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College Name :

DELHI GLOBAL INSTITUTE OF TECHNOLOGY

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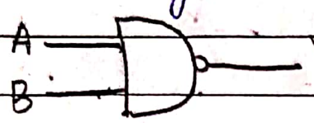
Course Code : PCC-CSE-205G

Subject : Digital Electronics

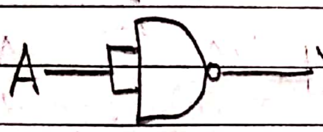
Session : 2019 - 2023

Ans 1 a) ~~Nand~~ NAND and NOR are called universal gates. Because by using these gates we can implement any other gates.

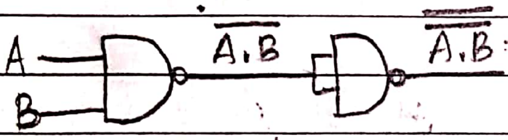
For example by using NAND gate we make various gates:



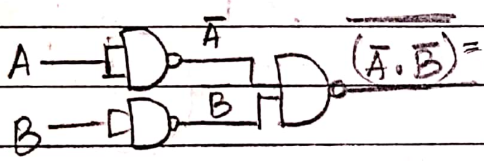
$Y = \overline{A \cdot B}$ (NAND gate)



$Y = \overline{A}$ (NOT gate) or Inverter

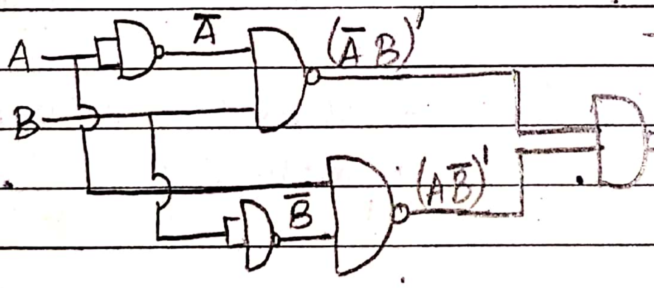


$Y = A \cdot B$ (AND gate)



$\overline{(\overline{A} \cdot \overline{B})} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

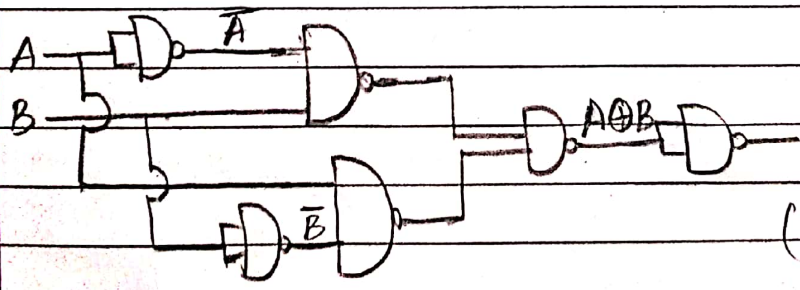
$Y = A + B$ (OR gate)



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

$Y = (\overline{A}B + A\overline{B}) = A \oplus B$

(EXOR gate)



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

(EXNOR gate)

ExNOR gate is the complemented form of EXOR gate.

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Using NOR gate

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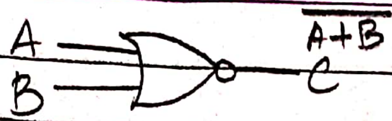
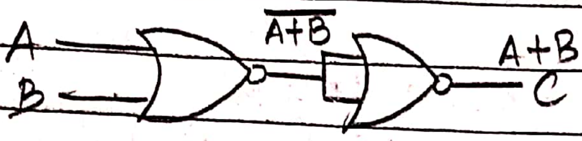
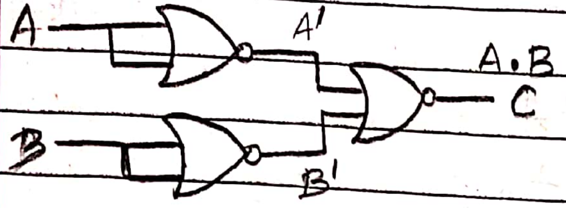


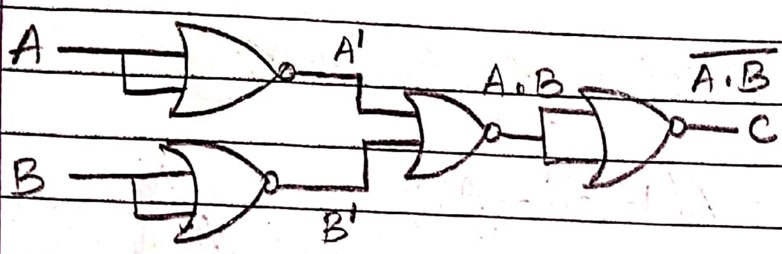
NOR gate



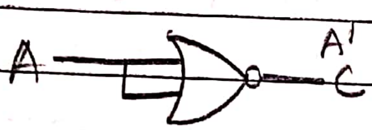
OR gate



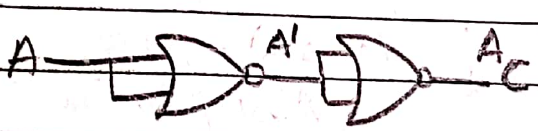
AND gate



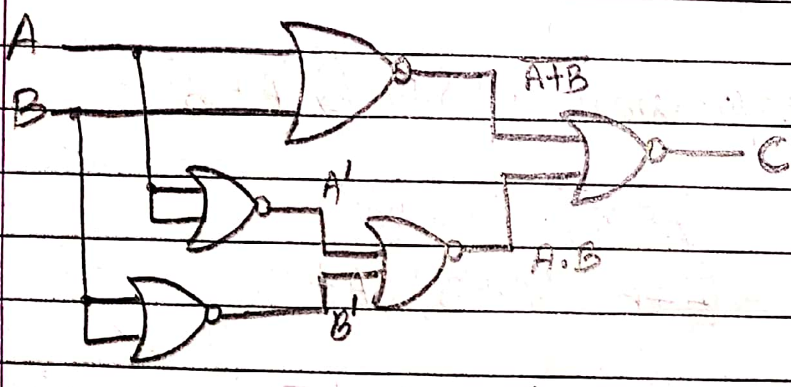
NAND gate



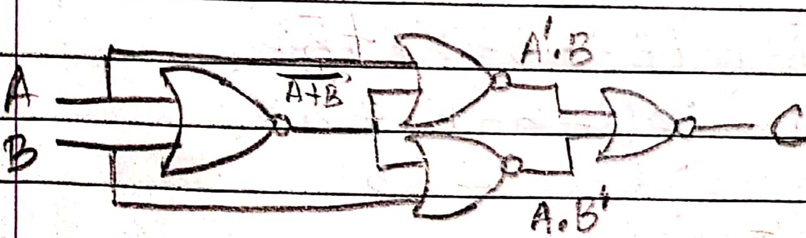
NOT gate (Inverter)



Buffer



Exclusive -OR gat



Exclusive -NOR gate

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Ans 1b)

Combinational Circuits	Sequential Circuits
① It is the circuits whose output is determined by the present values of its input only.	① It is the circuits whose output is determined by the present values of the input as well as past values of the output.
② It does not have a feedback path from output to input.	② It has a memory and a feedback path from output to input.
③ It does not have a clock signal. Its action does not depend on clock transition.	③ It may or may not have clock signal but most sequential circuit have a clock signal.
④ It's circuit is simpler than that of sequential logic circuits.	④ Its circuit is more complex than that of combinational circuits.
⑤ It is built using basic gates i.e., NOT, AND, OR	⑤ It is built using basic gates and combinational circuits.
⑥ Example: Adder, subtractor, multiplexer, etc.	⑥ Example: Flip flops, counters, Shift registers.

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Ans 2(a) De Morgan's Theorem

It works on the principle of duality.
Duality states that interchanging the operators and variables in a function, such as replacing AND operator with OR operator and OR operator with AND operator, replacing 0 with 1 and 1 with 0.
So, it states that:

$$(A+B)' = A'.B'$$
$$(A.B)' = A'+B'$$

Show that: $\overline{ABC} = \overline{A}+\overline{B}+\overline{C}$
We use truth table:

A	B	C	ABC	$\overline{ABC}$	$\overline{A}$	$\overline{B}$	$\overline{C}$	$\overline{A}+\overline{B}+\overline{C}$
0	0	0	0	1	1	1	1	1
0	0	1	0	1	1	1	0	1
0	1	0	0	1	1	0	1	1
0	1	1	0	1	1	0	0	1
1	0	0	0	1	0	1	1	1
1	0	1	0	1	0	1	0	1
1	1	0	0	1	0	0	1	1
1	1	1	1	0	0	0	0	0

So, from the above table:
Column of $(\overline{ABC})$ = column of $(\overline{A}+\overline{B}+\overline{C})$

Hence, $\overline{ABC} = \overline{A}+\overline{B}+\overline{C}$

Now, show that : $\overline{((A+B+C)D)} = \bar{A}\bar{B}\bar{C} + \bar{D}$

A	B	C	D	$(A+B+C)$	$((A+B+C)D)$	$\overline{((A+B+C)D)}$	$\bar{A}\bar{B}\bar{C}$	$\bar{A}\bar{B}\bar{C}+\bar{D}$
0	0	0	0	0	0	1	1	1
0	0	0	1	0	0	1	1	1
0	0	1	0	1	0	1	0	1
0	0	1	1	1	1	0	0	0
0	1	0	0	1	0	1	0	1
0	1	0	1	1	1	0	0	0
0	1	1	0	1	0	1	0	1
0	1	1	1	1	1	0	0	0
1	0	0	0	1	0	1	0	1
1	0	0	1	1	1	0	0	0
1	0	1	0	1	0	1	0	1
1	0	1	1	1	1	0	0	0
1	1	0	0	1	0	1	0	1
1	1	0	1	1	1	0	0	0
1	1	1	0	1	0	1	0	1
1	1	1	1	1	1	0	0	0

So, from the above table we can easily see that

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

Hence,

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

Ans 3. b) $F(A,B,C,D) = \Sigma(0,1,2,3,6,7,9,13) + \Sigma_d(11,15)$

From the above function, we have given the minterms as well as don't care term

$\Sigma m = (0,1,2,3,6,7,9,13)$

$\Sigma_d = (11,15)$

Using the above terms, we construct a k-map

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

From the above K-map we can easily see that by using the minterms and don't care terms we form 3 quads.

First quad using $= \Sigma(0,1,2,3)$

Second quad using $= \Sigma(2,3,6,7)$

Third quad using $= \Sigma(13,9) + \Sigma_d = (11,15)$

Now, from first quad we get,

$\bar{A}\bar{B}$

From second quad we get,

$\bar{A}C$

From third quad we get,

AD

Now we ORed these terms so that we get the minimized expression :

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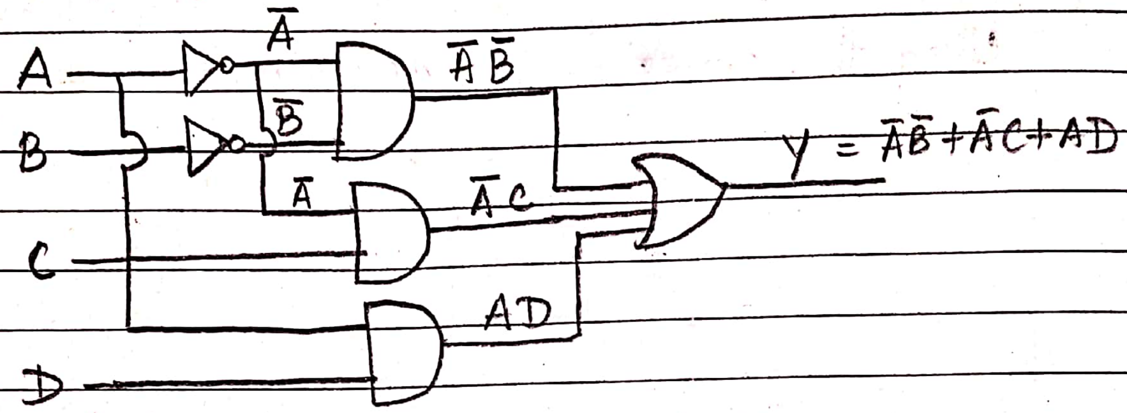
$Y = \bar{A}\bar{B} + \bar{A}C + AD$

Here, Y is the output.

Now using this simplified expression we design a circuit.



Here we are using 2 NOT gate, 3-Nand Gate and One 3-input OR gate.

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