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Internal Assessment Test – I

Sub:	**Introduction to Electronics Engineering/Basic Electronics**							**Code:**	**BESCK204C /BBEE203**
Date:	**12/ 04 / 2024**	**Duration:**	**90 mins**	**Max Marks:**	**50**	**Sem:**	**II**	**Sec:**	**Physics Cycle**

	Answer Any FIVE FULL Questions	**Marks**	**OBE CO**	**OBE RBT**
1.	Perform the following Conversions. (i) $(144.98)_{10} \rightarrow (\ ?\ )_8$ (ii) $(1764.36)_8 \rightarrow (\ ?\ )_{10}$ (iii) $(446.15)_8 \rightarrow (\ ?\ )_2 \rightarrow (\ ?\ )_{10}$ (iv) $(ABCD.EF)_{16} \rightarrow (\ ?\ )_8$ (v) $(888.86)_{10} \rightarrow (\ ?\ )_2$	[2*5=10]	CO3	L3
2.	Express the Boolean function in a sum of minterms, (i) F= A' + B'C (ii) F= A'B + B'A + C Write above functions in Product of Maxterms using De Morgan's law	[4+4+2]	CO3	L3
3.	Obtain the truth table, SOP Boolean equation and logic diagram for the given problem statements. a. To operate the lamp, switch A and either switch B or switch C must be operated. b. A logic circuit is to be constructed that will produce a logic 1 output whenever two or more of its three inputs are at logic 1.	[10]	CO3	L4

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4	Perform $(55)_{10} – (218)_{10}$ using a. 1’s complement method b. 2’s complement method Perform $(38)_{10} – (19)_{10}$ using a. 1’s complement method b. 2’s complement method	5+5]	CO3/ CO4	L3
5	With the help of truth table explain the operation of Full Adder with its circuit diagram and reduce the expression for Sum and carry.	[10]	CO3/ CO4	L2
6	Mention the different theorems and Postulates of Boolean Algebra and Prove each of them with truth table.	[2*5]	CO3/ CO4	L2
7	Subtract using (r-1)’s compliment method a)$4456_{(10)} - 34234_{(10)}$ Subtract using r’s compliment method a)$1010100_{(2)}-1000100_{(2)}$	[5+5]	CO3/ CO4	L3
8	Simplify following Boolean expression (i) $F(A,B,C)= (A + B' + C')(A +B' + C)(A + B + C')$ (ii) $F(A,B,C)=A'B+BC'+BC+AB'C'$	[5+5]	CO3/ CO4	L3

CI CCI HOD

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(1) (i) $(144.98)_{10} \rightarrow (\quad)_8$

8	144	
8	18	0
	2	2

$(144)_{10} \rightarrow (220)_8$

$(0.98)_{10} \rightarrow (0.7656)_8$

Fraction Part

$0.98 \times 8 = 7.84 \quad | \; 7$

$0.84 \times 8 = 6.72 \quad | \; 6$

$0.72 \times 8 = 5.76 \quad | \; 5$

$0.76 \times 8 = 6.08 \quad | \; 6$

$(144.98)_{10} \rightarrow (220.7656)_8$

(ii) $(1764.36)_8 \rightarrow (\quad)_{10}$

$(\overset{3}{1}\overset{2}{7}\overset{1}{6}\overset{0}{4}.\overset{-1}{3}\overset{-2}{6})_8$

$\Rightarrow 1\times8^3 + 7\times8^2 + 6\times8^1 + 4\times8^0 + 3\times8^{-1} + 6\times8^{-2}$

$= 512 + 448 + 48 + 4 + 0.375 + 0.09375$

$= 1012 + 0.46875$

$= 1012.46875$

$(1764.36)_8 \rightarrow (1012.46875)_{10}$

(iii) $(446.15)_8 \rightarrow (\quad)_2 \rightarrow (\quad)_{10}$

~~446.15~~

$(4\;\;4\;\;6\;.\;1\;\;5\;)_8$

$(100\;100\;110\;.\;001\;101)_2$ writing in term of 3-bit

$(446.15)_8 \rightarrow (100100110.001101)_2 \rightarrow (\quad)_{10}$

$(\overset{8}{1}\overset{7}{0}\overset{6}{0}\overset{5}{1}\overset{4}{0}\overset{3}{0}\overset{2}{1}\overset{1}{1}\overset{0}{0}.\overset{-1}{0}\overset{-2}{0}\overset{-3}{1}\overset{-4}{1}\overset{-5}{0}\overset{-6}{1})_2 = 2^8 + 2^5 + 2^2 + 2^1 + 2^{-3} + 2^{-4} + 2^{-6}$

$= 294 + 0.125 + 0.0625 + 0.015625$

$= 1\times10^{8} + 1\times10^{5} + 1\times10^{2} + 1\times10^{1} + 1\times10^{-3} + 1\times10^{-4} + 1\times10^{-6}$

$= 100000000 + 100000 + 100 + 10 + \frac{1}{10^3} + \frac{1}{10^4} + \frac{1}{10^6}$

$= 100100110 + .001 + 0.0001 + 0.000001$

$= \cancel{100100110 +}$

$= \cancel{10^{8} \times 10^{-6} + 10}$

$= (100100110.001101)_{10}$

$(446.15)_8 \rightarrow (10010011$

$(446.15)_8 \rightarrow (100100110.001101)_2 \rightarrow (294.765625)_{10}$

(iv) $(ABCD.EF)_{16} \longrightarrow (\quad)_8$

$(A \quad B \quad C \quad D \,.\, E \quad F)_{16}$] writing in terms of 4 bits

1010 1011 1100 1101 . 1110 1111

adding 0

001 010 101 111 001 101 . 111 011 110

$(1 \quad 2 \quad 5 \quad 7 \quad 1 \quad 5 \,.\, 7 \quad 3 \quad 6)_8$

$(ABCD.EF)_{16} \longrightarrow (125715.736)_8$

(v) $(888.86)_{10} \rightarrow (\quad)_2$

2	888	
2	444	0
2	222	0
2	111	0
2	55	1
2	27	1
2	13	1
2	6	1
2	3	0
	1	1

$(888)_{10} \rightarrow (1101111000)_2$

$0.86 \times 2 = 1.72$ | 1

$0.72 \times 2 = 1.44$ | 1

$0.44 \times 2 = 0.88$ | 0

$0.88 \times 2 = 1.76$ | 1

$0.76 \times 2 = 1.52$ | 1

$\cancel{0.52 \times 2}$

$(0.86)_{10} \rightarrow (0.11011)_2$

$(888.86)_{10} \rightarrow (1101111000.11011)_2$

2.) (i) $F = A' + B'C$

$F = A'(B+B')(C+C') + B'C(A+A')$

$= (A'B + A'B')(C+C') + AB'C + A'B'C$

$= A'BC + A'BC' + \underline{A'B'C} + A'B'C' + AB'C + \underline{A'B'C}$

$= A'BC + A'BC' + A'B'C + A'B'C' + AB'C$

$\;\;\; 011 \quad 010 \quad 001 \quad 000 \quad 101$

$= m_3 + m_2 + m_1 + m_0 + m_5$

$= m_0 + m_1 + m_2 + m_3 + m_5$

$F = \Sigma(0, 1, 2, 3, 5)$

Sum of minterms $= \Sigma(0, 1, 2, 3, 5)$

(ii) $F = A'B + B'A + C$

$= \cancel{(A'B + CC')}$

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

$= A'BC + A'BC' + AB'C + AB'C' + (AC + A'C)(B+B')$

$= \underline{A'BC} + A'BC' + \underline{AB'C} + AB'C' + ACB + \underline{ACB'} + \underline{A'BC} + A'B'C$

$= A'BC + A'BC' + AB'C + AB'C' + ACB + A'B'C$

$\;\;\; 011 \quad 010 \quad 101 \quad 100 \quad 111 \quad 001$

$= m_3 + m_2 + m_5 + m_4 + m_7 + m_1$

$F = \Sigma(1, 2, 3, 4, 5, 7)$

sum of minterms $= \Sigma(1, 2, 3, 4, 5, 7)$

<u>product of maxterms using De Morgan's law</u>

(i) $F = A' + B'C$

$F' = (A' + B'C)'$

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

$= A \cdot ((B')' + C')$

$= A \cdot (B + C')$

$= (A + BB')(B + C' + AA')$

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

$= (A+B+CC')(A+B'+CC')(B+C'+A)(B+C'+A')$

$= (A+B+C)(A+B+C')(A+B'+C)(A+B'+C')\cancel{(A+B+C')}\cancel{(A'+B+C')}$

$000 \quad 001 \quad 010 \quad 011 \quad 001 \quad 101$

$= \cancel{M_0}\ M$

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

$= M_0\, M_1\, M_2\, M_3\, M_5$

$F' = \Pi(0,1,2,3,5)$

$F = \Pi(4,6,7) \Rightarrow$ product of Maxterm

(ii) $F = A'B + B'A + C$

$F' = (A'B + B'A + C)'$

$= (A'B)'(B'A)'(C)'$

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

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

$= (A+B'+CC')(A'+B+CC')(C'+AA')$

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

$= (A+B'+C)(A+B'+C')(A'+B+C)(A'+B+C')(A+C'+BB')(A'+C'+BB')$

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

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

$\quad 010 \quad\quad 011 \quad\quad 100 \quad\quad 101 \quad\quad 001 \quad\quad 111$

$\Rightarrow M_2 \, M_3 \, M_4 \, M_5 \, M_1 \, M_7$

$F' = \Pi(1,2,3,4,5,7)$

$F = \Pi(0,6)$ Product of Maxterm

4 a) $(55)_{10} - (218)_{10}$ using 1's complement

$(55)_{10} \rightarrow (110111)_2$

$(55)_{10}$ — A

$(218)_{10}$ — B

2	55	
2	27	1
2	13	1
2	6	1
2	3	0
	1	1

1's complement of $(218)_{10}$

= 00100101

2	218	
2	109	0
2	54	1
2	27	0
2	13	1
2	6	1
2	3	0
	1	1

$(218)_{10} \rightarrow (11011010)_2$

Now,
```
   1   111      - carry
  00110111      - (55)10
+ 00100101      - 1's complement of (218)10
  --------
  01011100      - result
```

carry not generated

So, answer will be 1's complement of result → negative −

~~100~~ − $\boxed{10100011}$ — Answer

b) $(55)_{10} - (218)_{10}$ using 2's complement

$\quad A \quad\quad\quad B$

$(55)_{10} = (110111)_2$

$(218)_{10} = (11011010)_2$

1's complement of $(218)_{10}$ = 00100101
$+1$

2's complement of $(218)_{10}$ = 00100110

Now,

~~11 0 1 11~~
~~001 0 0 1 10~~

1   1 1 — carry.

$$\begin{array}{r l}
 & 00110111 - (55)_{10} \\
+ & 00100110 - \text{2's complement of } (218)_{10} \\
\hline
 & 01011101 - \text{result}
\end{array}$$

Carry not generated so answer will be in its 2's complement

$$\begin{array}{r}
10100010 \\
+1 \\
\hline
10100011
\end{array}$$

10100011 — Answer

→ $(38)_{10} - (19)_{10}$ using 1's complement

$(38)_{10} = (100110)_2$

$(19)_{10} = (10011)_2$

2	38	
2	19	0
2	9	1
2	4	1
2	2	0
	1	0

2	19	
2	9	1
2	4	1
2	2	0
	1	0

1's compliment of $(19)_{10}$

= 01100

Now, 1 1 — carry

$$\begin{array}{r l}
 & 100110 - (38)_{10} \\
+ & 001100 - \text{1's compliment of } (19)_{10} \\
\hline
 & 110010 - \text{result}
\end{array}$$

carry not generated so answe will be in its 1's complement

  1100110
      + 1
  110011 - Answer

~~110010~~

$\boxed{001101}$ - Answer

→ $(38)_{10} - (19)_{10}$ using 2's complement.

$(38)_{10} = (100110)_2$

$(19)_{10} = (10011)_2$

~~1's comp~~ 1's complement of $(19)_{10}$ = 01100
                                   + 1
2's complement = ⟶ 01101

Now,
```
  1 1          - Carry
  1 0 0 1 1 0  - (38)10
+ 0 0 1 1 0 1  - 2's complement of (19)10
  1 1 0 0 1 1  - result
```

Carry not generated so answer will be in 2's complement.

```
  0 0 1 1 0 0
          + 1
```

$\boxed{001101}$ - Answer

5

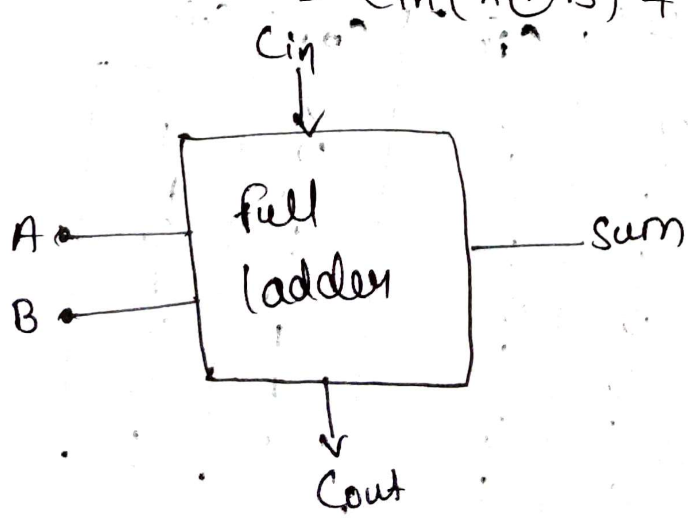
Inputs			Output	
A	B	Cin	Cout	Sum
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Full adder takes three inputs and gives two outputs. First two input A and B and third is input carry (Cin) and gives output as Sum and Cout.

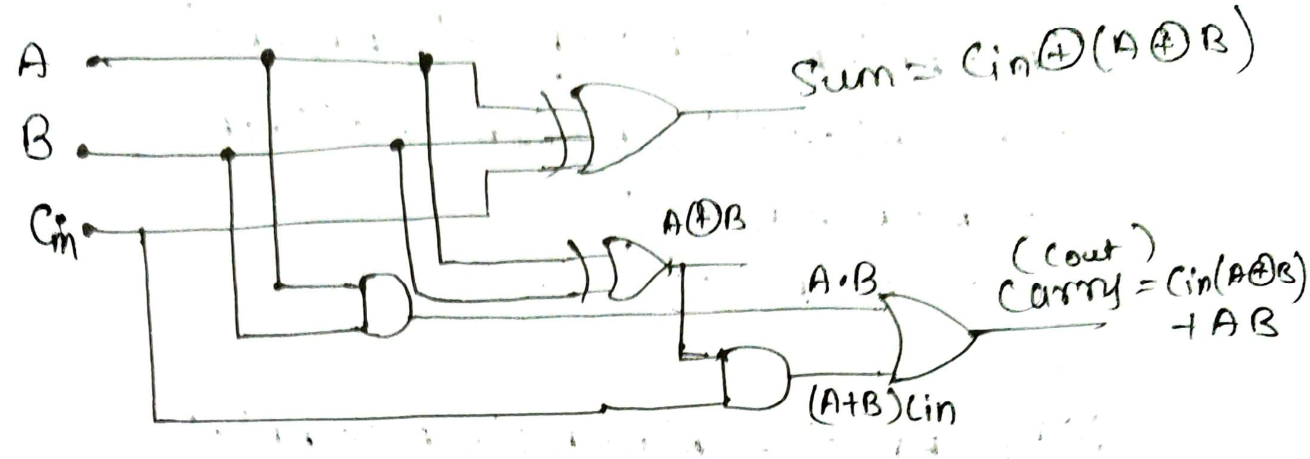
Expression :

$$Sum = A'B'C_{in} + A'BC_{in}' + AB'C_{in}' + ABC_{in}$$
$$= A'B'C_{in} + ABC_{in} + A'BC_{in}' + AB'C_{in}'$$
$$= C_{in}(A'B' + AB) + C_{in}'(A'B + AB')$$
$$= C_{in}(A \odot B) + C_{in}'(A \oplus B)$$
$$= C_{in}(\overline{A \oplus B}) + C_{in}'(A \oplus B)$$
$$Sum = C_{in} \oplus (A \oplus B)$$

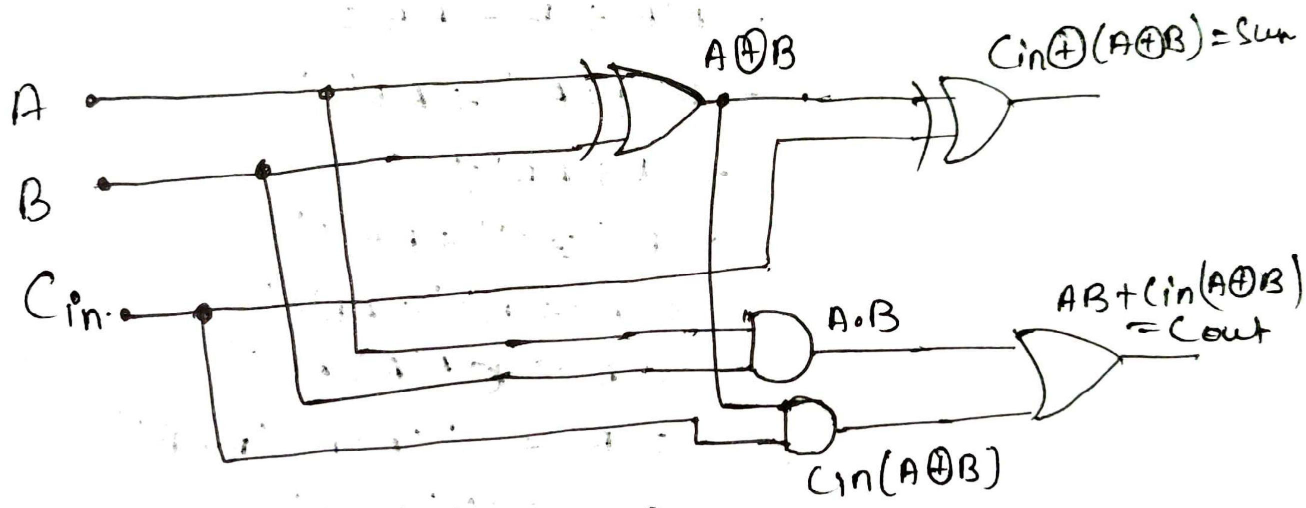
$$Carry\,(C_{out}) = A'BC_{in} + AB'C_{in} + ABC_{in}' + ABC_{in}$$
$$= C_{in}(A'B + AB') + AB(C_{in}' + C_{in})$$
$$= C_{in}(A \oplus B) + A \cdot B$$



Circuit Diagram



OR



8 (ii)

$$F(A,B,C) = A'B + BC' + BC + AB'C'$$
$$= A'B + B(C'+C) + AB'C'$$
$$= A'B + B + AB'C'$$
$$= B(1+A') + AB'C'$$
$$= B + AB'C'$$
$$= B(C+C') + AB'C'$$
$$= BC + BC' + AB'C'$$
$$= BC + C'(B + AB')$$
$$= BC + C'(A+B)(B+B')$$
$$= BC + AC' + BC'$$
$$= B(C+C') + AC'$$
$$= B + AC'$$

Apply: Distribution
$(A+\overline{B}+C)(A+B+\overline{C})A+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply: Distribution
$(A+B+\overline{C})AA+(A+B+\overline{C})A\overline{B}+(A+B+\overline{C})AC+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Idempotent Law: $AA = A$
$(A+B+\overline{C})A+(A+B+\overline{C})A\overline{B}+(A+B+\overline{C})AC+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$(A+B+\overline{C})A+(A+B+\overline{C})AC+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$(A+B+\overline{C})A+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply: Distribution
$AA+AB+A\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Idempotent Law: $AA = A$
$A+AB+A\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$A+A\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$A+(A+\overline{B}+C)(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply: Distribution
$A+(A+B+\overline{C})\overline{B}A+(A+B+\overline{C})\overline{B}\,\overline{B}+(A+B+\overline{C})\overline{B}C+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Idempotent Law: $AA = A$
$A+(A+B+\overline{C})\overline{B}A+(A+B+\overline{C})\overline{B}+(A+B+\overline{C})\overline{B}C+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$A+(A+B+\overline{C})\overline{B}+(A+B+\overline{C})\overline{B}C+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$A+(A+B+\overline{C})\overline{B}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply: Distribution
$A+\overline{B}A+\overline{B}B+\overline{B}\,\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Complement Law: $AA = 0$
$A+\overline{B}A+0+\overline{B}\,\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Identity Law: $A+0 = A$
$A+\overline{B}A+\overline{B}\,\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply the Absorption Law: $A+AB = A$
$A+\overline{B}\,\overline{C}+(A+\overline{B}+C)(A+B+\overline{C})\overline{C}$

Apply: Distribution
$A+\overline{B}\,\overline{C}+(A+B+\overline{C})\overline{C}A+(A+B+\overline{C})\overline{C}\,\overline{B}+(A+B+\overline{C})\overline{C}C$

Apply the Complement Law: $A\overline{A} = 0$
$A+\overline{B}\,\overline{C}+(A+B+\overline{C})\overline{C}A+(A+B+\overline{C})\overline{C}\,\overline{B}+0$

Answer 6. Laws of Boolean Algebra

There are six types of Boolean algebra laws. They are:

- Commutative law
- Associative law
- Distributive law
- AND law
- OR law
- Inversion law

Those six laws are explained in detail here.

Commutative Law

Any binary operation which satisfies the following expression is referred to as a commutative operation. Commutative law states that changing the sequence of the variables does not have any effect on the output of a logic circuit.

- A. B = B. A
- A + B = B + A

Associative Law

It states that the order in which the logic operations are performed is irrelevant as their effect is the same.

- (A. B). C = A . (B . C)
- (A + B) + C = A + (B + C)

Distributive Law

Distributive law states the following conditions:

- A. (B + C) = (A. B) + (A. C)
- A + (B. C) = (A + B) . (A + C)

AND Law

These laws use the AND operation. Therefore they are called AND laws.

- A . 1 = A
- A. A = A
- $A.\overline{A}=0$

OR Law

These laws use the OR operation. Therefore they are called OR laws.

- A + 0 = A
- A + 1 = 1
- A + A = A
- $A+\overline{A}=1$

Inversion Law

In Boolean algebra, the inversion law states that double inversion of variable results in the original variable itself.

- $\overline{\overline{A}}=A$

Boolean Algebra Theorems

The two important theorems which are extremely used in Boolean algebra are De Morgan's First law and De Morgan's second law. These two theorems are used to change the Boolean expression. This theorem basically helps to reduce the given Boolean expression in the simplified form. These two De Morgan's laws are used to change the expression from one form to another form. Now, let us discuss these two theorems in detail.

De Morgan's First Law:

De Morgan's First Law states that (A.B)' = A'+B'.

The first law states that the complement of the product of the variables is equal to the sum of their individual complements of a variable.

The truth table that shows the verification of De Morgan's First law is given as follows:

0	0	1	1	1	1
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

The last two columns show that (A.B)’ = A’+B’.

Hence, De Morgan’s First Law is proved.

De Morgan’s Second Law:

De Morgan’s Second law states that (A+B)’ = A’. B’.

The second law states that the complement of the sum of variables is equal to the product of their individual complements of a variable.

The following truth table shows the proof for De Morgan’s second law.

A	B	A’	B’	(A+B)’	A’. B’
0	0	1	1	1	1
0	1	1	0	0	0
1	0	0	1	0	0
1	1	0	0	0	0

The last two columns show that (A+B)’ = A’. B’.

Hence, De Morgan’s second law is proved.

7.(i) 4456 – 34234=   -29778

7(ii). Binary value:

1010100 – 1000100

= 10000

Decimal value:

84 – 68

= 16

Date
Page

7) Subtract using (r-1)'s compliment

a) $(4456)_{10} - (34234)_{10}$

Subtraction using 9's complement as ($r=10$) ($r-1=9$)

4456 — Minuend

34234 - Subtrahend

9's complement of subtrahend

Verification

$$\begin{array}{r} 34234 \\ -\ 4456 \\ \hline 29778 \end{array}$$

$$\begin{array}{r} 99999 \\ -\ 34234 \\ \hline 65765 \end{array}$$

65765 — 9's comp of subtrahend

Minuend + 9's complement of subtrahend

$$\begin{array}{rl} 4456 & \text{- Minuend} \\ +\ 65765 & \text{- 9's comp of subtrahend} \\ \hline 70221 & \end{array}$$

No carry. Take 9's complement of the result

KAVITHA

9's comp of result.

$$\begin{array}{r} 99999 \\ -\,70221 \\ \hline 29778 \end{array}$$

$= -29778$

b) Subtract using r's complement
∴ " " 2's complement (∵ r = 2)

1010100 – Minuend
– 1000100 – Subtrahend

2's complement of subtrahend

0111011 – 1's complement
+1
0111100 – 2's complement

Minuend + 2's complement of subtrahend

$$\begin{array}{r} 1010100 \\ +\,0111100 \\ \hline \boxed{1}0010000 \end{array}$$

Discard carry

$= (10000)_2$