DIGITAL ELECTRONICS

QUESTION BANK

UNIT- I

1 MARK

1. Explain XOR gate with truth table and logic diagram.

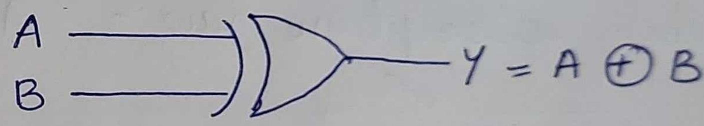
Ans. Exclusive OR (or) EX-OR (or) XOR gate has two inputs with one output.

- It produces high output when all inputs are different and low output when all inputs are same.
- It is also known as inequality detector.

Truth Table :-

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Logic Symbol



Equation :- $Y = A \oplus B = \bar{A}B + A\bar{B}$

2. Convert the given binary number to octal notation $(0110101011.010101011)_2$

Sol.

$$\underline{0}\ \underline{110}\ \underline{101}\ \underline{011}\ .\ \underline{010}\ \underline{101}\ \underline{011}$$

$$\underline{000}\ \underline{110}\ \underline{101}\ \underline{011}\ .\ \underline{010}\ \underline{101}\ \underline{011}$$

$$0\quad 6\quad 5\quad 3\ .\ 2\quad 5\quad 3$$

$\Rightarrow (653.253)_8$

3. Obtain the dual equation - $A'C' + ABC' + AB'C + AB'$

Ans. Given,

$$A'C' + ABC' + AB'C + AB'$$

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

4. Why are NAND and NOR gates ~~are~~ called universal gates?

Ans. NAND and NOR gates are called universal gates because by using them, we can implement any logic gate or any logic circuit.

5. Discuss absorption law with its truth table.

Ans. Absorption Law:- $A + AB = A$

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

3 MARKS

1. Write the steps for subtracting a number using 2's complement method.

Ans. **Subtraction using 2's Complement Method :-**

Step 1 :- Keep the first number as it is

Step 2 :- Find the 2's complement of second number.

Step 3 :- Add step 1 and step2.

Step 4 :-

Case (i) :- If carry is present, the number is a positive number. Ignore the carry. Thus, we get the final result.

Case (ii) :- If carry is not present, the number is negative. Take 2's complement of the result to get the final result. Put a negative sign to the final result.

2. Find the simplified Boolean expression for the following function $Y = (A+B)(A+C)(B+C)$

Sol.

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

$$Y = (AA + AC + AB + BC)(B+C)$$

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

$$[\because A \cdot A = A]$$

$$= (A(1 + C + B) + BC)(B+C)$$

$$= \cancel{(A + BC)(}\ (A(1) + BC)(B+C) \quad [\because 1 + A = A]$$

$$Y = (A + BC)(B + C)$$

$$= A \cdot B + A \cdot C + BC \cdot B + BC \cdot C$$

$$= AB + AC + BC + BC \quad [\because A \cdot A = A]$$

$$= AB + AC + BC \quad [\because BC + BC = BC]$$

$$\Rightarrow Y = AB + AC + BC$$

3. Explain duality theorem with example.

Ans. This theorem states that with an existing Boolean relation, we can derive another relation by

(a) changing each OR gate sign to AND gate.

(b) changing each AND gate sign to OR gate.

(c) complementing any 0 or 1 appearing in the expression

Ex:-

(i) Dual of $A \cdot \overline{A} = 1$ is

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

(ii) Dual of $AC + \overline{B}CD + (E+F)$ is

$$(A+C) \cdot (\overline{B} + C + D) \cdot (EF).$$

4. Convert $(36.21)_{10}$ to binary.

Ans.

Ans.

$$
\begin{array}{r|l}
2 & 36 \\
\hline
2 & 18 - 0 \\
2 & 9 - 0 \\
2 & 4 - 1 \\
2 & 2 - 0 \\
 & 1 - 0
\end{array}
$$

$0.21 \times 2 = 0.42 = 0$

$0.42 \times 2 = 0.84 = 0$

$0.84 \times 2 = 1.68 = 1$

$0.68 \times 2 = 1.36 = 1$

$0.36 \times 2 = 0.72 = 0$

$(36.21)_{10} = (100100.00110)_2$

5. Prove Consensus theorem.

Ans. Statement :-

$$AB + BC + \bar{A}C = AB + \bar{A}C$$

Proof:-

$AB + \bar{A}C + BC(A + \bar{A}) \quad [\because A + \bar{A} = 1]$

$= AB + \bar{A}C + ABC + \bar{A}BC$

$= \cancel{AB(1+C) + A}$

$= AB + ABC + \bar{A}C + \bar{A}BC$

$= AB(1+C) + \bar{A}C(1+B)$

$= AB(1) + \bar{A}C(1) \quad [\because 1 + A = 1]$

$= AB + \bar{A}C$

$\therefore AB + BC + \bar{A}C = AB + \bar{A}C \quad \Rightarrow$ BC is the redundant term

5 MARKS

1 a. State and prove DeMorgans Law.

Ans. (i) $\overline{A \cdot B} = \bar{A} + \bar{B}$

A	B	$\bar{A}$	$\bar{B}$	$A \cdot B$	$\overline{A \cdot B}$ ✓	$\bar{A} + \bar{B}$ ✓
0	0	1	1	0	1	1
0	1	1	0	0	1	1
1	0	0	1	0	1	1
1	1	0	0	1	0	0

$\therefore \overline{A \cdot B} = \bar{A} + \bar{B}$

Complement of product = Sum of individual complements

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

A	B	$\bar{A}$	$\bar{B}$	$A + B$	$\overline{A + B}$	$\bar{A} \cdot \bar{B}$
0	0	1	1	0	1	1
0	1	1	0	1	0	0
1	0	0	1	1	0	0
1	1	0	0	1	0	0

Complement of sum = Product of individual complements

b. Reduce the expression $F = (B+BC)(B+B'C)(B+D)$

Sol. Given,

$$F = (B+BC)(B+B'C)(B+D)$$

$F = (B \cdot B + B \cdot B'C + BC \cdot B + BC \cdot B'C)(B+D)$

$= (B + 0 + BC + 0)(B+D)$ $\left[\because A \cdot A = A \text{ so, } B \cdot B = B\right]$

$[\because B \cdot \overline{B} = 0]$

$= B(1+C)(B+D)$

$= B \cdot 1(B+D)$ $[\because 1 + A = 1]$

$= B \cdot B + B \cdot D$

$= B + BD$

$= B(1+D)$

$= B(1)$

$F = B$

$\therefore F = B$

2. Obtain the complement of the following Boolean function

$F = A'B + A'BC' + A'BCD + A'BC'D'E$

Sol. $\overline{F} = \overline{A'B + A'BC' + A'BCD + A'BC'D'E}$

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

$= \overline{A'B(1 + C' + CD + C'D'E)}$

$= \overline{A'B(1)}$ $\because (1 + A = 1)$

$= \overline{A'B}$

$= \overline{\overline{A}} + \overline{B}$ $[\because$ De Morgans Law$]$

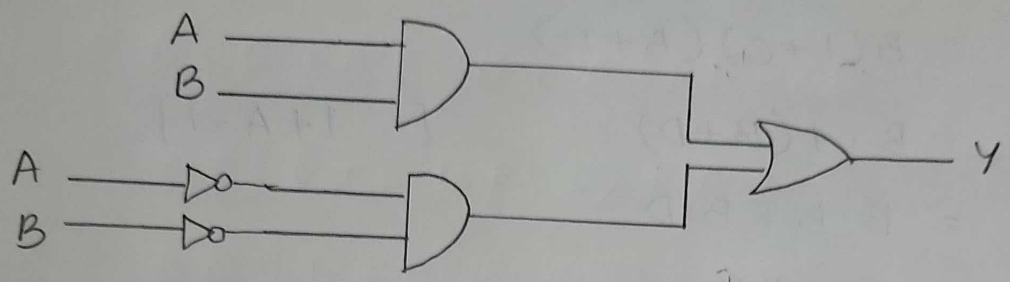
$= A + \overline{B}$ $[\because \overline{\overline{A}} = A]$

$\therefore \overline{F} = A + \overline{B}$

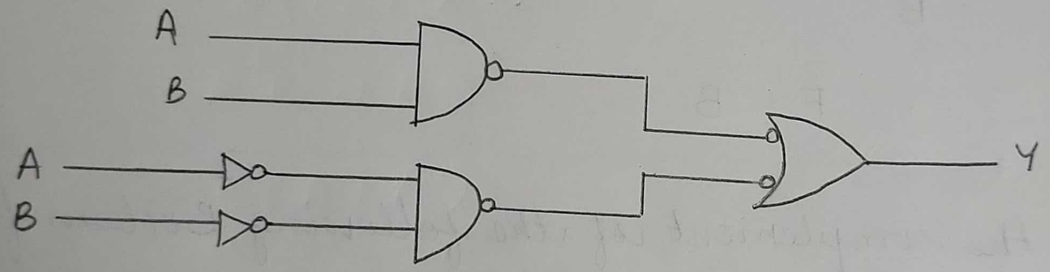
3. Implement X-NOR using NAND gates.

Ans. Step 1:- Draw AOI (AND OR INVERTOR) logic

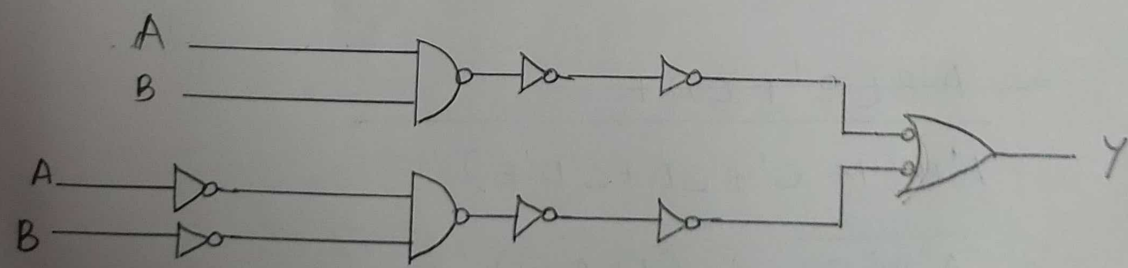
$f = A.B + \bar{A}\bar{B}$



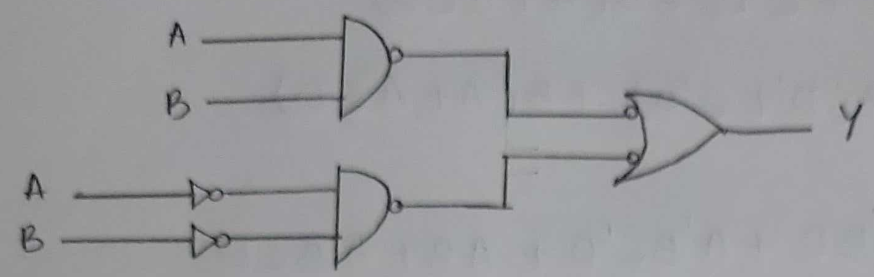
Step 2:- Add bubbles at the output of AND gate and input of OR gate



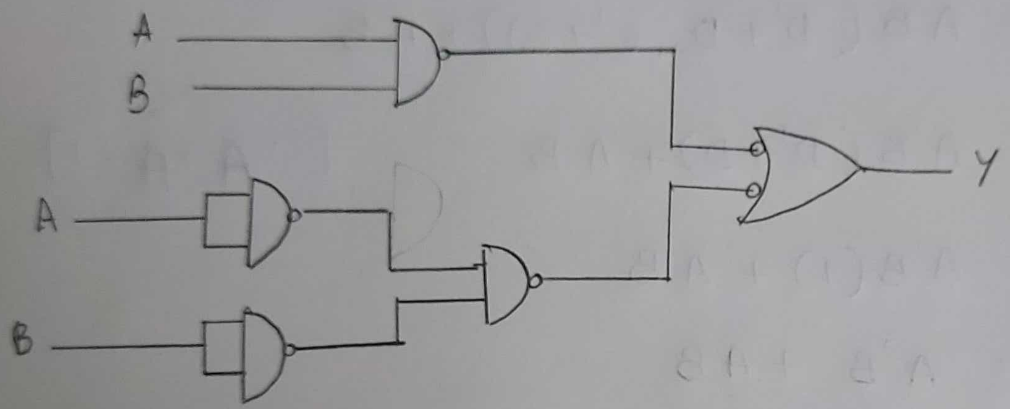
Step 3:- When bubbles are placed, in that particular path, ~~add a~~ place a NOT gate



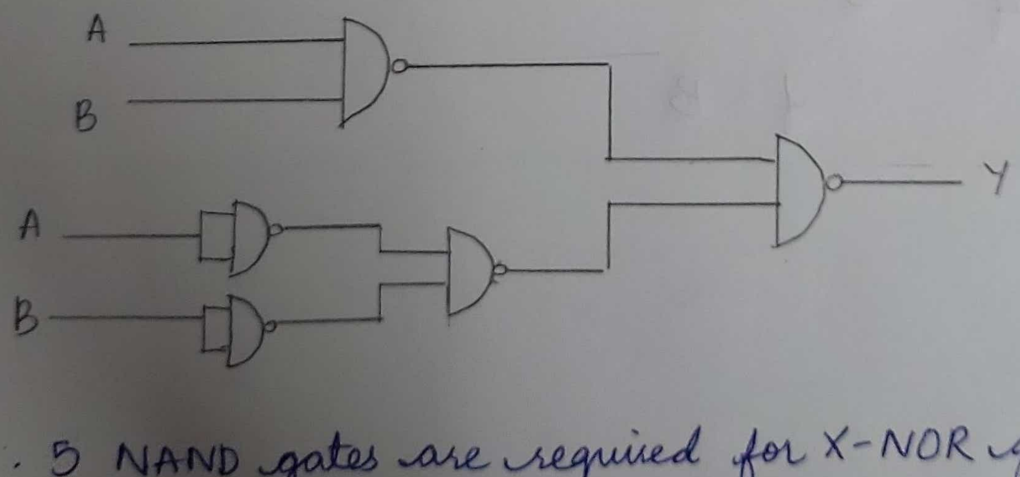
Step 4 :- Eliminate double inversion



Step 5 :- Replace NOT gate with single input NAND gate



Step 6 :- Replace input bubbled OR gate with NAND gate.



∴ 5 NAND gates are required for X-NOR gate implementation.

4. Simplify the following using Boolean laws.

$$A'B(D'+C'D)+B(A+A'CD)$$

Sol. $f = A'B(D'+C'D)+B(A+A'CD)$

$= A'BD'+A'BC'D+AB+A'BCD$

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

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

$= A'B(D'+D)+AB$ $\quad [\because A'+A=1]$

$= A'B(1)+AB$

$= A'B+AB$

$= B(A+A')$

$= B(1)$ $\quad [\because A+A'=1]$

$f = B$

$\therefore f = B$

5. Convert $(A0C9.0EB)_{16}$ to decimal & binary

Sol. (i) $(A0C9.0EB)_{16}$ to decimal

$$\begin{array}{ccccccc} A & 0 & C & 9. & 0 & E & B \\ 16^3 & 16^2 & 16^1 & 16^0 & 16^{-1} & 16^{-2} & 16^{-3} \end{array}$$

$$= (A \times 16^3) + (0 \times 16^2) + (C \times 16^1) + (9 \times 16^0) + \left(0 \times \frac{1}{16}\right) + \left(E \times \frac{1}{16^2}\right) + \left(B \times \frac{1}{16^3}\right)$$

$$= (10 \times 4096) + 0 + (12 \times 16) + (9 \times 1) + 0 + \left(14 \times \frac{1}{256}\right) + \left(11 \times \frac{1}{4096}\right)$$

$$= 40960 + 0 + 192 + 9 + 0 + \frac{14}{256} + \frac{11}{4096}$$

$$= 41161.057$$

$$\Rightarrow (A0C9.0EB)_{16} = (41161.057)_{10}$$

(ii) $(A0C9.0EB)_{16}$ to binary

$$\begin{array}{ccccccc} A & 0 & C & 9 & . & 0 & E & B \\ 1010 & 0000 & 1100 & 1001 & . & 0000 & 1110 & 1011 \end{array}$$

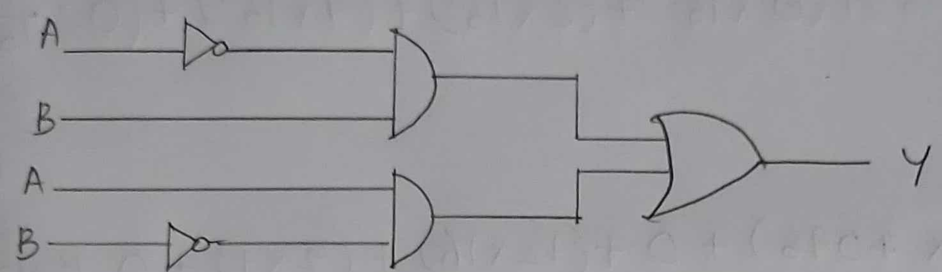
$$(A0C9.0EB)_{16} = (1010000011001001.000011101011)_2$$

10 MARKS

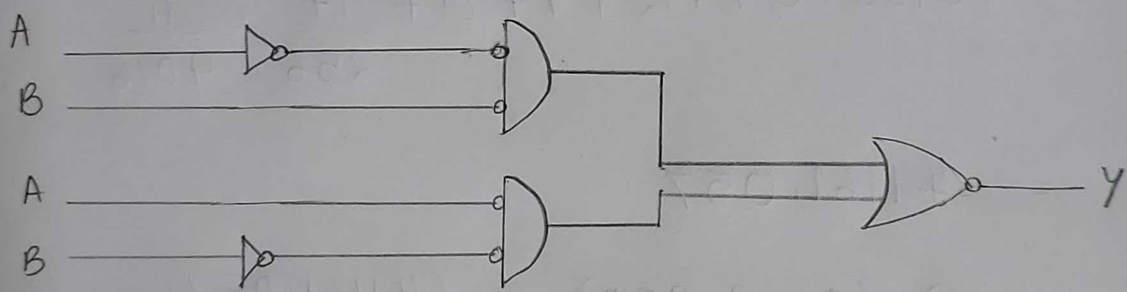
10 a. Implement EX-OR gate using NOR gates.

Ans. **Step 1**:- Draw AOI logic for given equation

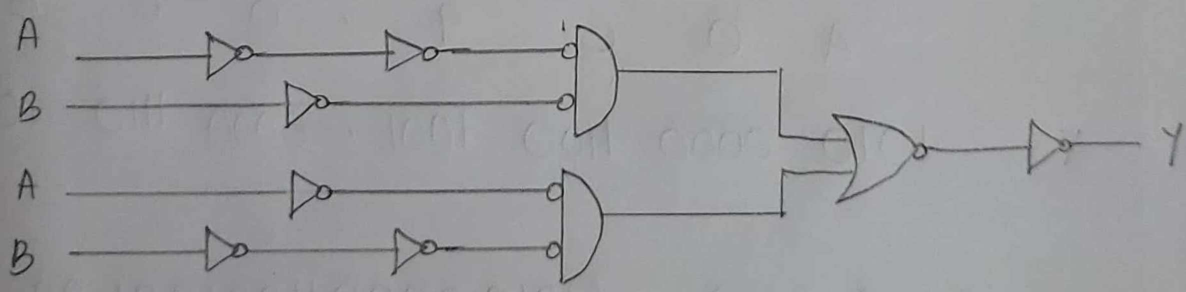
$$f = \bar{A}B + A\bar{B}$$



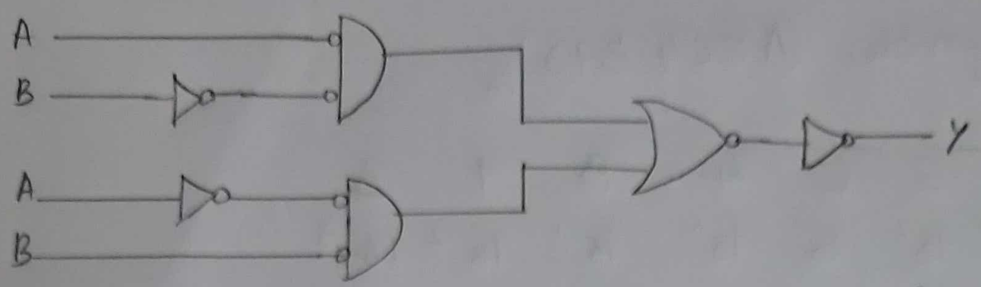
Step 2:- Add bubbles at output of OR gate and input of AND gate.



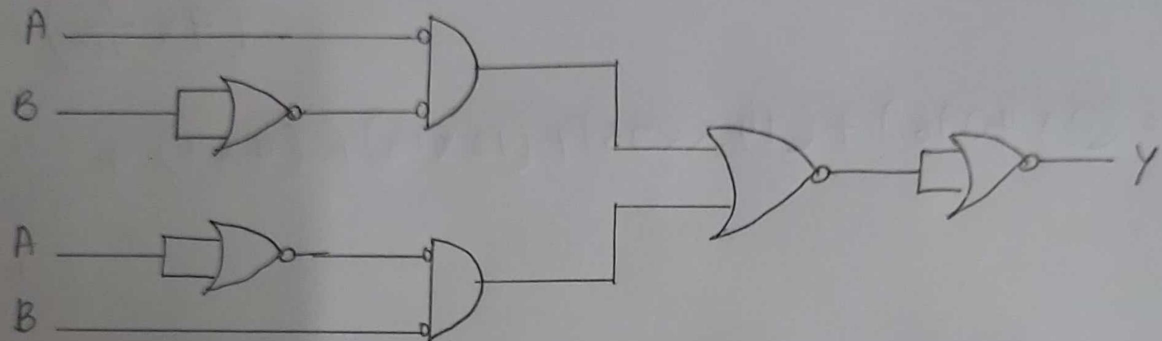
Step 3:- When bubbles are placed, in that path, place NOT gate.



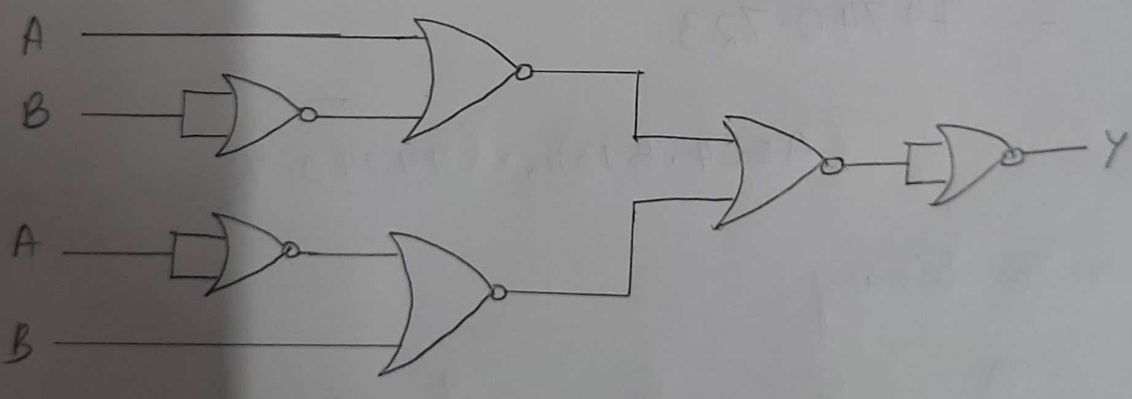
Step 4:- Eliminate double inversion



Step 5:- Replace NOT gate with single input NOR gate



Step 6:- Replace input bubbled AND gate with NOR gate



∴ 6 NOR gates are required for X-OR gate implementation.

b. Simplify $(AEC4.B93)_{16}$ to binary, decimal & octal

(i) To decimal

Given, $(AEC4.B93)_{16}$

A	E	C	4 .	B	9	3
16^3	16^2	16^1	16^0	16^{-1}	16^{-2}	16^{-3}

$$= (A \times 16^3) + (E \times 16^2) + (C \times 16^1) + (4 \times 16^0) + (B \times \frac{1}{16}) + (9 \times \frac{1}{16^2}) + (3 \times \frac{1}{16^3})$$

$$= (10 \times 4096) + (14 \times 256) + (12 \times 16) + (4 \times 1) + \frac{11}{16} + \frac{9}{256} + \frac{3}{4096}$$

$$\simeq 40960 + 3584 + 192 + 4 + \frac{11}{16} + \frac{9}{256} + \frac{3}{4096}$$

$$= 44740.723$$

$$(AEC4.B93)_{16} = (44740.723)_{10}$$

(ii) To binary

A	E	C	4	.	B	9	3
1010	1110	1100	0100	.	1011	1001	0011

$$(AEC4.B93) = (1010111011000100.101110010011)_2$$

(iii) To Octal

We know from (ii) that

$$(AEC4.B93)_{10} = (1010111011000100.101110010011)_2$$

Converting the above binary number to octal

001	010	111	011	000	100	.	101	110	010	011
1	2	7	3	0	4	.	5	6	2	3

$$\therefore (AEC4.B93)_{10} = (127304.5623)_8$$

2. a. What is 2's complement of a number? Subtract 43 from 27 using 2's complement subtraction method.

Ans. __2's complement__ :- 2's complement is the result that is obtained by adding 1 in LSB position to 1's complement of a number.

Ex:- 2's complement of 1011 is

1's complement → 0100

2's complement → 0100

$$\begin{array}{r} 0100 \\ +\ 1 \\ \hline 0101 \end{array}$$

__43-27 using 2's complement subtraction__ :-

Step 1:- Keep the first number as it is

$$
\begin{array}{r|l}
2 & 43 \\
2 & 21 - 1 \\
2 & 10 - 1 \\
2 & 5 - 0 \\
2 & 2 - 1 \\
 & 1 - 0
\end{array}
$$

$\therefore 43 = (101011)_2$

$= (00101011)_2$

Step 2:- Find 2's complement of second number i.e. 27

$$
\begin{array}{r|l}
2 & 27 \\
2 & 13 - 1 \\
2 & 6 - 1 \\
2 & 3 - 0 \\
 & 1 - 1
\end{array}
$$

$27 = (11011)_2$

$27 = (00011011)_2$

1s comp = 11100100

2s comp = 11100100

$$
\begin{array}{r}
11100100 \\
+\ 1 \\
\hline
11100101 \\
\hline
\end{array}
$$

Step 3:- Add step 1 and step 2.

$$
\begin{array}{r}
1\ 1\ \ \ 1\ 1\ 1\ 1\ \ \\
0\ 0\ 1\ 0\ 1\ 0\ 1\ 1 \\
1\ \ 1\ 1\ 0\ 0\ 0\ 1\ 0\ 1 \\
\hline
0\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\
\hline
\end{array}
$$

Step 4:- Carry is present, the no. is positive.
We get the final result:

$43 - 27 = (00010000)_2 = 16$

b. Prove $(A+C)(A'+B) = AB + A'C$

Sol. Consider LHS,

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

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

$$= 0 + AB + A'C + BC \quad [\because A \cdot \bar{A} = 0]$$

$$= AB + A'C + BC(A + A') \quad [\because A + A' = 1]$$

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

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

$$= AB(1+C) + A'C(1+B)$$

$$= AB(1) + A'C(1) \quad [\because 1 + A = 1]$$

$$= AB + A'C$$

$$= RHS.$$

3. a. State and prove any 3 Boolean theorems

Ans. (i) <u>Absorption Property</u>

a) $A + A \cdot B = A$

Proof :- $A + AB = A(1+B)$

$$= A(1) \quad [\because 1 + B = 1]$$

$$= A$$

b) $A \cdot (A+B) = A$

Proof :- $A \cdot (A+B) = (A \cdot A) + (A \cdot B)$

$$= A + AB \quad [\because A \cdot A = A]$$

$$= A(1+B)$$

$$= A \quad [\because 1 + B = 1]$$

(ii) Redundant Property :-

a) $A + \bar{A}B = A + B$

Proof :- $A + \bar{A}B = (A + \bar{A}) \cdot (A + B)$

$= 1(A + B) \quad [\because A + \bar{A} = 1]$

$= A + B$

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

Proof :- $A \cdot (\bar{A} + B) = A \cdot \bar{A} + AB$

$= 0 + AB \quad [\because A \cdot \bar{A} = 0]$

$= AB$

(iii) DeMorgans Property :-

a) $\overline{A \cdot B} = \bar{A} + \bar{B}$

A	B	$\bar{A}$	$\bar{B}$	$A \cdot B$	$\overline{A \cdot B}$ ✓	$\bar{A}+\bar{B}$ ✓
0	0	1	1	0	1	1
0	1	1	0	0	1	1
1	0	0	1	0	1	1
1	1	0	0	1	0	0

b) $\overline{A+B} = \bar{A} \cdot \bar{B}$

A	B	$\bar{A}$	$\bar{B}$	$A+B$	$\overline{A+B}$ ✓	$\bar{A} \cdot \bar{B}$ ✓
0	0	1	1	0	1	1
0	1	1	0	1	0	0
1	0	0	1	1	0	0
1	1	0	0	1	0	0

b. Convert Binary to Gray for $(0110101001101)_2$ and Gray to Binary for $(1011001001011)_2$

Ans. (i) Binary to Gray for $(0110101001101)_2$

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

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

∴ The gray code is 0101111101011

(ii) Gray to Binary for $(1011001001011)_2$

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

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

∴ The binary code is $(1101110001101)_2$