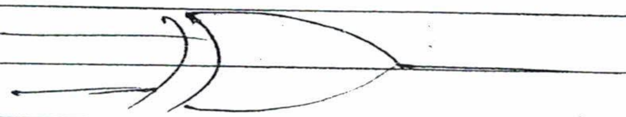
OR



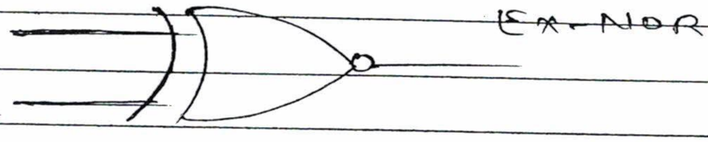
NAND



NOR

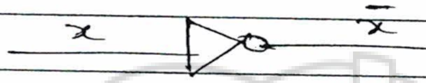


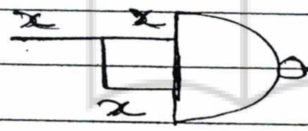
Ex-OR



→ NOT, AND, OR are basic Logic Gates.

→ NAND, NOR known as Universal Logic Gate.





$\overline{x.x}$

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

$= \bar{x}$

	NAND & NOR	
NOT	1	1
AND	2	3
OR	3	2
Ex-OR	4	5
Ex-NOR	5	4

DUALITY

Step 1) Interchange the operator. $(\cdot , +)$
Step 2) Interchange the Identity. $(0, 1)$

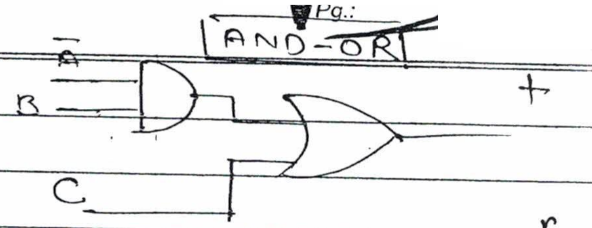
example

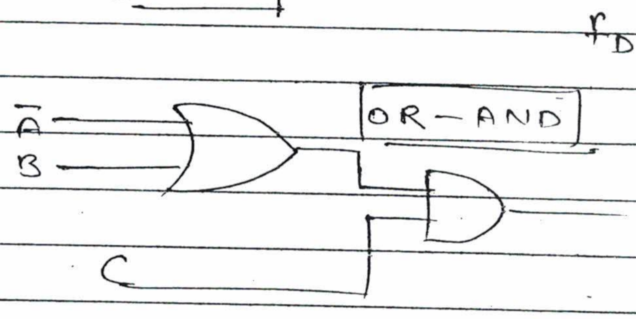
$\rightarrow \quad f = \bar{A} \cdot B + C$

$f^D = ?$

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

$(f^D)^D = f$





$\rightarrow \quad x \cdot 0 = 0$

$x + 1 = 1$

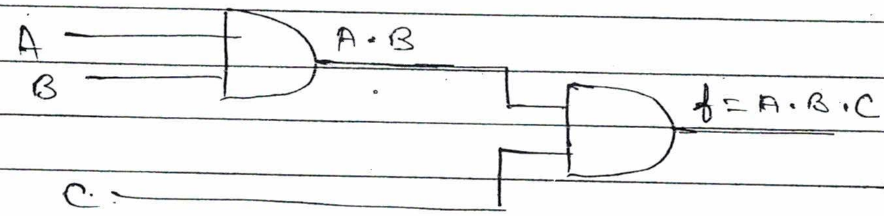
AND	OR
$x \cdot x = x$	$x + x = x$
$x \cdot 0 = 0$	$x + 0 = x$
$x \cdot 1 = x$	$x + 1 = 1$
$x \cdot \bar{x} = 0$	$x + \bar{x} = 1$

Degenerative forms

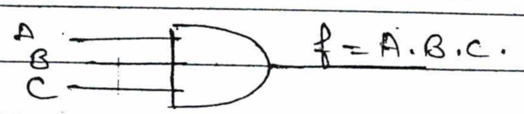
If a two level logic gate system output is expressed by a single logic gate then the two level logic Gate system is known as Degenerative forms for a single Logic Gate.

Ex :- AND-AND is the degenerated form for AND Gate.

AND - AND

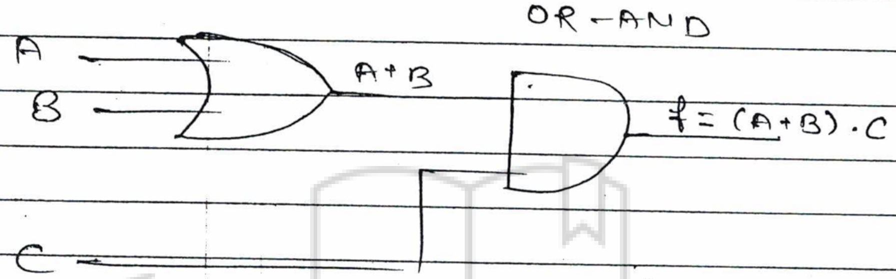


AND



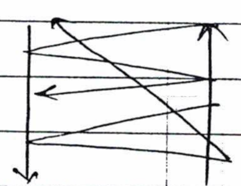
Non-Degenerative forms

OR - AND



List of Non-Degenerative forms.

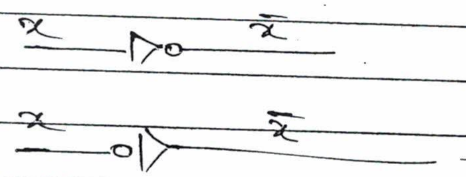
Equivalent	AND - OR	OR - AND	Equivalent
	NAND - NAND	NOR - NOR	
	NOR - OR	NAND - AND	
	OR - NAND	AND - NOR	

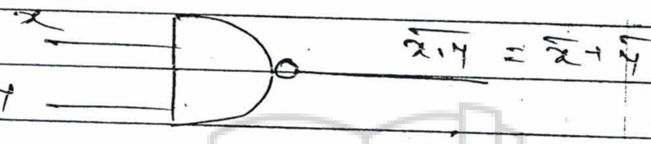


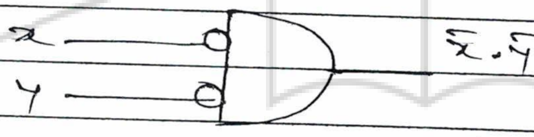
In the above Representation of Non-Degenerative List combination of the same horizontal line are dual forms.

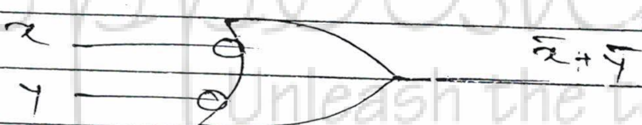
eg.
AND - OR dual is OR - AND

→ Alternative logic Gate









	Bubbled
NAND	→ OR
NOR	→ AND
AND	→ NOR
OR	→ NAND

$\overline{x \cdot y} = \bar{x} + \bar{y}$

$\overline{x + y} = \bar{x} \cdot \bar{y}$

→ Positive Negative Logics

(+) ve Logic
High → 1
Low → 0

(−) ve Logic
High → 0
Low → 1

(+) ve Logic
−2V → 1
−7V → 0

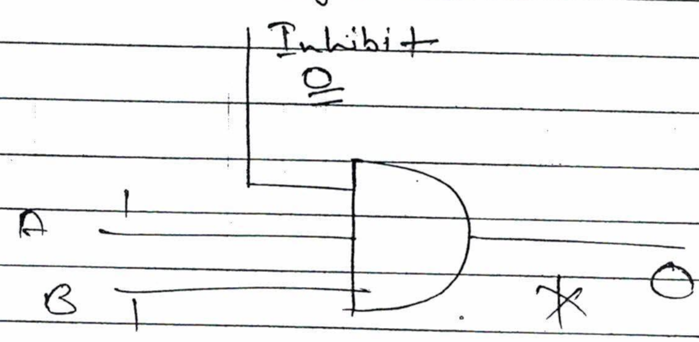
(+) ve AND logic

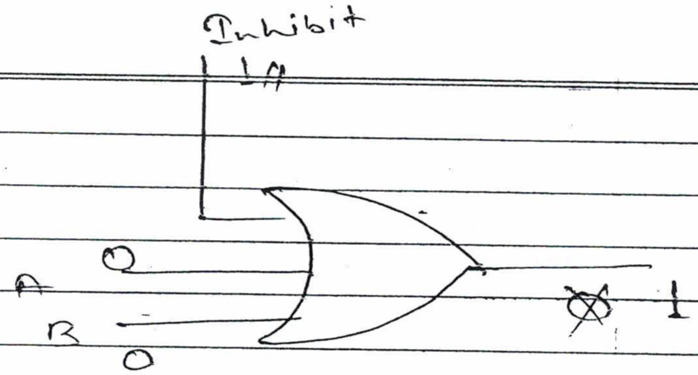
A	B	f = A · B
0	0	0
0	1	0
1	0	0
1	1	1

(−) ve AND logic = (+) ve OR Logic

A	B	f
1	1	1
1	0	1
0	1	1
0	0	0

→ Inhibit Input of Logic Gate





Inhibit

	Disable	Enable
NAND	L	H
NOR	H	L
AND	L	H
OR	H	L

Ex-OR (Imp.)

$x \oplus x = 0$

$x \oplus \bar{x} = 1$

$x \oplus 1 = \bar{x}$

$x \oplus 0 = x$

$x \oplus 1 = \bar{x}$

$\bar{x} 1 + x \cdot \bar{1}$

$= \bar{x} \cdot 1 + 0 = \bar{x}$

$x \odot x = 1$

$x \odot \bar{x} = 0$

$x \odot 1 = x$

$x \odot 0 = \bar{x}$

$\left.\begin{array}{l} \overline{x \oplus y} \\ x \oplus y' \\ x' \oplus y \end{array}\right\} x \odot y$

$x \oplus \bar{y}$

$= x'y' + x \cdot (y')'$

$= x'y' + xy$

$= x \odot y$

$$x \oplus y = x \odot y$$
$$x \oplus y \oplus z = x \odot y \odot z$$
$$w \oplus x \oplus y \oplus z = w \odot x \odot y \odot z$$

for even variable (Bar = NOT)
for odd variable (Ex-OR = Ex-NOR)

→ Complementing the boolean expression

Step 1) Duality
Step 2) Compl'ing the individual variable

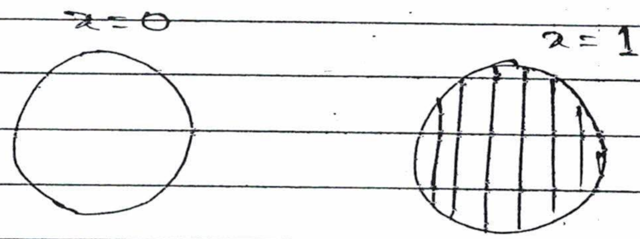
Eg:
$$f = A'B + C$$
$$\bar{f} = ?$$

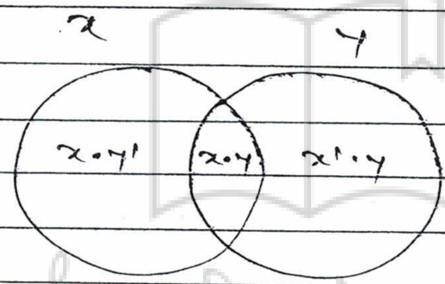
1. $(A' + B) \cdot C$
2. $(A + B') \cdot C' = f'$

→ Order of Operators

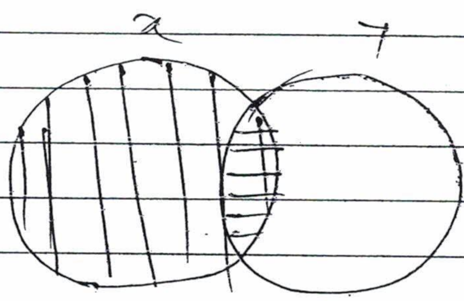
1. [ ]
2. NOT
3. AND
4. OR

Venn Diagrams

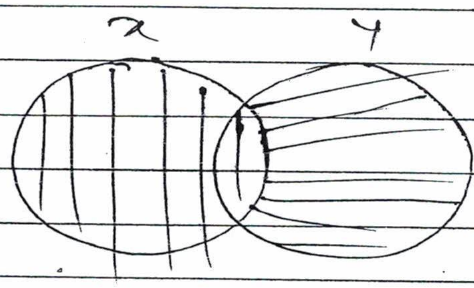


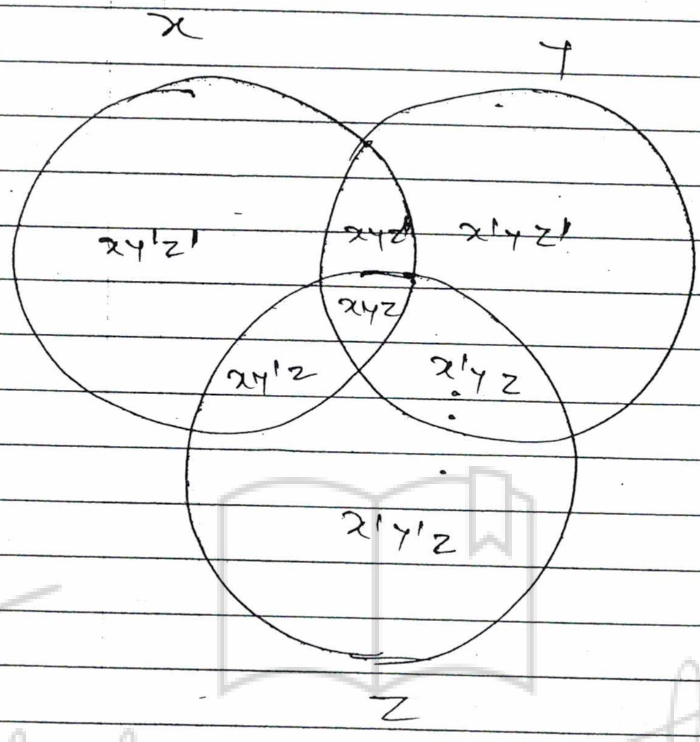


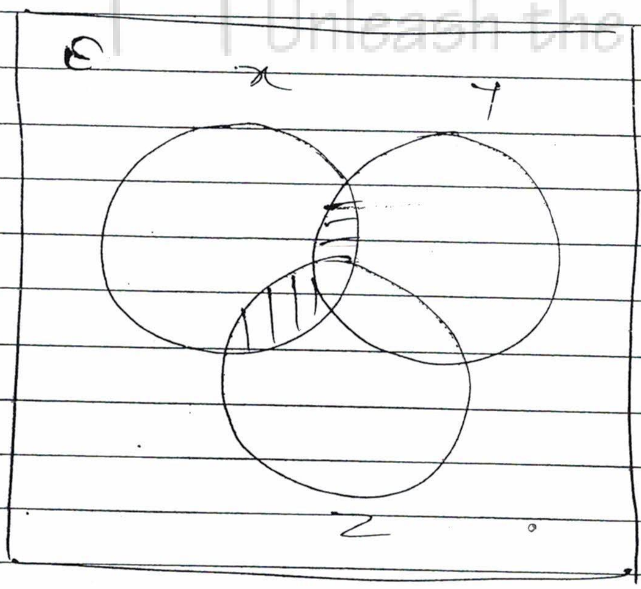
$\Rightarrow \quad x + xy = x$



$\Rightarrow \quad x + x'y = x + y$







$f = E.(xyz' + xy'z$

Toppersnotes
Unleash the topper in you

→ Logic minimization Techniques.

NOT   Boolean Law

if $x = 0$

$\bar{x} = 1$

$(x')' = x$

AND

$x \cdot x = x$

$x \cdot \bar{x} = 0$

$x \cdot 1 = x$

$x \cdot 0 = 0$

OR

$x + x = x$

$x + 1 = 1$

$x + 0 = x$

$x + \bar{x} = 1$

Commutative Law

$x \cdot y = y \cdot x$

$x + y = y + x$

Associative Law

$(x \cdot y) \cdot z = x \cdot (y \cdot z)$

$(x + y) + z = x + (y + z)$

$1 + B + C = 1$

$1 + \bar{C} + CD + \overline{CDE} =$

Distributive Law

$x \cdot (y+z) = x \cdot y + x \cdot z$

$x + (y \cdot z) = (x+y)(x+z)$

De morgan's Law

$\overline{x \cdot y} = \bar{x} + \bar{y}$

$\overline{x + y} = \bar{x} \cdot \bar{y}$

Consensus Theorem

A variable is associated with some variable & its compliment is associated with another variable then the next term is formed by the left over variable then the term becomes Redundant. 15

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

$\Downarrow$

Redundant

$\Uparrow$

$A \cdot B + \bar{A}C + BCDE = A \cdot B + \bar{A}C$

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

Transposition Theorem

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

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

operators & association can be interchange.

Absoption law

OR in the variable with ANDing of that variable with another variable result in the same variable.

$$x + x.y = x$$
$$x.(x+y) = x$$

Redundant Lateral Rule

ORing of a variable with ANDing of its component by another variable results in the ORing of those two variable.

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$$x + x'y = x + y$$
$$x.(x'+y) = x.y$$

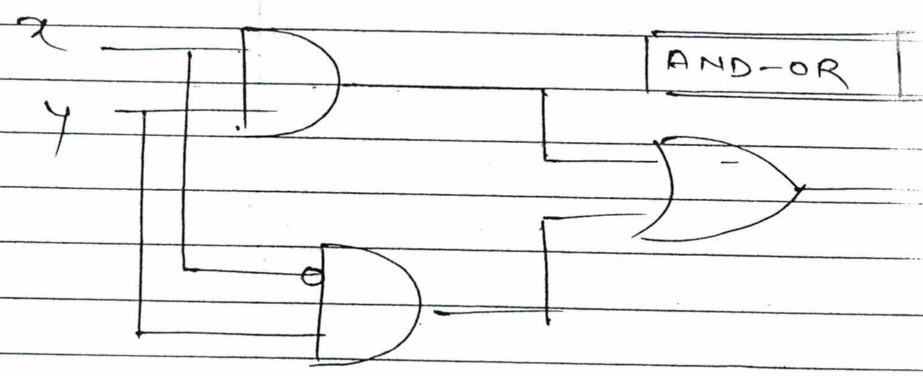
SOP & POS forms

SOP (Σm)

	x	y	$\boxed{\text{minterm}}$	f
0	0	0	$\bar{x}.\bar{y}$	0
1	0	1	$\bar{x}.y$	1
2	1	0	$x.\bar{y}$	0
3	1	1	$x.y$	1

$$f = \Sigma m(1,3) = \Pi m(0,2)$$

$f = x \cdot y + \bar{x} y$



→ Half Adder

0	0	1	1
0	1	0	$\boxed{1}$ 1
0	1	1	0

x	y	carry	sum
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

$Sum = \bar{x} \cdot y + x \cdot \bar{y}$
$= x \oplus y$

$Carry = x \cdot y$