Digital Logic & Design(Theory)

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Course Codes: CSC-201

EDP Codes: 102002077

Mid-Term Assignment

Semester: Spring 2020

Program: BS(CS)

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Q1) Convert each of the following.

ⓐ $45.25_{10} = (?)_2$

Give that

45.25_{10}

Required:

Convert $45.25_{10} = (?)_2$ to binary number System

Soln

using Repeated division of 45

2	45	
2	22	→ 1
2	11	→ 0
2	5	→ 1
2	2	→ 1
	1	→ 0

So,

$(45)_{10} = (101101)_2$

Now,

$0.25 \times 2 = 0.5$

$.5 \times 2 = 1$

$(45)_{10} = (101101.01)_2$ Ans,

(b) $10000000 \cdot 1010_2 = (?)_{10}$

Given that

$10000000 \cdot 1010_2$

Required:

To convert the given binary number into decimal number system.

Soln

using weight notation.

$(1\times2^7)+(1\times2^{-1})+(1\times2^{-3})$

$(1\times128)+(0\cdot5)+(1\times0\cdot125)$

$128+0\cdot5+0\cdot125$

$(128\cdot625)_{10}$

So,

$(10000000\cdot1010)_2 = (128\cdot625)_{10}$

c) $4D7F_{16} = (?)_{10}$

Given that

$4D7F_{16}$

Required:

Convert the given Hexa number into decimal number system.

Soln

using wheigted notation

$\Rightarrow (4\times16^3)+(D\times16^2)+(7\times16^1)+(F\times16^0)$

$\Rightarrow (4\times16^3)+(13\times16^2)+(7\times16^1)+(15\times16^0)$

$\Rightarrow (4\times4096)+(13\times256)+(7\times16)+(15\times1)$

$\Rightarrow 16384+3328+112+15$

$\Rightarrow (19839)_{10}$

So,

$(4D7F)_{16} = (19839)_{10}$ An

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

Given that:

$(128)_{10}$

Required:

~~Dec~~ Convert to the given Hex.

Soln

using Repeated division by 16

$$\begin{array}{r|l} 16 & 128 \\ \hline & 8 \rightarrow 0 \\ \hline \end{array}$$

Hence

$(128)_{10} = (80)_{16}$ Ans

e) $3A6F_{16} = (?)_2$

Given that $(3A6F)_{16}$

Required:

To convert the hex number into binary.

Soln

3	A	6	F
0011	1010	0110	1111

Hence $3A6F_{16} = 0011101001101111_2$ Ans

(f) $110000111100101_2 = (?)_{16}$

Given that:

110000111100101_2

Required:-

Hex equilent of given binary number.

Soln

$\underset{6}{0110}\ \underset{1}{0001}\ \underset{E}{1110}\ \underset{5}{0101}$.

So,

$(110000111100101)_2 = (61E5)_{16}$

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

Given that

$(6173)_8$

Required:

Decimal equilent of $(6173)_8$

Soln

$\Rightarrow (6\times8^3)+(1\times8^2)+(7\times8^1)+(3\times8^0)$

$\Rightarrow (6\times512)+(1\times64)+(7\times8)+(3\times1)$

$\Rightarrow 3072+64+56+3$

$\Rightarrow (3195)_{10}$

So, $(6173)_8 = (3195)_{10}$ Ans

H) $(169)_{10} = (?)_8$

Given:

$(169)_{10}$

Required:

octal equalent of $(169)_{10}$

Sol/n

$$\begin{array}{c|l} 8 & 169 \\ \hline 8 & 21 \rightarrow 1 \\ \hline & 2 \rightarrow 5 \end{array}$$

Hence, $(169)_{10} = (251)_8$ Ans

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

Given that $(2A7D)_{16}$

Required:

octal equalient of $(2A7D)_{16}$

Sol/n

2	A	7	D	convert Hexa to binary
0010	1010	0111	1101	

	210	210	210	210	210	
000	010	101	001	111	101	binary to octal
0	2	5	1	7	5	

Hence,

$(2A7D)_{16} = (025175)_8$

J) $(1111111)_2 = \pm(?)_{10}$

Given:

$(1111111)_2$

Required:

Decimal value of the given single number.

Soln

$\Rightarrow (1\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$\Rightarrow 64+32+16+8+4+2+1$

$\Rightarrow (127)_{10}$

Since a single bit

$(1111111)_2 = (-127)_{10}$ An

K) $-12_{10} = (?)_2$

Given:

$(-12)_{10}$

Required:

Binary equilent of -12_{10}

Soln

$$
\begin{array}{c|l}
2 & 12 \\ \hline
2 & 6 - 0 \\ \hline
2 & 3 - 0 \\ \hline
 & 1 - 1 \\ \hline
\end{array}
$$

$-12_{10} = (1100)_2 \Rightarrow 00001100_{(2)}$

Now ~~the~~ taking 2's complement of obtain number.

$$
\begin{array}{r}
00001100 \\ \hline
11110011 \\
1 \\ \hline
11110100
\end{array}
$$

Hence, $(-12)_{10} = (11110100)_2$ An

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

Given:
$(198)_{10}$

Required:
convert the given decimal number to binary codded decimal.

Sol:

1	9	8
0001	1001	1000

Hence,
$(198)_{10} = (000110011000)_{BCD}$

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

Given:
$(100001110000)_{BCD}$

Req: Decimal equalient of the given BCD number.

Sol: using BCD-Decimal table

1000	0111	0000
8	7	0

Hence,
$(100001110000)_{BCD} = (870)_{10}$

N) $(1001010)_2 = (?)_{gray}$

Given:

$(1001010)_2$

Req:-

Gray equilent of $1001010_{(2)}$

Sol:-

$$1 \rightarrow + 0 \rightarrow + 0 \rightarrow + 1 \rightarrow + 0 \rightarrow + 1 \rightarrow + 0$$

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

$$1 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1$$

Hence,

$(1001010)_2 = (1101111)_{gray}$ Ans.

O) $(10101111)_{gray} = (?)_2$

Given: $(10101111)_{gray}$

Req:

Binary equilent to gray

Sol:-

$$1 \rightarrow + 0 \rightarrow + 1 \rightarrow + 0 \rightarrow + 1 \rightarrow + 1 \rightarrow + 1 \rightarrow + 1$$

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

$$1 \quad 1 \quad 0 \quad 0 \quad 1 \quad 0 \quad 1 \quad 0$$

Hence,

$(10101111)_{gray} = (11001010)_2$

P) $01000001 = (?)_{ASCII}$

Given:

$01000001_{(2)}$

Req:

ASCII Equivalent $01000001_{(2)}$

Sol

using ASCII table

$\Rightarrow (1\times2^6)+(1\times2^0)$

$\Rightarrow (1\times64)+(1\times1)$

$\Rightarrow 64+1$

$\Rightarrow (65)_{10} \Rightarrow 64_{(10)} = (A)$ ASCII character.

Q) $111000 = (?111000)$ Even Parity

Given:

$111000_{(2)}$

Req:

Attach Even Parity bit to (111000)

Soln

Since there has to ~~en~~ even amount of 1's in an even parity number. we add 1 to the given number:

$1\,111000 \Rightarrow 1111000_{(2)}$

Q2) Calculate each of the following number:

a) $01111111_{(2)} - 00000111_{(2)}$

Soln

Taking 2's complement on

$$
\begin{array}{cccccccccl}
 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & \\
\hline
 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & \rightarrow 1\text{'s complement} \\
+ & & & & & & & & 1 & \rightarrow 2\text{'s complement} \\
\hline
 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 &
\end{array}
$$

Now;

$$
\begin{array}{cccccccccc}
 & & 1 & 1 & 1 & 1 & 1 & 1 & 1 & \\
 & & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
+ & & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 \\
\hline
 & 1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0
\end{array}
$$

Discard bit

Hence;

$(01111000)_2$ Ans

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b) $01101010_{(2)} \times 11110001_{(2)}$

Soln

using 2's complement

```
  1 1 1 1 0 0 0 1
  0 0 0 0 1 1 1 0   -> 1's complement
                1   -> 2's complement
  0 0 0 0 1 1 1 1
```

Now;

```
                          0 0 0 0 1 1 1 1
                          0 1 1 0 1 0 1 0
                          0 0 0 0 0 0 0 0
                        0 0 0 0 1 1 1 1 X
                      0 0 0 0 0 0 0 0 X X
                    0 0 0 0 1 1 1 1 X X X
                  0 0 0 0 0 0 0 0 X X X X
                0 0 0 0 1 1 1 1 X X X X X
              0 0 0 0 1 1 1 1 X X X X X X
            0 0 0 0 0 0 0 0 X X X X X X X
          0 0 0 0 0 1 1 0 0 0 1 1 0 1 1 0
```

Hence;

$11000110110_{(2)}$ Ans

(c) $10001000_{(2)} \div 00100010_{(2)}$

Soln

Quotient = 00000000

Now; subtracting deviser from divident using 2's complement

$$\begin{array}{r} 10001000 \\ +\ 11011110 \\ \hline 101100110 \end{array}$$

Discard bit ←

Adding "1" to Quotient

⇒ 00000001

Substract deviser from 1st partial remainder using 2's complement.

$$\begin{array}{r} 01100110 \\ +\ 11011110 \\ \hline 101000100 \end{array}$$

Discard bit ←

Adding "1" to quotient

⇒ 00000010

Again

$$\begin{array}{r} 01000100 \\ +\ 11011110 \\ \hline 100100010 \end{array}$$

Discard bit ←

Adding "1" to quotient

⇒ 00000011

Now again

$$\begin{array}{r} 00100010 \\ +\ 11011110 \\ \hline 100000000 \end{array}$$

discard ←

Adding "1" quotient

Quotient = 00000100

Ans

$$\begin{array}{r} 00100010 \\ \hline 11011101 \\ 1 \\ \hline 11011110 \end{array}$$

11011101 → 1's complement

1 → 2's complement

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d) $6D_{16} - 3F_{16}$

Sol

Hexa convert to to binary number

$$\frac{6}{0110}\ \frac{D}{1001}$$

$6D_{(16)} = 01101001_{(2)}$

$$\begin{array}{r} 6D \\ +\ C1 \\ \hline 12E \end{array}$$

$$\frac{3}{0011}\ \frac{F}{1111}$$

2's complement of 3F

$$\begin{array}{r} 00111111 \\ \hline 11000000 \\ 1 \\ \hline 11000001 \end{array}$$

11000000 → 1's complement

1 → 2's complement

$$\frac{1100}{C}\ \frac{0001}{1}$$

Hence, $\boxed{12E}$ Ans

e) $(00010110)_{BCD} + 00010101_{BCD} = (?)_{16}$

Sol

$$\begin{array}{r} 0001\ 0110 \\ +\ 0001\ 0101 \\ \hline 0010\ 1010 \end{array}$$

→ invilid due to (>9) ~~invalid~~

Add to invalid code

$$\begin{array}{r} 0010\ 1011 \\ +0110 \\ \hline 0011\ 0001 \end{array}$$

$$\frac{0011}{3}\ \frac{0001}{1}$$

Hence, (31) Ans

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Q3) Apply CRC to data bits $11010011_{(2)}$ using generator code $1010_{(2)}$ to produced transmitted CRC code.

Sol

$D = 11010011$, $G = 1010$

Since its four data bits add four to data byte

$D' = 11010011\boxed{0000}$

Now, divided D' by G.

```
110100110000
1010
----
 1110
 1010
 ----
  1000
  1010
  ----
   1011
   1000
   ----
      1000
      1010
      ----
       100
```

R = 0100 and add more four zero → 110100110100

```
110100110100
1010
----
 1110
 1010
 ----
  1000
  1010
  ----
   1011
   1010
   ----
   1010
```

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Q4) Assume that the code produced in Problem Q.3 incurs and error in the most significant bit during transmission. Apply CRC to detect the error.

Given:-

Recieved Data = D′ = 010100110100

G = 1010

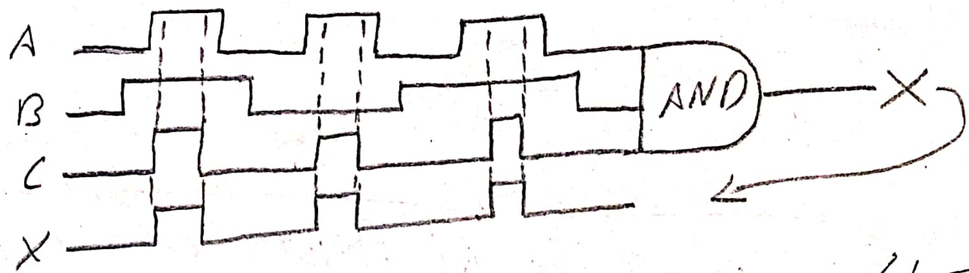
Req:-

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

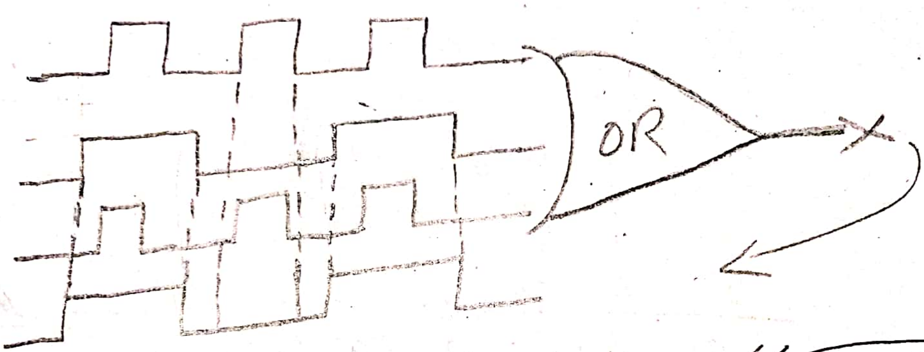
Reminder ≠ 0

Hence; Error has been occured

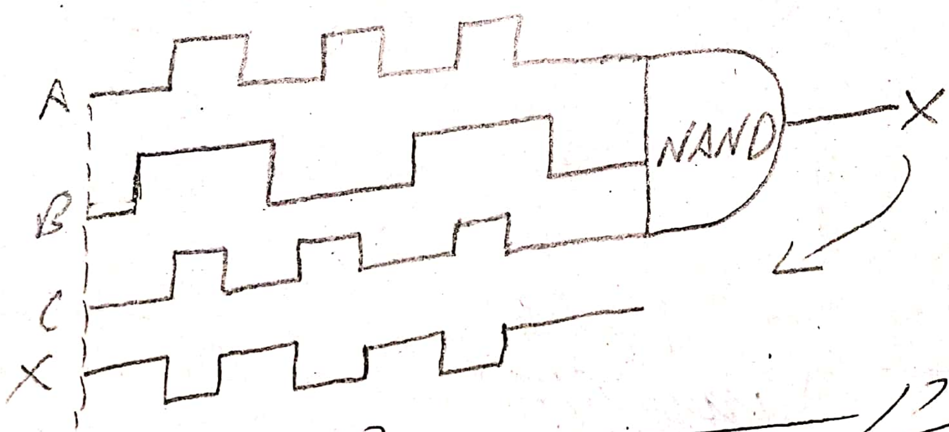
Q5) The input waveform in figure 1 is applied to a 3-input AND gate. Show the output waveform in proper relation to the inputs with a timming diagram.



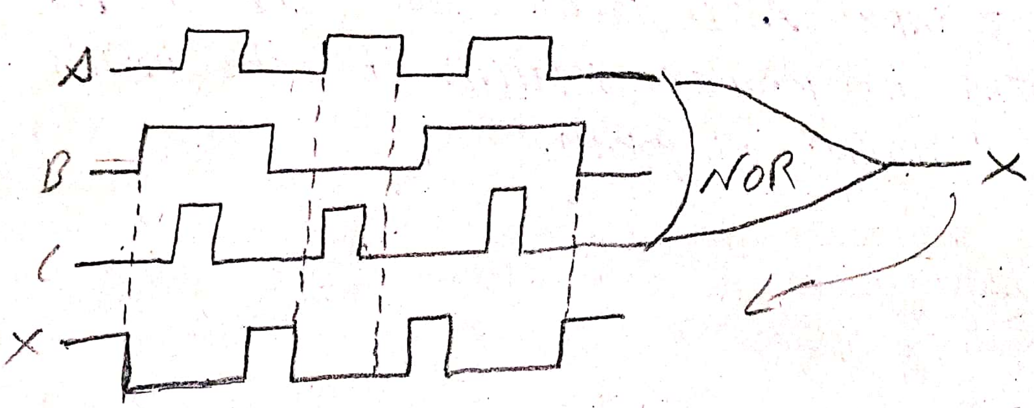
Q6) Repeat Q.5 for a 3-input OR gate:



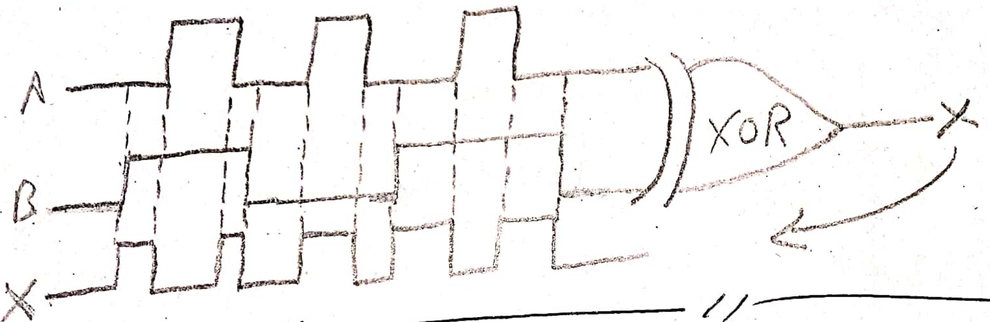
Q7) Repeat Q.5 for Nand gate:



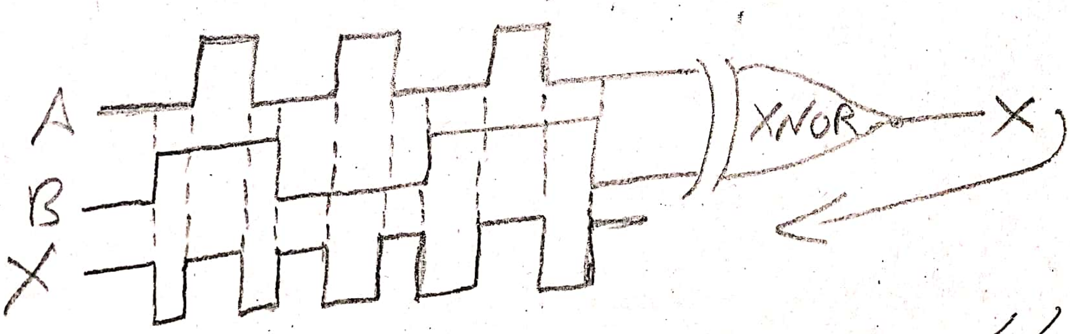
Q8) Repeat Q5 for Nor Gates



Q9) The input waveform in figure are applied to a XOR gate, Show the output waveform with timming diagram.



Q10) Repeat Q.9 for XNOR gate.



Q11) using boolean algebra tecniques, simplify the following expression as much as possible.

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

Sol:

using boolean Alegebra Rules

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

$\Rightarrow \overline{A+AB} = A$

$\Rightarrow A\bar{B} + A\bar{B}CD + A\bar{B}CDE$

$\Rightarrow \overline{A+AB} = A$

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

$\Rightarrow \overline{A+AB} = A$

$\Rightarrow A\bar{B}$ Answer

R.W

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

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

$\overline{A+1} = 1$

$A\bar{B}(1)$

$(A\bar{B})$

Q12) Convert the following expression into stander SOP form.

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

Soln

convert expression to SOP form

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

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

$\Rightarrow CA+CD+D\bar{A}+DD$

Domain of this SOP is ACD term CA is missing D.

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

Term CD is missing A

$\Rightarrow CD = CD(A+\bar{A}) = CDA + CD\bar{A}$

Term $D\bar{A}$ is missing C

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

Term DD is missing A and C

$\Rightarrow DD = DD(A+\bar{A}) = DDA + DD\bar{A}$

Term DDA and $DD\bar{A}$ is missing C

$\Rightarrow DDA = DDA(C+\bar{C}) = DDAC + DDA\bar{C}$

$\Rightarrow DD\bar{A} = DD\bar{A}(C+\bar{C}) = DD\bar{A}C + DD\bar{A}\bar{C}$

Hence;

$(C\bar{A}D + C\bar{A}\bar{D} + CDA + CD\bar{A} + D\bar{A}C + D\bar{A}\bar{C} + DDAC + DDA\bar{C} + DD\bar{A}C + DD\bar{A}\bar{C})$

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Date:

Q13) write Standard POS expression using Standard POS expression from Q12.

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

Soln

Evaluation of the POS expression is

(101)+(100)+(110)+(111)

Since there are three variables in the domain of this expression; there are $2^3 = 8$ possible combination. Four of which are contained by the expression the rest are,

000, 010, 011, 001

Hence, the equivalent POS expression is

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

Q14) Draw a Sing Truth for both Standard Pos and Standar 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	$(A+C+\bar{D})$
0	1	0	0	$(A+\bar{C}+D)$
0	1	1	0	$(A+\bar{C}+\bar{D})$
1	0	0	1	$(A\bar{C}\bar{D})$
1	0	1	1	$(A\bar{C}D)$
1	1	0	1	$(AC\bar{D})$
1	1	1	1	(ACD)

Pos Expression:

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

Sop Expression:

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

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Date:

Q15) use karnaugh map to simply the following expression to minimum SOP form

Sol^

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

$000 + 011 + 101 + 110$

AB \ C	0	1	
00	1		$(\bar{A}\bar{B}\bar{C})$
01		1	$(\bar{A}BC)$
11	1		$(AB\bar{C})$
10		1	$(A\bar{B}C)$

$(\bar{A}\bar{B}\bar{C}) + (\bar{A}BC) + (AB\bar{C}) + (A\bar{B}C)$ minimum sop.

Q16) obtain the minimum pos expression from K-m used in Q.15.

Soln

AB \ C	0	1	
00	1	0	$(A+B+\bar{C})$
01	0	1	$(A+\bar{B}+C)$
11	1	0	$(A+B+\bar{C})$
10	0	1	$(\bar{A}+B+C)$

$(A+B+\bar{C})(A+B+C)(A+B+\bar{C})(A+B+C)$ is the manimum pos expression

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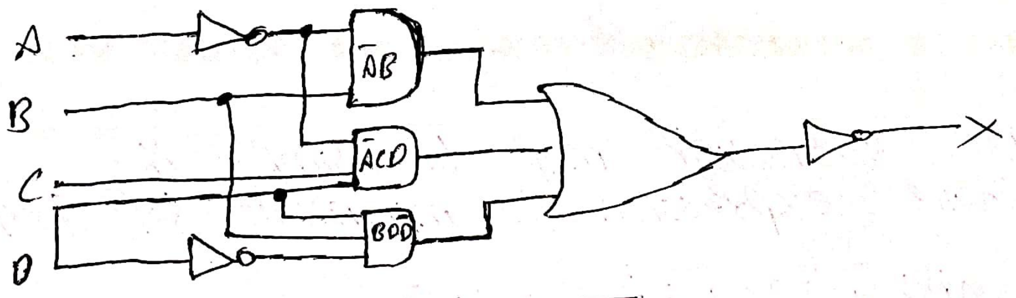
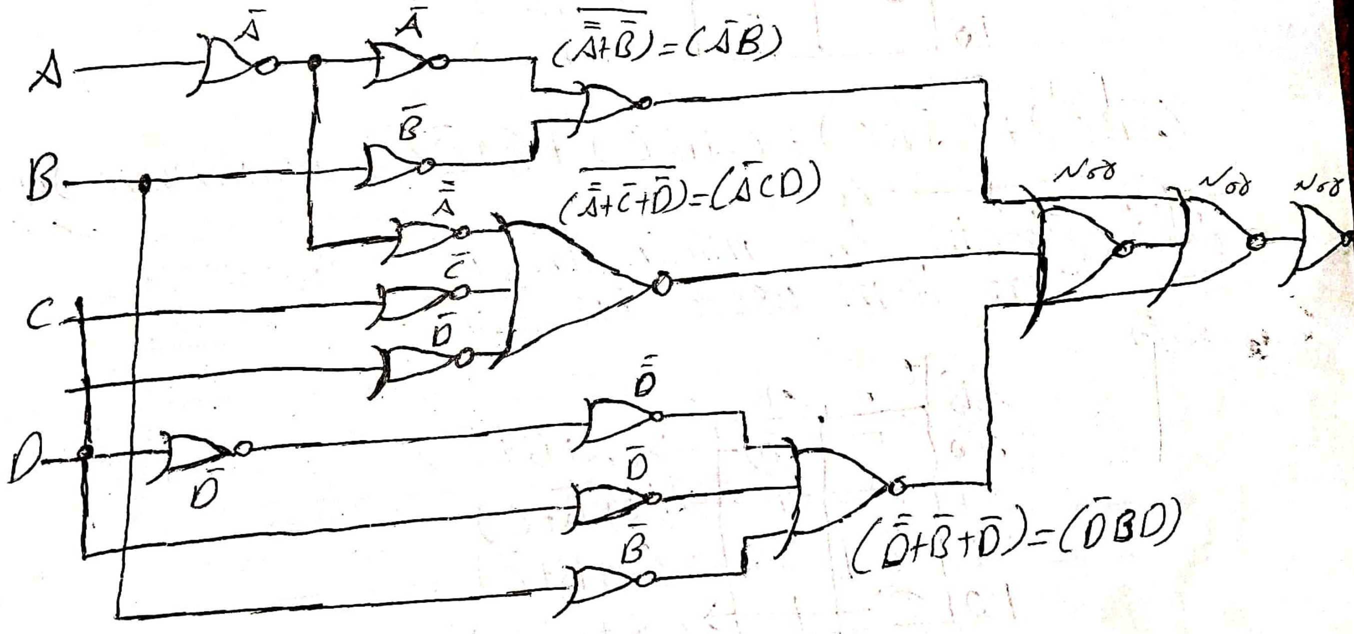
Q17) write the output expression for circuit in figure:



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

Q18) Implement the logic circuit using only Nor gate.



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

Ans

Date:

Q19) Same as Q18 :-

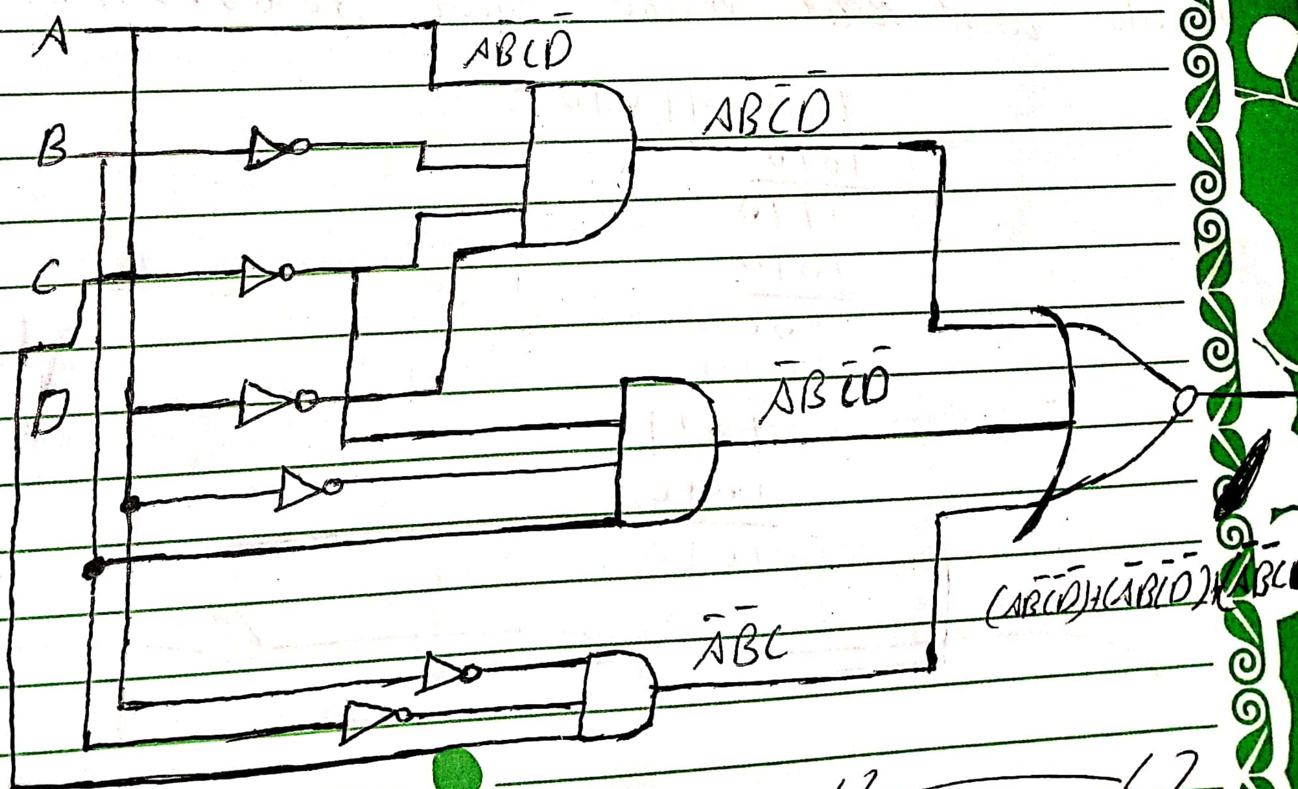
Q20) Implement a logic circuit for the truth table in table (1).

Sol

Obtain expression from truth table is
$(\bar{A}\bar{B}C\bar{D})+(\bar{A}\bar{B}CD)+(\bar{A}\bar{B}\bar{C}\bar{D})+(A\bar{B}\bar{C}\bar{D})+(A\bar{B}CD)+(A\bar{B}C\bar{D})$
$+(A\bar{B}CD)+(ABCD)$

By reducing expression using boolean laws and rules:

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



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