COMPUTER LOGIC AND GATES

EXERCISE

Q1. Select the best answer for the following MCQs:

Which operation is represented by "+" sign?

A. AND

B. OR

C. NOT

D. NAND

Which operation is represented by a dot or absence of an operator?

A. AND

B. OR

C. NOT

D. NAND

Which of the following gates is also known as inverter?

A. OR gate

B. NOR gate

C. NAND gate

D. NOT gate

Which combination of inputs to a two input AND gate will produce output of HIGH?

A. LOW and LOW

B. LOW and HIGH

C. HIGH and HIGH

D. None

Which logic gate is represented by the function F = $\overline{(x + y)}$?

A. NAND

B. NOR

C. Exclusive-OR

D. Excusive-NOR

Which logic gate is represented by the function F = $\overline{(xy)}$?

A. NAND

B. NOR

C. Exclusive-OR

D. Exclusive-NOR

What is the maximum number of possible input combinations in a truth table that has three variables?

A. 3

B. 6

C. 8

D. 9

How many AND gates are required to create the logic circuit of the Boolean function F = x + yz + xyz?

A. 1

B. 2

C. 3

D. 4

Q2. Give short answers to the following questions.

i. What is a logic gate?

Ans: Logic Gate:

Logic gate are the basic building blocks of digital computer. Logic gates operate

on two voltage levels and process digital signals which represent binary digits 0 ana

ii.Define Truth table

Ans: Truth table:

A truth table represents a digital logic circuit in table form. It shows how a logic circuit's output responds to all the possible combinations of the inputs using logic '1' for true and 'O'for false.

iii. Define Boolean function

Ans: Boolean function:

A Boolean function can be transformed from an algebraic expression into a logic circuit composed of AND, OR and NOT gates.

A Boolean function is an expression formed with binary variables, the logical operator (OR, AND and NOT). Parenthesis and equal sign. A binary variable can take the value of 0 or 1. For a given value of the variables, the function can be either 0 or 1.

iv. What is Karnaugh map and why it is used?

Ans: Karnaugh map:

K-map is a pictorial form of truth table. It consists of square boxes called cells. All the possible combinations of variables involved in Boolean function are written inside the cells in their respective positions. A two-variable K-map contains 22=4 so on forth.

Use of Karnaugh map:

Karnaugh map is used for logic simplification. A Karnaugh map provides a pictorial method of grouping together expressions with common factors and therefore eliminating unwanted variables.

v. Draw three-variable Karnaugh map for variables x, y and z.

Ans: Simplification of three-variable Boolean function using Karnaugh map: The three-variable K-map for variables A, B and C is shown in Fig.

	$\bar{B}$	$\bar{B}$	B	B
$\bar{A}$	$\bar{A}\bar{B}\bar{C}$	$\bar{A}\bar{B}C$	$\bar{A}BC$	$\bar{A}B\bar{C}$
A	$A\bar{B}\bar{C}$	$A\bar{B}C$	ABC	$AB\bar{C}$
	$\bar{C}$	C	C	$\bar{C}$

Three-variable K-map

Example: As an example, consider the following Boolean function

F=x+y

The function F is equal to 0, if x=0 and y=0, For all the other combination of x and y, the function will be equal to 1.

It consists of eight cells having two rows and two columns. Rows are labelled with the complement and normal form of the variable A. Each column is labelled with two variables B and C in their normal or complemented form. Each example the term ABC is placed in cell that is in row A and column BC.

The following are the rules for simplifying a three-variable K-map

- •For each term of the function, place 1 in the corresponding cell in Karnaugh map
- Form groups of four, if possible, otherwise group of two
- Groups can contain only 1s
- Groups can overlap and wrap around the side of K-map
- If possible, include each 1 in at least one group
- Eliminate the variables that are in normal and complemented form in a group and create a term for each group

Write the simplified function in the form of sum of terms. If a cell containing a 1 cannot be included in any group, then write the full term with three variables

Q3. Draw the graphical symbols of AND, OR, NOT, NAND and NOR gates and write their functions.

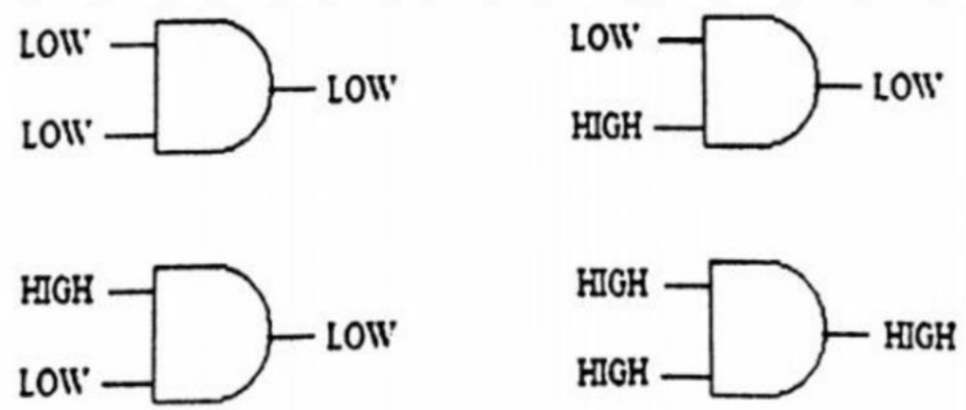
Ans: Basic Logic Gates:

There are three basic logic gates used in digital circuits which are AND, OR and NOT gates

• AND Gate:

The AND gate has two or more inputs that can be LOW (0) or HIGH (1). The output is HIGH only when all the inputs are HIGH. It produces a LOW output when at least one of the inputs is LOW.

The logic operation of a two-input AND gate is shown in Fig, with all the possible input combinations and the resulting output for each.

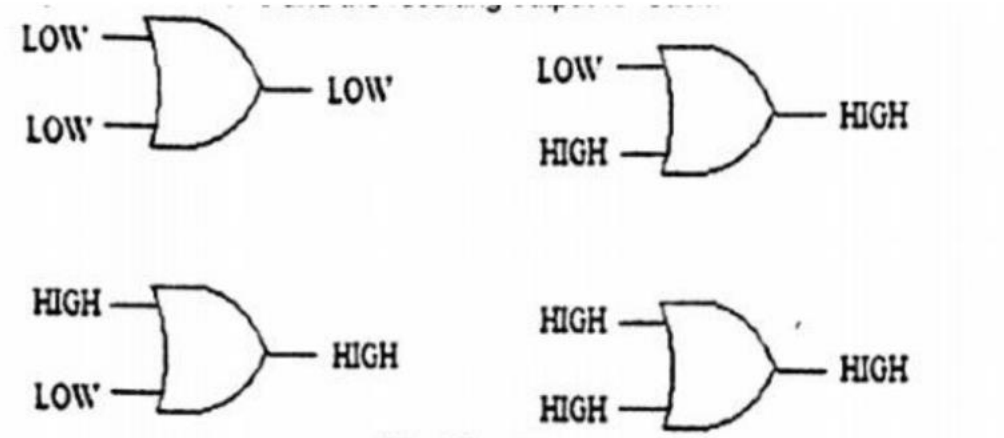


The AND gate

OR Gate:

The OR gate has two or more inputs. The output of an OR gate is LOW only when all the inputs are LOW. The output is HIGH when one or more of its inputs are HIGH

The logic operation of a two-input OR gate is shown in Fig. with all the possible input combinations and the resulting output for each



The OR gate

NOT Gate:

The NOT gate performs the functions of inversion. Therefore, it is also known as inverter.

It has single input.

The output of NOT gate is HIGH when the input is LOW and vice versa.

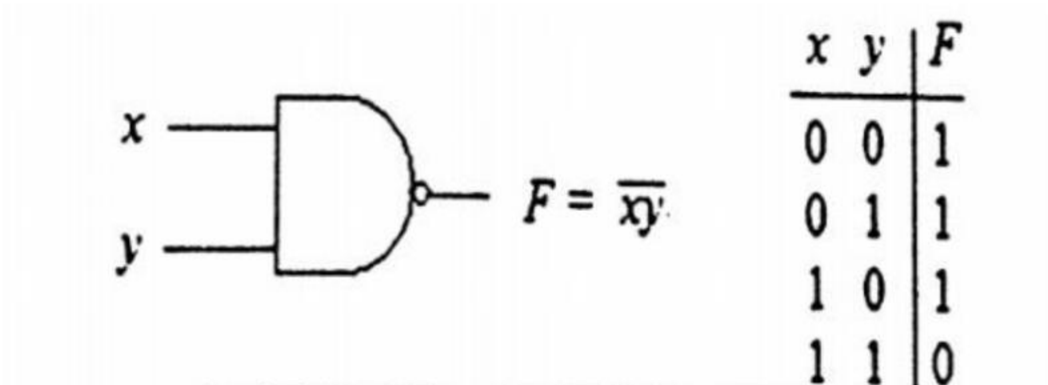
The NOT gate

The NAND Gate:

The NAND gate combines the AND and NOT gates, such that the output will be 0 only when all the inputs are 1 as shown in Fig.

Its logic expression **F =** $\overline{(xy)}$ which indicates that inputs x and y are first AND and then the result is inverted. Inversion is indicated by a bar.

Thus, an and gate always produces an output that is the inverse of (opposite) of and gate.

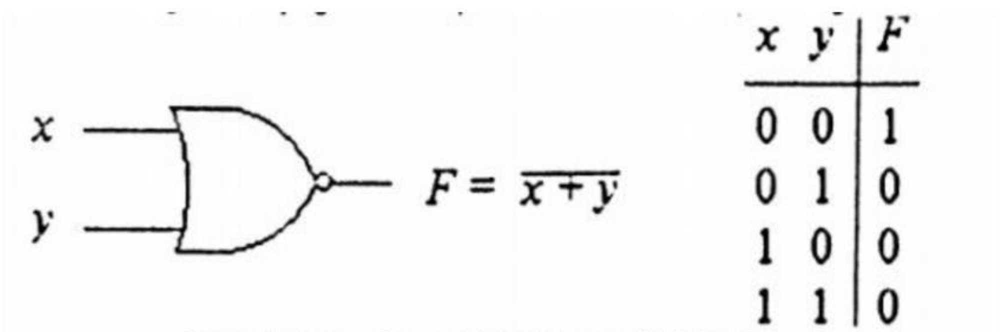


Symbol, expression and truth table of NAND gate

· The NOR Gate:

The NOR gate combines the OR and NOT gate, such that the output will be 0 when any

input is 1 as shown in Fig. Its logic expression is F = $\overline{(x + y)}$which indicates that x and y are first OR and then the result is inverted. Inversion is indicated by a bar.

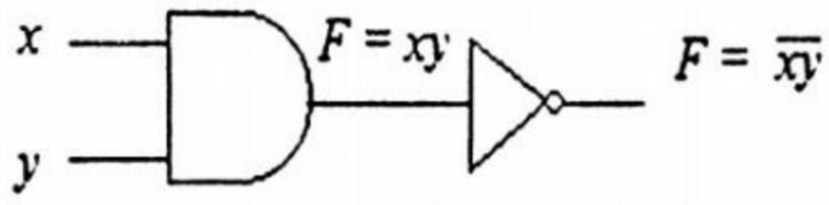


Symbol expression and truth table of NOR gate

Q4. Explain how NAND and NOR gates can be created using AND, OR and NOT gates.

Ans: Creating NAND Gate Using Basic Gates:

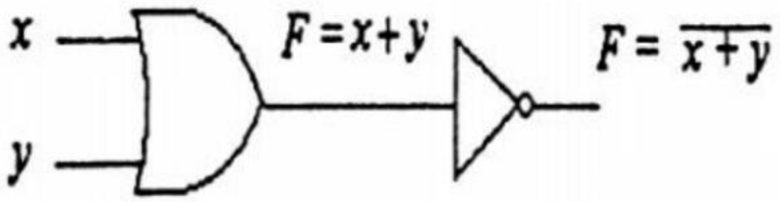
i. The NAND gate can be easily created by using an AND gate and a NOT gate as shown in Fig.



Creating a NAND gate using basic gates

Creating NOR Gate Using Basic Gates:

The NOR gate can be also created in a similar way by using an OR gate and a NOT gate shown in Fig.



Creating a NOR gate using basic gates

Q5. Draw the truth table of the following Boolean functions.

i. $F_1 = \bar{x}y\bar{z} + \bar{x}yz + xy\bar{z}$

ii. $F_2 = \bar{x}z + y\bar{z} + xyz$

iii. $F_3 = \overline{xy}\bar{z} + \overline{xy}z + \bar{x}yz + xy\bar{z}$

iv. $F_4 = x\bar{z} + \overline{xy}$

i. $F_1 = \bar{x}y\bar{z} + \bar{x}yz + xy\bar{z}$

x	y	z	$\bar{x}$	$\bar{y}$	$\bar{z}$	$\bar{x}y\bar{z}$	$\bar{x}yz$	$xy\bar{z}$	F_1
1	1	1	0	0	0	0	0	0	0
1	1	0	0	0	1	0	0	1	1
1	0	1	0	1	0	0	0	0	0
1	0	0	0	1	1	0	0	0	0
0	1	1	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0	0	1
0	0	1	1	1	0	0	0	0	0
0	0	0	1	1	1	0	0	0	0

ii. $F_2 = \bar{x}z + y\bar{z} + xyz$

x	y	z	$\bar{x}$	$\bar{y}$	$\bar{z}$	$\bar{x}z$	$y\bar{z}$	xyz	F_2
1	1	1	0	0	0	0	0	1	1
1	1	0	0	0	1	0	1	0	1
1	0	1	0	1	0	0	0	0	0
1	0	0	0	1	1	0	0	0	0
0	1	1	1	0	0	1	0	0	1
0	1	0	1	0	1	0	1	0	1
0	0	1	1	1	0	1	0	0	1
0	0	0	1	1	1	0	0	0	0

iii. $F_3 = \overline{x}\overline{y}\overline{z} + \overline{x}\overline{y}z + \overline{x}yz + xy\overline{z}$

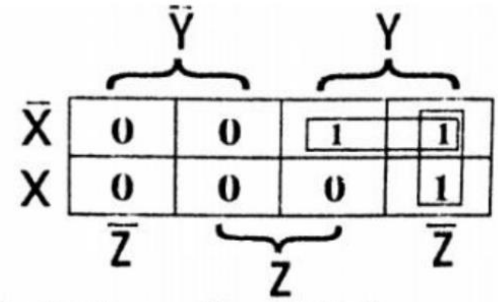
x	y	z	$\overline{x}$	$\overline{y}$	$\overline{z}$	$\overline{x}\overline{y}\overline{z}$	$\overline{x}\overline{y}z$	$\overline{x}yz$	$xy\overline{z}$	F_3
1	1	1	0	0	0	0	0	0	0	0
1	1	0	0	0	1	0	0	0	1	1
1	0	1	0	1	0	0	0	0	0	0
1	0	0	0	1	1	0	0	0	0	0
0	1	1	1	0	0	0	0	1	0	1
0	1	0	1	0	1	0	0	0	0	0
0	0	1	1	1	0	0	1	0	0	1
0	0	0	1	1	1	1	0	0	0	1

iv. $F_4 = x\overline{z} + \overline{x}\overline{y}$

x	y	z	$\overline{x}$	$\overline{y}$	$\overline{z}$	$x\overline{z}$	$\overline{x}\overline{y}$	F_4
1	1	1	0	0	0	0	0	0
1	1	0	0	0	1	1	0	1
1	0	1	0	1	0	0	0	0
1	0	0	0	1	1	1	0	1
0	1	1	1	0	0	0	0	0
0	1	0	1	0	1	0	0	0
0	0	1	1	1	0	0	1	1
0	0	0	1	1	1	0	1	1

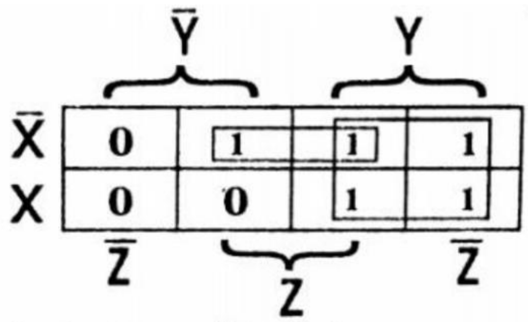
Q6. Simplify Boolean functions of question 5 using K map.

i. $F_1 = \bar{x}y\bar{z} + \bar{x}yz + xy\bar{z}$



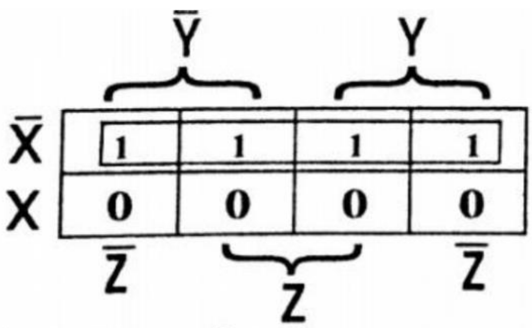
The simplified function is: $F_1 = \bar{x}y + y\bar{z}$

ii. $F_2 = \bar{x}z + y\bar{z} + xyz$



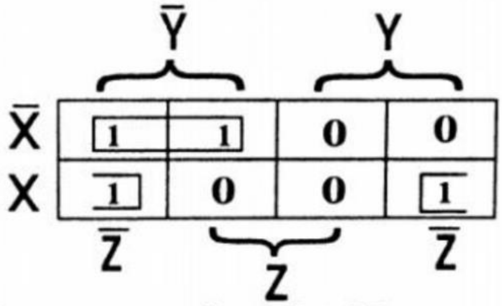
The simplified function is: $F_2 = \bar{x}z + y$

iii. $F_3 = \overline{xy}\bar{z} + \overline{xy}z + \bar{x}yz + xy\bar{z}$



The simplified function is: $F_3 = \bar{x}$

iv. $F_4 = x\bar{z} + \overline{xy}$



The simplified function is: $F_3 = x\bar{z} + \bar{x}\bar{y}$

Q7. Draw the logic circut of the following Boolean functions.

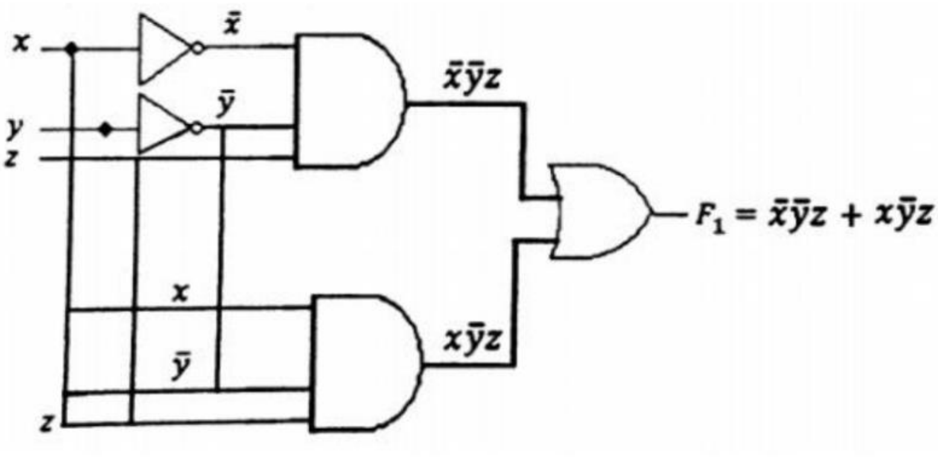
i. $F_1 = \bar{x}\bar{y}z + x\bar{y}z$

ii. $F_2 = \bar{x} + yz$

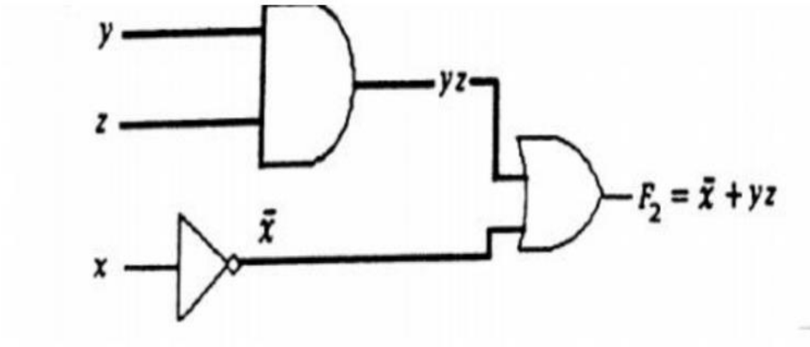
iii. $F_3 = x\bar{y} + x\bar{y}z + xyz$

iv. $F_4 = \bar{x}\bar{y}z + x\bar{y}z$

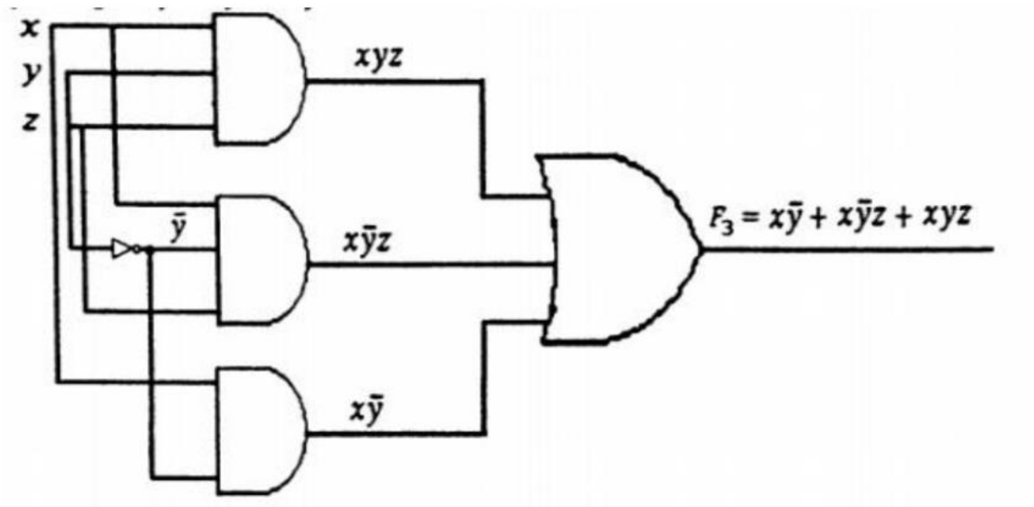
i. $F_1 = \bar{x}\bar{y}z + x\bar{y}z$



ii. $F_2 = \bar{x} + yz$



iii. $F_3 = x\bar{y} + x\bar{y}z + xyz$



iv. $F_4 = \bar{x}\bar{y}z + x\bar{y}z$