DE UNIT - I

1)

a) Write short notes on binary number systems?

Ans:- Bi means 2, It is a number system which uses only two different symbols they are 0 & 1. Hence radix of the number system is '2'. Starting from the decimal point moving toward left are $2^0, 2^1, 2^2$... and moving toward right are $2^{-1}, 2^{-2}, 2^{-3}$

Eg:- (1010.0101)

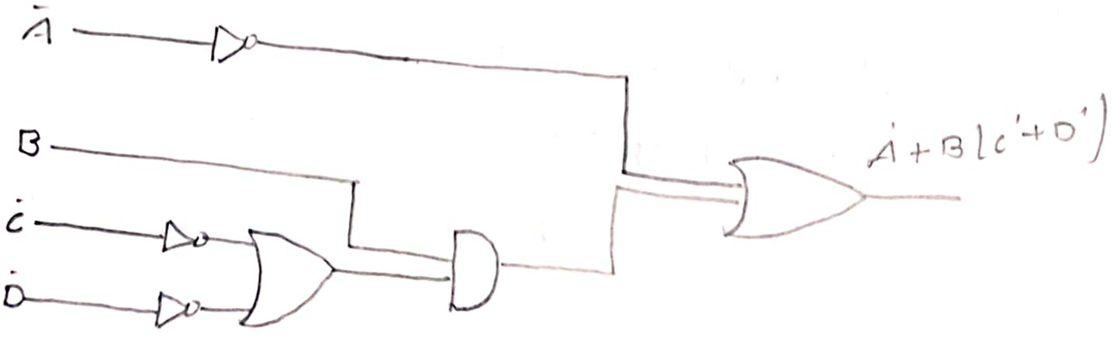
$2^3\ 2^2\ 2^1\ 2^0\ 2^{-1}\ 2^{-2}\ 2^{-3}\ 2^{-4}$

b) What are the characteristics of Digital Systems?

Ans:- The main characteristic of digital system is that they process and represent information using discreate values, typically binary (0's and 1's).

c) Realize the expression $F = A' + B(C' + D')$ using logic gates?

Ans:- Given expression $F = A' + B(C' + D')$



d) why NAND and NOR gates are called universal gates?

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

e) what is the 2's complement of $(234)_{10}$?

Ans: 234 - binary number of $(1110\ 1010)_2$

1110 1010 - is converted to 1's complement

1's complement of 234:-

$$\begin{array}{r} 0001\ 0101 \\ +1 \\ \hline 0001\ 0110 \\ \hline \end{array}$$

2's complement of 234:-

$$\begin{array}{r} 1110\ 1001 \\ +1 \\ \hline 1110\ 1010 \\ \hline \end{array}$$

The 2's complement of 234 is $(11101010)_2$

1's complement is obtained by replacing 1's by 0's and 0's by 1's.

So 1's complement of 234 = 0001 0101.

2's complement is obtained by adding 1 to the 1's complement of the given number.

So 2's complement of 234 =

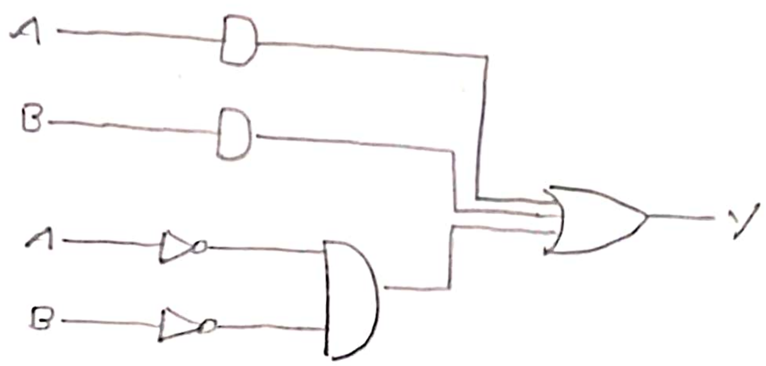
$$\begin{array}{r} 0001\ 0101 \\ +1 \\ \hline 0001\ 0110 \\ \hline \end{array}$$

2)

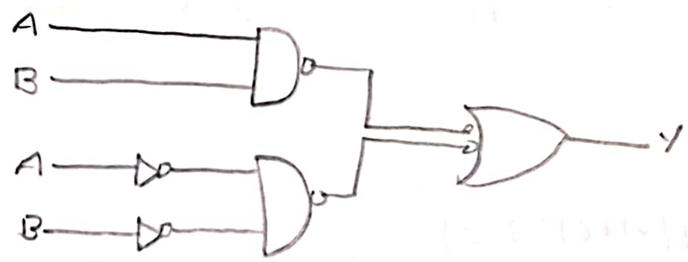
a) Represent the X-OR gate with minimum two NAND gates!

Ans: Step 1:- Draw AOI (And or Inverter) logic

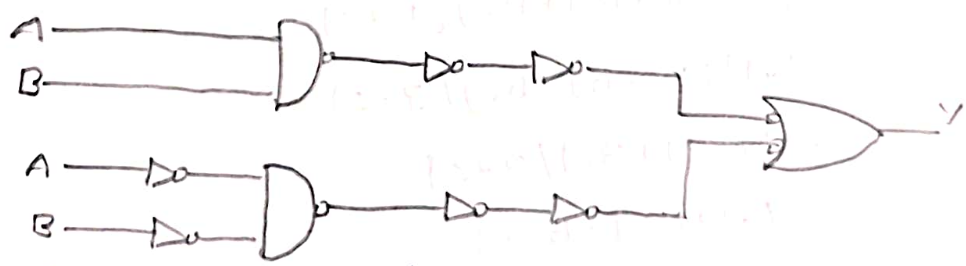
$f = AB + \bar{A}\bar{B}$



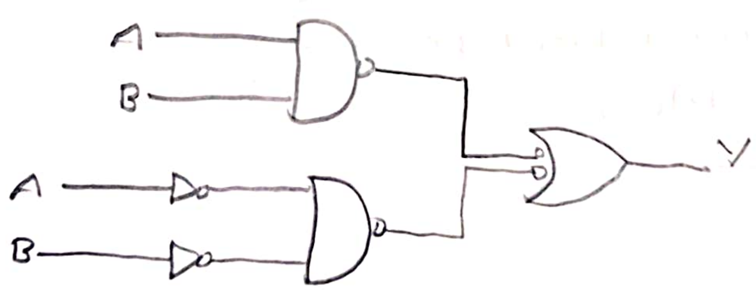
Step 2:- Add bubbles at the output of AND gate and input of OR-gate



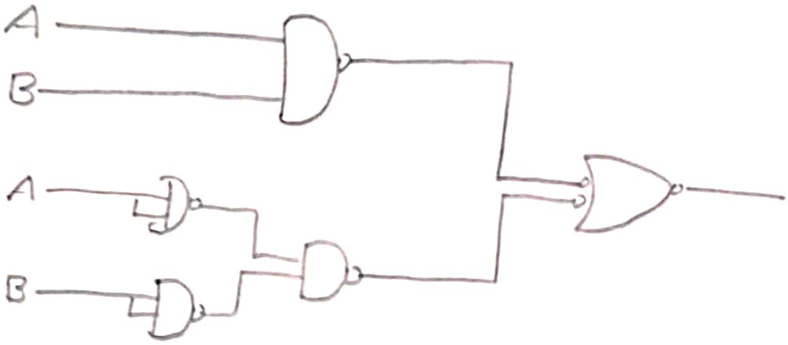
Step 3:- when bubbles are placed in that particular path, a place NOT gate



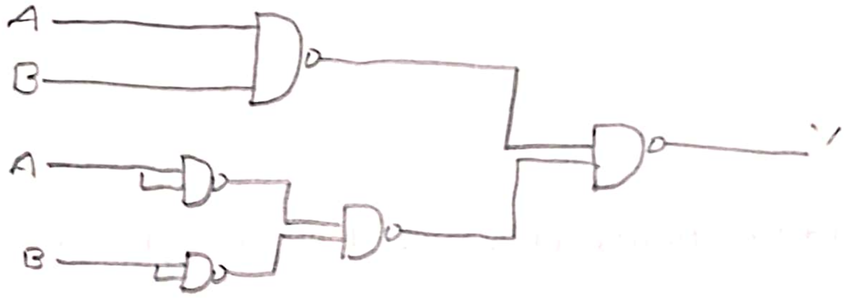
Step 4:- Eliminate double inversion.



Step5 :- Replace NOT-gate with single input NAND-gate



Step6 :- Replace input bubbled OR-gate with NAND gate.



b) Find the simplified boolean expression for the following function

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

Ans. Given Expression is

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

$$= (AA + AC + BA + BC)(B+C) \quad [\because A.A = A]$$

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

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

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

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

$$= A.B + A.C + BC.B + BC.C$$

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

$$= AB + AC + BC$$

$$Y = AB + AC + BC$$

b) i) convert $(FF)_{16}$ to octal number system?

A:- convert $(FF)_{16} = (\quad)_8$

$= (F \quad F)_{16} = (\quad)_8$

$\downarrow \quad \downarrow$

$1111 \quad 1111)_2$

$= (11\,111\,111)_2 = (\quad)_8$

$\downarrow \quad \downarrow \quad \downarrow$

$3 \quad 7 \quad 7$

$\therefore (FF)_{16} = (377)_8$

ii) Reduce $A'B'C' + A'BC' + A'BC$

A:-

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

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

$= A'C' + A'BC$

$= A'(C' + BC)$

$= A'(B + C')$

(

9) i) Explain Duality theorm with example?

A:- Duality theorm says that, starting with boolean relation, you can derive another boolean relation by

1. changing each OR sign to AND sign
2. changing each AND sign to OR sign
3. complementing any 0 (or) 1 appearing in the expression.

Ex: 1) Dual of $A+\bar{A}=1$

$A.\bar{A}=0$

2) Dual of $x+(\overline{\bar{x}\bar{y}+\bar{x}z})$ is $x.\overline{[(\bar{x}+\bar{y}).(\bar{x}+\bar{z})]}$

ii) State and prove consensus theorm.

A:- The consensus theorm is a simplification rule in boolean algebra, which is particularly useful in digital logic design for simplifying expressions.

The theorm states:-

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

LHS:- $AB+A'C+BC$

$=AB+A'C+BC.1$

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

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

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

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

$=AB+A'C$

c) State and Proove De morgan's theorm?

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

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

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

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

d) what is the gray code equivalent of the $(3A7)_{16}$?

Ans: $(3A7)_{16}$ - hexadecimal to binary

3 A 7

0011 1010 0111

Gray code to binary (001110100111)

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

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

The ~~binary code~~ is $(\cancel{001011000101})_2$

Gray code = 0 ⊕ 0 ⊕ 1 ⊕ 1 ⊕ 1 ⊕ 0 ⊕ 1 ⊕ 0 ⊕ 0 ⊕ 1 ⊕ 1 ⊕ 1

0 0 1 0 0 1 1 1 0 1 0 0.

e) Simplify $(A9)_{16}$ in to decimal?

Ans: Given Expression is $(A9)_{16}$

$$= \overset{16^1}{A}\ \overset{16^0}{9}$$

$$= 10 \times 16 + 9 \times 16^0$$

$$= 160 + 9(1)$$

$$= 160 + 9$$

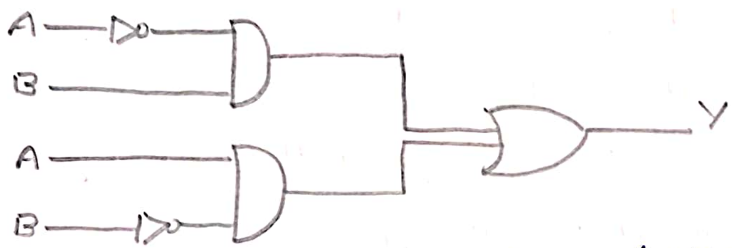
$$= 169$$

3)

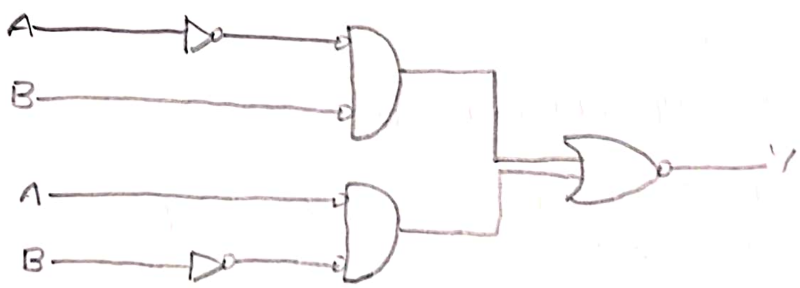
a) Implement EX-OR gate using NOR-gates only.

Ans: step 1:- Draw AOI logic for given expression.

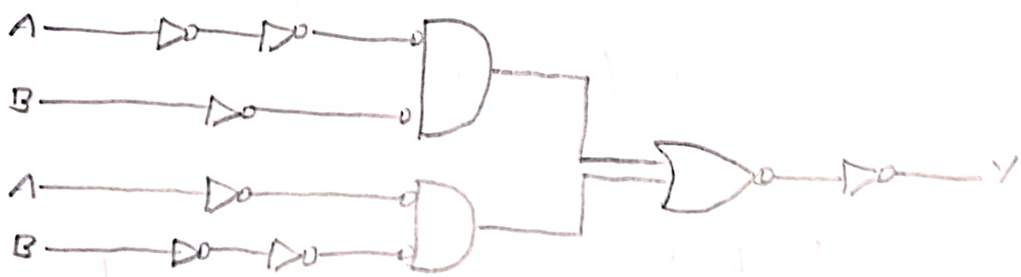
$$f = \bar{A}B + A\bar{B}$$



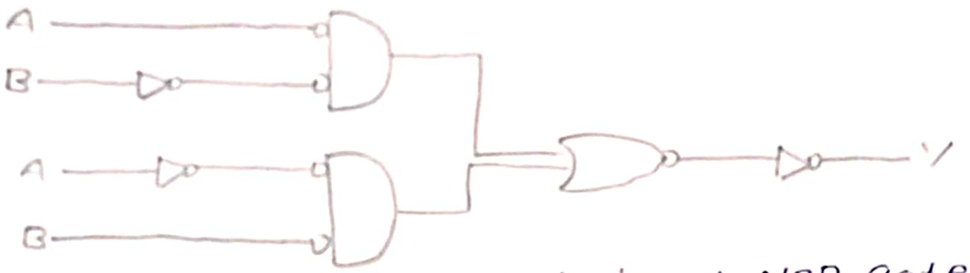
step 2:- Add bubbles at the output of OR gate and input of And gate.



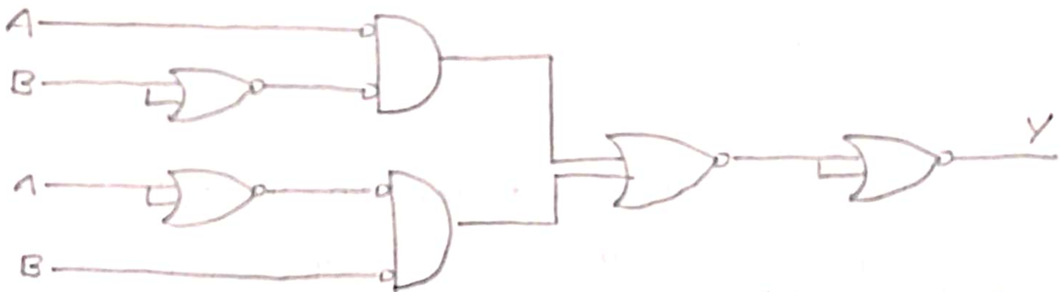
step 3:- when bubbles are placed in that path, place NOT gate



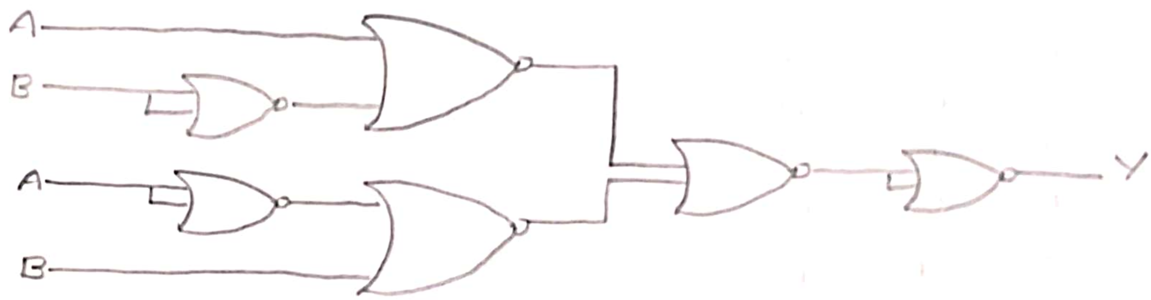
Step4:- Eliminate double inversion



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



Step6:- Replace input bubbled AND gate with NOR gates



b) What is one's complement? ~~Sho~~ Subtract 48 from 23 using one's complement subtraction method?

Ans:. 1's complement:. one's complement is a method of representing negat binary number in which all the bits of the number are inverted (i.e 1's are changed to 0's and 0's are changed to 1's).

Subtract 48-23 using 1's complement.

48 → 110000 → 1 1 0 0 0 0

23 → 010111 → 1 0 1 0 0 0

+ 1

1 0 1 0 0 1

48 - 23 =>

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

ignore

The result is +ve

1's complement of 25

c) Discuss the operation of basic logic gates and universal gates using truth table?

Ans: i) AND Gate: An AND gate is a digital logic gate that outputs 1 (true) only if all inputs are 1; otherwise it outputs 0 (false).

Truth table:-

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

ii) OR-gate:- An OR-gate has two or more input signals but a single output signal. OR gate produces output high when atleast one input is high, and when all inputs are low the output of OR gate is low.

Truth table:-

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

iii) NOT gate:- NOT gate has one input and one output. The output is complement to the input

Truth table:

A	Y
0	1
1	0

4) NAND gate:- NAND gate may have one (or) more inputs with only one output. NAND gates produces the output as complement i/p i.e it produces o/p high only when atleast one i/p is Low and produces o/p Low, when all inputs are high.

Truth table:-

A	B	$Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

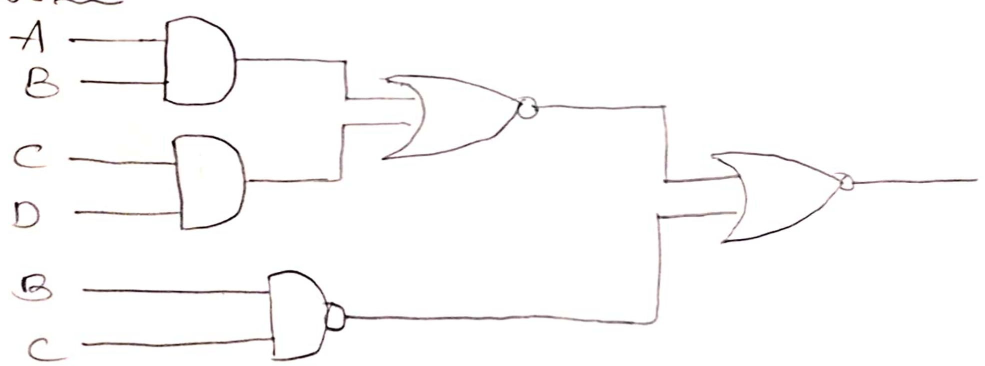
5) NOR-gate:- NOR-gate may have one or more i/p's with only one o/p. NOR gate produces the o/p as complement of OR gate i.e it produces o/p high only when all i/p's are low and the o/p is low if atleast one i/p is high.

A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

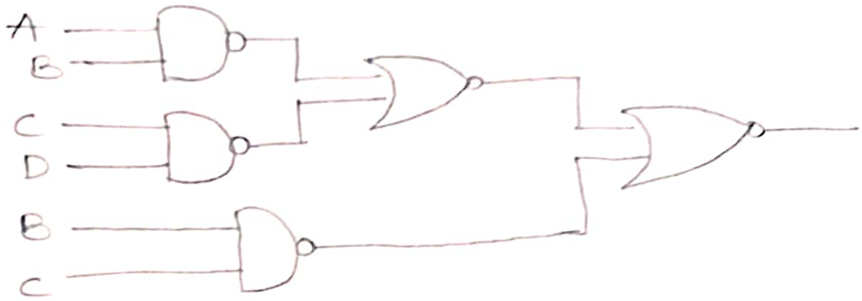
4) Implement the following function using NAND gates $F = A(B+CD)+(BC)'$

Ans:- Given Expression is $F = A(B+CD)+(BC)'$

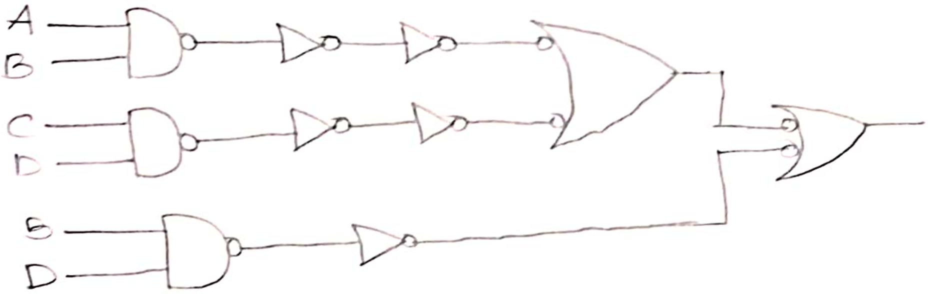
Step-I



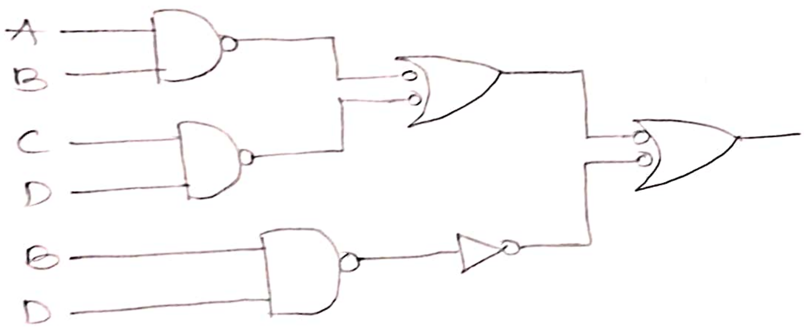
step-II



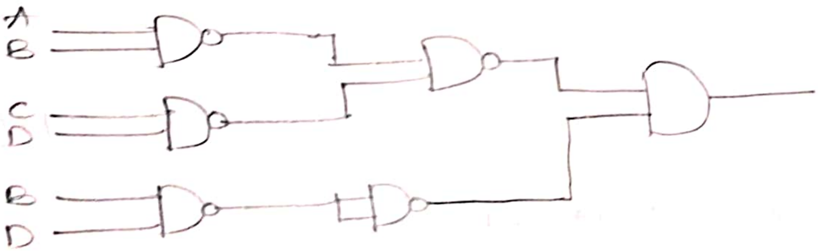
step-III



step-IV



step-V



4)
a) i) Prove the following by using the boolean algebric theorms:

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

A:- Let us consider

LHS :- $A'BC + AB'C + ABC' + ABC$

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

$= BC + AB'C + ABC'$

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

$= BC + AB + AC$

$= AB + BC + AC.$

ii) what is the gray code of equavalent of the Hex Number 2B7

A:- Given Hex Number :- 2B7

2 in hex is 0010 in binary

B in hex is 1011 in binary

7 in hex is 0111 in binary

So, 2B7 in hex is

0010 1011 0111 (binary)

Gray code to binary

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

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

Thus the Gray code equivalent is

= 001111101100

e) convert $(A0F9.0EB)_{16}$ to decimal, binary, octal?

A:- i) <u>Hexadecimal to decimal</u>

convert $(ADF9.DEB)_{16} = (\quad)_{10}$

$$\begin{array}{ccccccccc} (A & D & F & 9 & . & D & E & B)_{16} \\ \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow \\ 16^3 & 16^2 & 16^1 & 16^0 & & 16^{-1} & 16^{-2} & 16^{-3} \end{array}$$

$= (A\times16^3)+(0\times16^2)+(F\times16^1)+(9\times16^0)+(0\times16^{-1})+(E\times16^{-2})+(B\times16^{-3})$

$= (10\times4096)+0+(15\times16)+(9\times1)+0+(14\times\frac{1}{256})+(11\times\frac{1}{4096})$

$= 40960+0+240+9+0+\frac{14}{256}+\frac{11}{4096}$

$= 40960+249+0.054+0.002$

$= 41209.056$

$\Rightarrow (A0F9.0EB)_{16} = (41209.056)_{10}$

ii) <u>Hexadecimal to binary</u>

convert $(A0F9.0EB)_{16} = (\quad)_2$

A	0	F	9	.	0	E	B
1010	0000	1111	1001	.	0000	1110	1011

$\Rightarrow (A0F9.0EB)_{16} = (1010000011111001.000011101011)_2$

iii) <u>Hexadecimal to octal:-</u>

convert $(ADF9.0EB)_{16} = (\quad)_8$

we know that

$(A0F9.0EB) = (1010\,0000\,1111\,1001.0000\,1110\,1011)_2$

Convert the above binary number to octal

$$\begin{array}{cccccccccccc} 001 & 010 & 000 & 011 & 111 & 001 & . & 000 & 011 & 101 & 011 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow & \downarrow \\ 1 & 2 & 0 & 3 & 7 & 1 & & 0 & 3 & 5 & 3 \end{array}$$

~~011 101 011~~

$\Rightarrow (A0F9.0EB)_{16} = (120371.0353)_8$