Name: Hidayat Khan

ID: 17024

Program: BS Software Engineering

Assignment: Digital Logic Design

Q1 a) $(45.25)_{10} = (?)_2$

$= (101101.01)_2$

b) $(10000000.1010)_2 = (?)_{10}$

$= (128.625)_{10}$

c) $(4D7F)_{16} = (?)_{10}$

$= (19839)_{10}$

d) $(128)_{10} = (?)_{16} =$

$= (80)_{16}$

e) $(3A6F)_{16} = (?)_2$

$= (0011101001101111)_2$

f) $(1100001111001011)_2 = (?)_{16}$

$= C3E5_{16}$

g) $(6173)_8 = (?)_{10}$

$= (3195)_{10}$

h) $169_{10} = ()_8$

$= (251)_8$

I) $(2A7D)_{16} = ()_8$

$= (25175)_8$

J) $(11111111)_2 = \pm (?)_{10}$ using 2's complement

$= (-1)_{10}$

K) $-12_{10} = (?)_2$ using 2's compliment

$= (11110100)_2$

L) $198_{10} = (?)_{BCD}$

$= (000110011000)_{BCD}$

M) $100001110000_{BCD} = ()_{10}$

$= (870)_{10}$

N) $1001010_2 = ()_{Gray}$

$= (1101111)_{gray}$

O) $(10101111)_{excess} = (\ )_2$

$= (11001010)_2$

P) $0100\ 0001 = (?)_{ASCII}$

$= (A)_{ASCII}$

Q) $111000 = (?111000)_{even\ parity}$

$= (00111000)_{even\ parity}$

Q2:- a) $(01111111)_2 - (00000111)_2$

A B

Using 2's complement

Sol:- First finding B's 2's complement

2's Complement of B =>

```
  1 1 1 1 1 1 1 1
- 0 0 0 0 0 1 1 1
-----------------
  1 1 1 1 1 0 0 0
```

Now add 1 => 11111000 + 1 = 11111001

Now add this 2's complement of B to A

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

carry

Ans => 01111000

A B

Q2: b) $(10110101)_2 \times (11110001)_2$

Using 2's complement for $B = (00001110)_2$

Sol.

```
  01101010
x 00001110
----------
  01101010
 011010100
0110101000
01101010000
000000000000
0000000000000
00000000000000
000000000000000
----------------
0000101101110110
```

Product → 0000 1011 0111 0110

A B

Q2 c) $(10001000)_2 \div (00100010)_2$

Soln 2's complement of B = 11011110

```
  10001000
+ 11011110
-----------
1 01100110
```

discard ← 1

Add 1 to quotient

=> 00000000 + 00000001

=> 00000001

```
  01100110
+ 11011110
-----------
1 01000100
```

discard ← 1

quotient = 00000001 + 00000001

= 00000010

$$
\begin{array}{r}
01000000 \\
+\ 11011110 \\
\hline
\text{discard} \leftarrow (1)\,00100010
\end{array}
$$

quotient = 00000011

$$
\begin{array}{r}
00100010 \\
+\ 11011110 \\
\hline
\text{discard} \leftarrow (1)\,00000000
\end{array}
$$

quotient $00000011 + 00000001 = 00000100$

Answer = 00000100

Q2 D) $6D_{16} - 3F_{16}$ using 2's C

Sol:
=> 3F = 00111111
=> 2's Complement of 3F = 11000001
=> $11000001 = C1_{16}$

=>
$$\begin{array}{r} 6D \\ +\ C1 \\ \hline 34_{16} \end{array}$$
=> Answer

Q2 E) $00010110_{BCD} + 00010101_{BCD} = (?)_{10}$

$$\begin{array}{rr} 0001\ 0110 & 16 \\ +\ 0001\ 0101 & +\ 15 \\ \hline 0010\ 1011 & 31 \\ +\ 0110 & \leftarrow \text{Add 6 b/c invalid BCD} \\ \hline \underbrace{0011}_{3}\ \underbrace{0001}_{1} & \end{array}$$

$00010110_{BCD} + 00010101_{BCD} = (31)_{10}$

Q3:- Apply CRC to the data bits 11010011_2 using the generator code 1010_2 to produce the transmitted CRC Code.

$D' = 11010011$

$G = 1010$

$D' = 11010011\,0000$

$$\frac{D}{G} = \frac{11010011\,0000}{1010}$$

```
11010011 0000
1010 ↓
-----
1110
1010↓
-----
 1011
 1010
 -----
  1000
  1010
  -----
  0100
```

→ Remainder is not zero, replace the generator 0000 with the remainder 0100

```
1 1 01 00 11 01 00
1 0 1 0
---------
  1 1 1 0
  1 0 1 0
---------
    1 0 0 0
    1 0 1 0
-----------
      1 0 1 1
      1 0 1 0
-------------
          1 0 1 0
          1 0 1 0
-----------------
Remainder is zero ⇒ 0 0
```

QUESTION - No 4

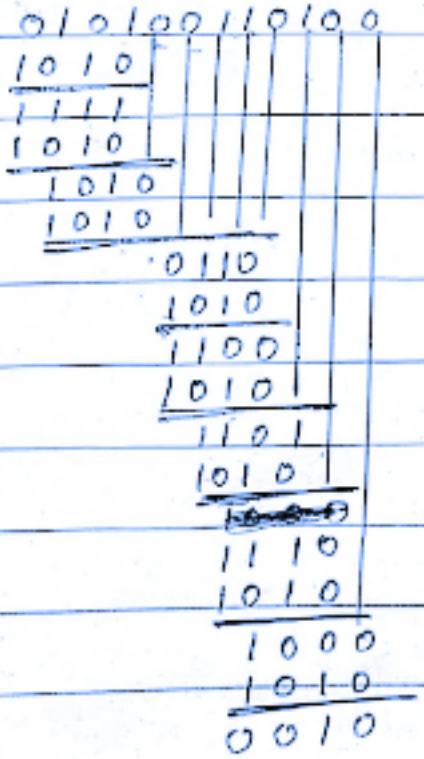
Assume that the code produced in problem 6.3 occur an error in the most significant bit during transmission Apply CRC to detect the error.

Ans:-

The code that we assumed in question No. 3 in which the transmitted CRC code is D = 11010011010 0

Now the error occurs in the most significant bit

D = 01010011010 0



So the remainder is not zero so

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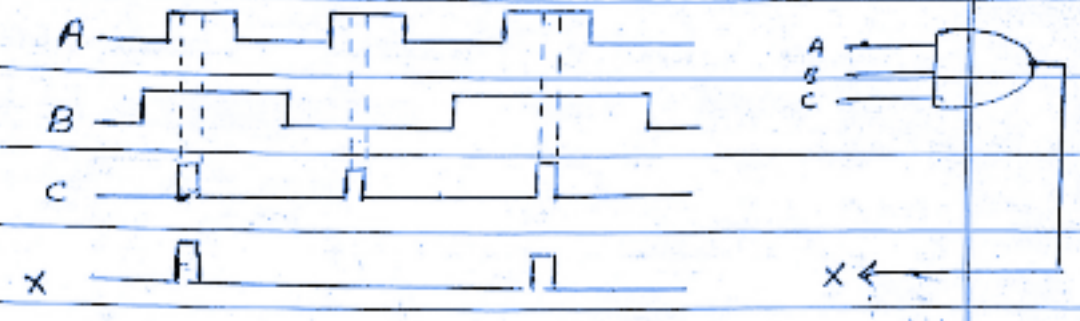
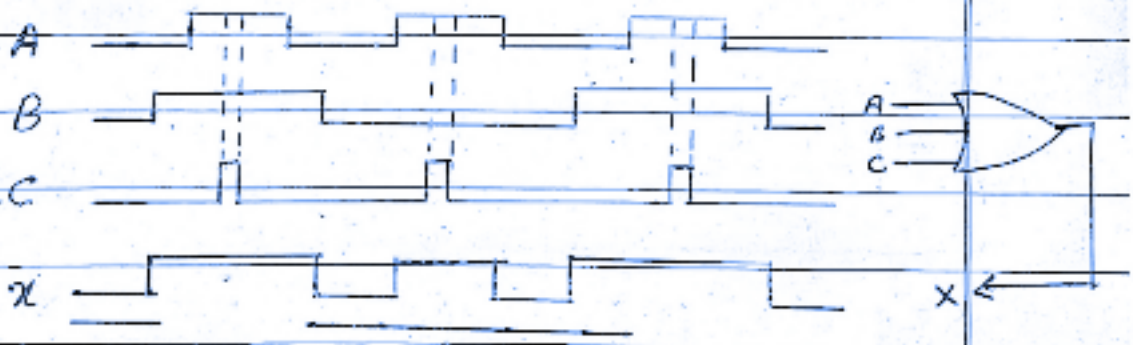
QUESTION - No - 5

3-input AND gate



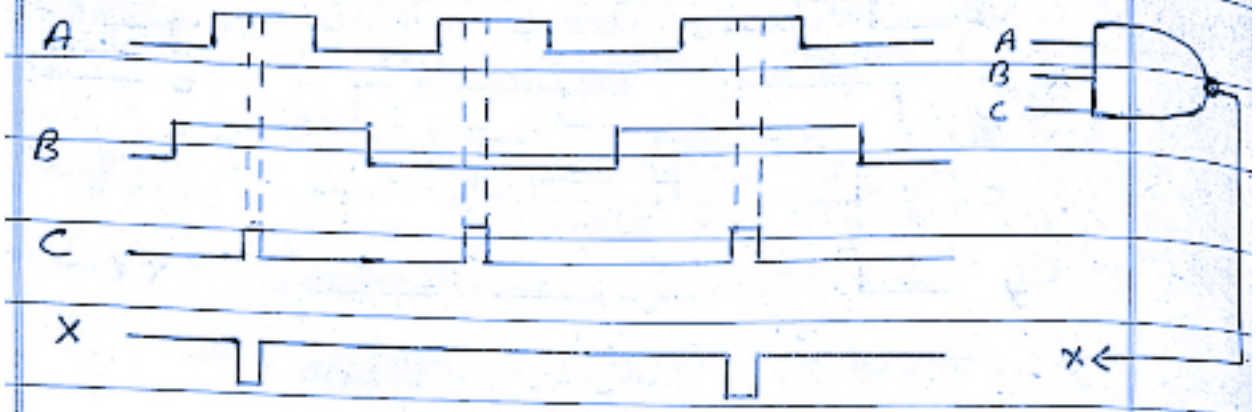
QUESTION - No - 6

3-input OR gate



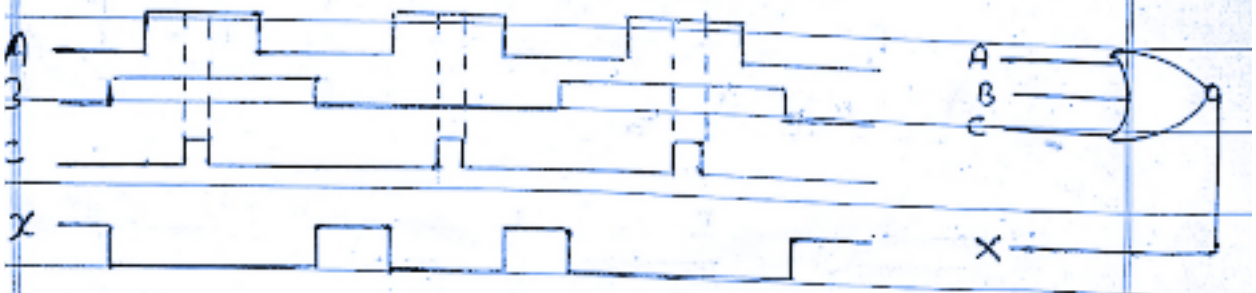
QUESTION - No - 7

3-input NAND Gate



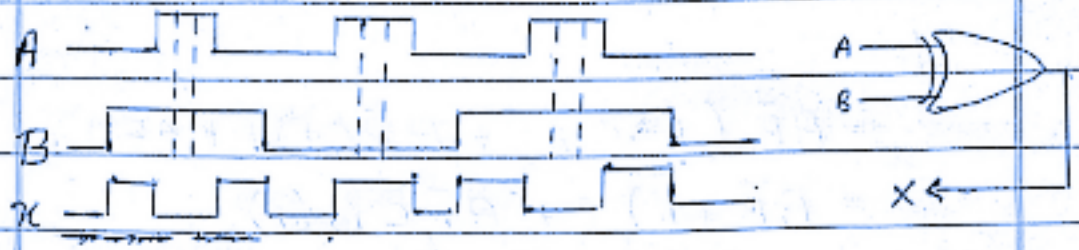
QUESTION - No - 8

3-input NOR gate



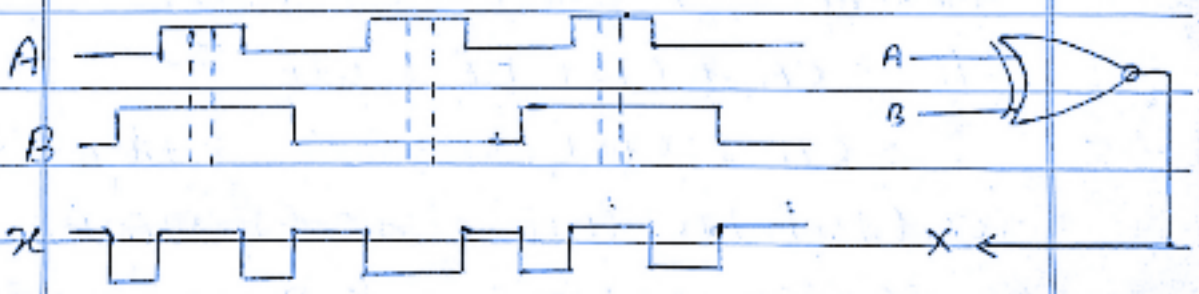
QUESTION - No - 9

2-input XOR gate



QUESTION - No - 10

XNOR gate



QUESTION - NO - 11

Using Boolean algebra

$A\bar{B} + A\bar{B}C + A\bar{B}CDE$

Sol:

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

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

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

$= A\bar{B}(1+CD)$ $\quad \because 1+x=1$

$= A\bar{B}(1)$

$= A\bar{B}$

QUESTION - NO - 12

Convert the following expressions to standard SOP form $(C+D)(\bar{A}+D)$

Sol:- $= C\bar{A} + CD + D\bar{A} + DD$

$= C\bar{A} + CD + D\bar{A} + D$ $\quad \because A.A = A$

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

$(C\bar{A}D) + (C\bar{A}\bar{D}) + CDA + CD\bar{A} + D\bar{A}C + D\bar{A}\bar{C} + DA + D\bar{A}$

$\Rightarrow C\bar{A}D + C\bar{A}\bar{D} + CDA + CD\bar{A} + D\bar{A}C$

$+ D\bar{A}\bar{C} + DA(C+\bar{C}) + D\bar{A}(C+\bar{C})$

$\Rightarrow C\bar{A}D + C\bar{A}\bar{D} + CDA + CD\bar{A} + D\bar{A}C$

$+ D\bar{A}\bar{C} + DAC + DA\bar{C} + D\bar{A}C + DA\bar{C}$

The SoP is

$\Rightarrow ACD + \bar{A}CD + \bar{A}C\bar{D} + \bar{A}\bar{C}D + A\bar{C}D$

QUESTION-No-13

Write the standard Pos expression using the standard sop expression obtained in Q.12

$ACD + \bar{A}CD + \bar{A}C\bar{D} + \bar{A}\bar{C}D + A\bar{C}D$

$(1\,1\,1) + (0\,1\,1) + (0\,1\,0) + (0\,0\,1) + (1\,0\,1)$

Since there are three variable in the domain of this expression, there are $2^3 = 8$ possible combination by ~~these~~ ~~five~~ of which are contained by this expression the rest are

000, 100, 101, 110, 010

$(A+C+D)(\bar{A}+C+D)(\bar{A}+C+\bar{D})(\bar{A}+\bar{C}+D)(A+\bar{C}+D)$

Hence this is the Pos expression.

QUESTION - NO - 14

Draw a single truth table for both Pos and standard sop expression obtained in Q. 12 and Q 13

A	C	D	x	Pos / sop
0	0	0	0	$A + C + D$
0	0	1	0	$\bar{A} + C + D$
1	0	1	0	$\bar{A} + C + \bar{D}$
1	1	0	0	$\bar{A} + \bar{C} + D$
0	1	0	0	$A + \bar{C} + D$
1	1	1	1	ACD
0	1	1	1	$\bar{A}CD$
0	1	0	1	$\bar{A}C\bar{D}$
0	0	1	1	$\bar{A}\bar{C}D$
1	0	1	1	$A\bar{C}D$

Pos :-

$(A + C + D)(\bar{A} + C + D)(\bar{A} + C + \bar{D})(\bar{A} + \bar{C} + D)(A + \bar{C} + D)$

Sop :-

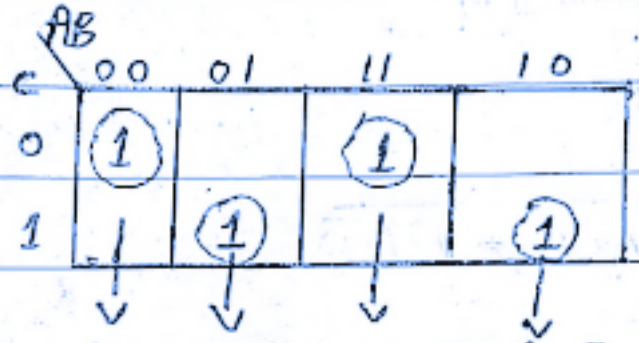
$(ACD) + (\bar{A}CD) + (\bar{A}C\bar{D}) + (\bar{A}\bar{C}D) + (A\bar{C}D)$

QUESTION - NO - 15

Use a Karnaugh map to simplify expression to a minimum SOP form.

$$\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C}$$

Ans:- (0 0 0) + (0 1 0) + (1 0 1) + (1 1 0)

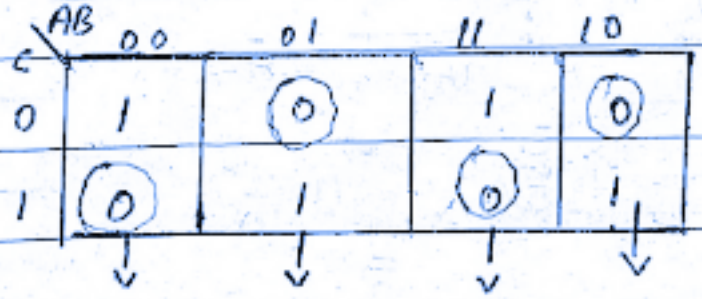


$\Rightarrow (\bar{A}\bar{B}C)\ (\bar{A}BC)\ (AB\bar{C})\ (A\bar{B}C)$ is minimum SOP form.

QUESTION - NO - 16

Obtain the minimum POS expression form the Karnaugh map used in Q.15

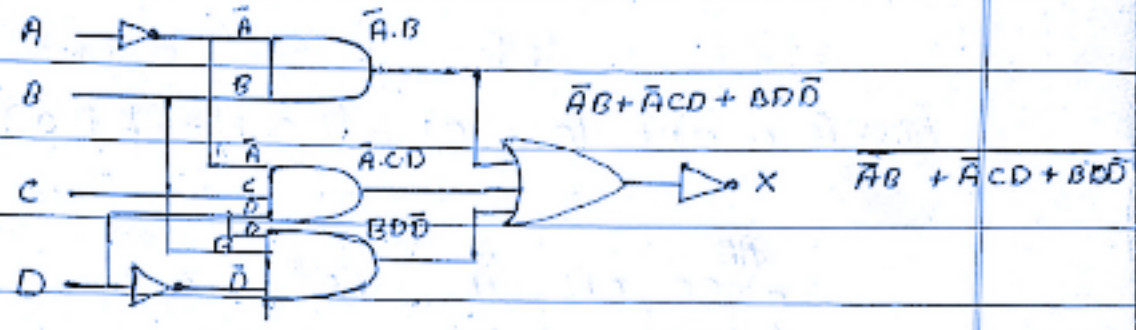
Ans:-



$\Rightarrow (A+B+\bar{C})\ (A+\bar{B}+C)\ (A+B+\bar{C})\ (A+B+C)$

QUESTION - No - 17

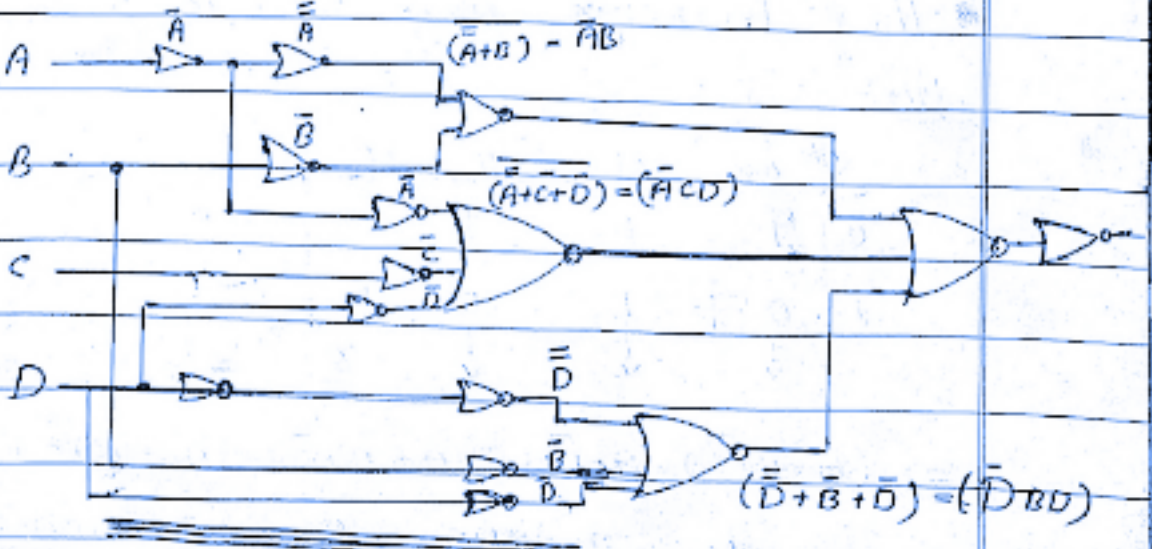
Write the output expression for circuit.



$$x = \overline{\bar{A}B + \bar{A}CD + BD\bar{D}}$$

QUESTION - No - 18

Implements the logic circuit in figure using only NOR gates



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

$$x = (AB) + (\bar{A}CD) + (\bar{D}BD) \quad \text{Ans.}$$

Q.19: It is the same as the above question 18.

QUESTION - No - 20

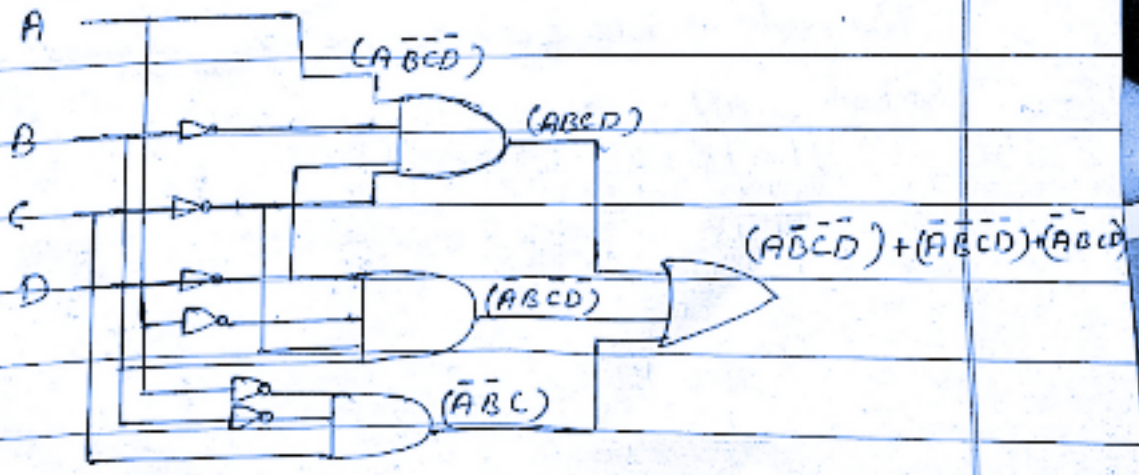
Implement a logic circuits for the truth table

Ans:- We obtained the following expression from the truth table is

$\Rightarrow (\bar{A}\bar{B}CD) + (\bar{A}B\bar{C}D) + (\bar{A}BC\bar{D}) + (A\bar{B}\bar{C}D) + (A\bar{B}C\bar{D}) + (A\bar{B}CD) + (ABCD)$

using boolean expression and laws we get

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



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