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Paper: Digital Logic Design.

QUESTION: 1:

Convert each of the following.

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

Answer

$(45.25)_{10} = (?)_2$.

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

101101

Now for 0.25.

0.25 × 2

0.50 → 0 carry

0.50 × 2

1.00 → 1 carry.

So, The answer is

$\boxed{101101.01}$ → **Answer.**

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

Solution :

$$\begin{array}{cccccccccccccc} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & . & 1 & 0 & 1 & 0 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow & \downarrow \\ 2^7 & 2^6 & 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 & . & 2^{-1} & 2^{-2} & 2^{-3} & 2^{-4} \end{array}$$

$1 \times 128 + 0 \times 64 + 0 \times 32 + 0 \times 16 + 0 \times 8 + 0 \times 4 + 0 \times 2 + 0 \times 1$
$1 \times \frac{1}{2} + 0 \times \frac{1}{4} + 1 \times \frac{1}{8} + 0 \times \frac{1}{16}$.

$128 + \frac{1}{2} + \frac{1}{8}$.

$128 + \frac{1 \times 8 + 1 \times 2}{16}$

$128 + \frac{8+2}{16}$.

$128 + \frac{10}{16}$

$128 + 0.625$.

$\boxed{128.625}$ → Answer.

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

Answer.

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

4D7F

$4 \times 16^3 + D \times 16^2 + 7 \times 16^1 + F \times 16^0$

$16384 + 3328 + 112 + 15$.

$\boxed{(19839)_{10}}$ Answer.

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

Answer.

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

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

$\boxed{(128)_{10} = (80)_{16}}$ Answer.

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

Answer.

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

we will solve this through table.

0011101001101111.

So, the answer is

$(3A6F)_{16} = (0011101001101111)_2$.

f $1100001111100101_2 = (?)_{16}$.

Answer :

Inorder to convert binary into hexa-decimal, we will make groups of 4 digits.

$$\underbrace{1100}\ \underbrace{0011}\ \underbrace{1110}\ \underbrace{0101}$$

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

$$C \quad 3 \quad E \quad 5$$

So, the answer is :

$|(C3E5)_{16}|$ Answer.

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

Answer :

$$\begin{array}{cccc} 6 & 1 & 7 & 3 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 8^3 & 8^2 & 8^1 & 8^0 \end{array}$$

$6 \times 8^3 + 1 \times 8^2 + 7 \times 8^1 + 3 \times 8^0$

$6 \times 512 + 1 \times 64 + 7 \times 8 + 3 \times 1$

$|(3195)_{10}|$ Answer.

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

Answer

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

$(169)_{10} = (251)_8$ | Answer.

i $2A7D_{16} = (?)_8$.

Answer :

2A7D

0010 1010 0111 1101

$\underbrace{0\,010}_{2}\underbrace{101}_{5}\underbrace{001}_{1}\underbrace{111}_{7}\underbrace{101}_{5}$

2 5 1 7 5

$(25175)_8$ | Answer.

j $11111111_2 = \pm(?)_{10}$.

Answer:-

$11111111_2 = \pm(?)_{10}$.

Now finding 1's complement.

00000000 → 1's complement.

Now for finding ~~2+0~~ 2's complement we will add 1 with 1's complement.

00000000
$\underline{\quad\quad\quad +1}$
00000001

$0\times2^7+0\times2^6+0\times2^5+0\times2^4+0\times2^3+0\times2^2+0\times2^1+1\times2^0$

$0+1\times1$

$=+1$ | for positive 1 Ans is 0001

Now for finding 2's complement of -1.

0001
1's complement is
1110
Adding 1
1110
$\underline{\quad +1}$
1111 | Answer for -1

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

Answer:

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

for +12 -) 00000001
flip 11111110
Now adding +1.

11111110
$\underline{\quad\quad +1}$
11111111

So, That is The answer.
$(-12)_{10}=(11111111)_2$.

l. $(198)_{10} = (?)_{BCD}$.

Answer:

1	9	8
↓	↓	↓
8 4 2 1	8 4 2 1	8 4 2 1
0 0 0 1	1 0 0 1	1 0 0 0

$(198)_{10} = (000110011000)_{BCD}$.

Answer.

m. $100001110000_{BCD} = (?)_{10}$.

Answer:

1000	0111	0000
8 4 2 1	8 4 2 1	8 4 2 1
8	7	0

$(870)_{10}$ Answer.

n. $1001010_2 = (?)_{Gray}$.

Answer:

1001010

↓

1101111.

$(1001010)_2 = (1101111)_{Gray}$.

Answer.

O. $10101111_{Gray} = (?)_2$.

Answer:

Gray code 1 0 1 0 1 1 1 1

$\downarrow\uparrow$

Binary Code 1 1 0 0 1 0 1 0

$(10101111)_{Gray} = (11001010)_2$.

Answer.

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

Answer.

$\underbrace{0000000}_{}$ $\underbrace{1000001}_{}$ → for finding ascii of a code, we will divide it into 7 digit code.

as it is zero, so leave it

we will take this

64 32 16 8 4 2 1
1 0 0 0 0 0 1.

So,

64 + 1 => 65.

And in Ascii table 65 is equal to A.

So,

$0100\ 0001 = (A)_{Ascii}$ Answer.

q. 111000 = (? 111000) Even Parity.

Answer :

111000 = (1111000)

Answer.

QUESTION : 2.

a. $01111111_2 - 00000111_2$.

~~Answer:~~

~~01111111~~
~~- 00000111~~
~~01111000~~

~~Answer~~

PART : A :

ANSWER :

$01111111_2 - 00000111_2$

↓

we will take 2's complement of this

00000111.

2's complement.

flip: 11111000

Now add 1

11111000

+1

11111001

Now ~~Subtracting~~ Adding it with 1st number

~~SUBTRACTING~~ ADDING:

 01111111
+ 11111001
(1)01110110

carry so, it will be dropped

ANSWER IS:

01110110

Q:2

PART : A.

$01111111_2 - 00000111_2$.

Answer:

01111111 - 00000111

value 1 — value 2.

↓

we will take 2's complement of ~~value~~ 2

00000111.

flip: 11111000.

And now add 1.

$$\begin{array}{r} 11111000 \\ +1 \\ \hline 11111001 \end{array}$$

→ 2's complement of value 2.

Now adding This with value 1.

$$\begin{array}{r} \scriptstyle 1\ 1\ 1\ 1 \quad\quad \\ 01111111 \\ +\ 11111000 \\ \hline (1)01110111 \end{array}$$

Carry we will drop This value

So, Answer is 01110111.

b. $01101010_2 \times 11110001_2$

ANSWER :-

RULES:

$0 \times 0 = 0$

$0 \times 1 = 0$

$1 \times 0 = 0$

$1 \times 1 = 1.$

Now applying the above rules

```
              01101010
           x  11110001
           -----------
              01101010
             00000000x
            00000000xx
           00000000xxx
          01101010xxxx
         01101010xxxxx
        01101010xxxxxx
       01101010xxxxxxx
       ---------------
      110110111001010
```

110110111001010

Answer.

c. 10001000 ÷ 00100010.

Answer:

first converting the two values into decimal number

10001000	00100010
$2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$	$2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
$1 \times 2^7 + 1 \times 2^3$	$1 \times 2^5 + 1 \times 2^1$.
$128 + 8$	$32 + 2$.
136	34.

dividing both these values

$$34 \overline{)136}$$

4

136

136

x

~~The~~ Now converting 4 into binary, which is 0100

So, **Answer is 0100.**

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

Answer:

borrowed 16

$$\begin{array}{r} {}^{5}6\ D \\ -\ 3\ F \\ \hline 2\ E \end{array}$$

So, $16 + 13 \Rightarrow 29$.
And $29 - 15$ equals to 14
i.e E.

So, Answer is

$2E_{16}$

e. $00010110_{BCD} + 00010101_{BCD} = (?)_{10}$.

Answer:

$$\begin{array}{r} 00010110 \\ 00010101 \\ \hline 00101011 \end{array}$$

0010 + 1011.
8 4 2 1   8 4 2 1

2 + 11.

13

Now checking invalid BCD code.

13 → 1101.

Adding 6 i.e 0110.

$$\begin{array}{r} 1101 \\ +\ 0110 \\ \hline 000(1)\,0011 \end{array}$$

Carry 1   3

$(13)_{10}$ → Answer.

QUESTION : 3

Apply CRC to The data bits 11010011_2 using the generator code 1010_2 to produce The transmitted CRC code.

ANSWER :-

$$
\begin{array}{r|l}
 & 11101001 \\
\hline
1010 & 11010011\underline{000} \\
 & 1010 \\
\hline
 & 01110 \\
 & 1010 \\
\hline
 & 01000 \\
 & 1010 \\
\hline
 & 00101 \\
 & 0000 \\
\hline
 & 01011 \\
 & 1010 \\
\hline
 & 00010 \\
 & 0000 \\
\hline
 & 00100 \\
 & 0000 \\
\hline
 & 01000 \\
 & 1010 \\
\hline
 & 0\underbrace{010}
\end{array}
$$

→ additional code generated which is 1 bit lesser then generator code.

0010 → Remainder.

11101001 → That is the transmitted CRC code which has an error as remainder is not zero.

QUESTION : 4 :

Assume that The code produced in problem Q.3 incurs an error in the most significant bit during transmission. Apply CRC to detect the error.

ANSWER :-

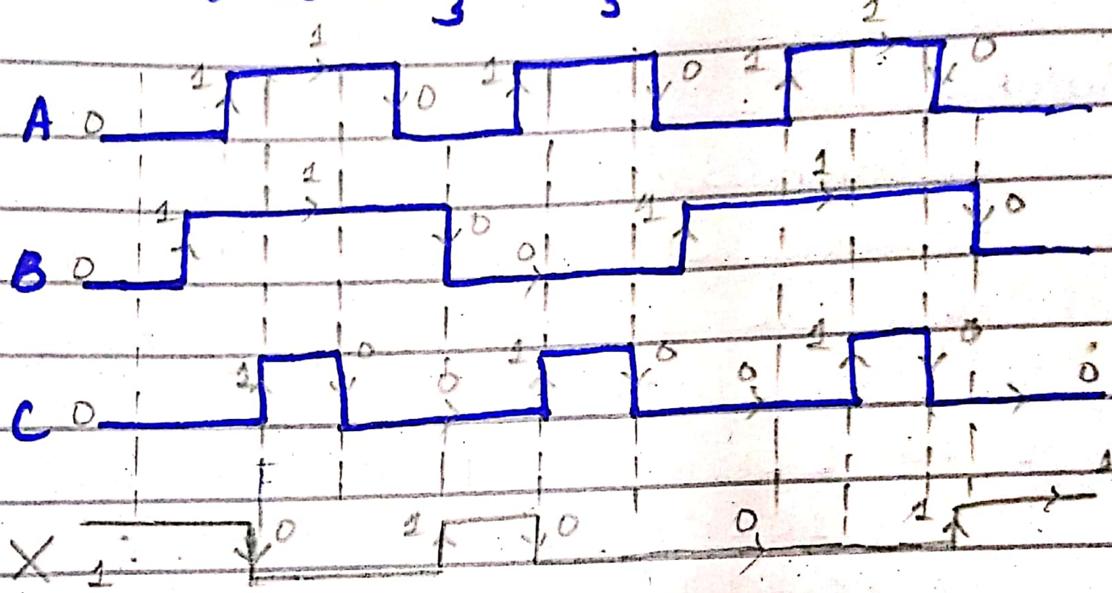
Question : 3 has an error because the remainder does not came zero, so inorder to finish that we will again apply CRC.

```
              11101001
       ___________________
  1010 | 11010011010   → Remainder.
         1010↓
         -----
         01110
          1010↓
          -----
          01000
           1010↓
           -----
           00101
            0000↓
            -----
            01011
             1010
             -----
             00010
              0000
              -----
              00101
               0000
               -----
               01010
                1010
                -----
                0000
```

Now That is transmitted code without any error.

QUESTION: 5:

The input waveforms in Figure 1 is applied to a 3-input AND gate. Show the output wave form in proper relation to the inputs with a Timing diagram.



3-input AND gate.

A	B	C	X
0	0	0	1
1	1	1	0
0	0	0	1
1	0	1	0
0	1	0	0
1	1	0	0
1	1	1	0
1	1	0	0
0	0	0	1

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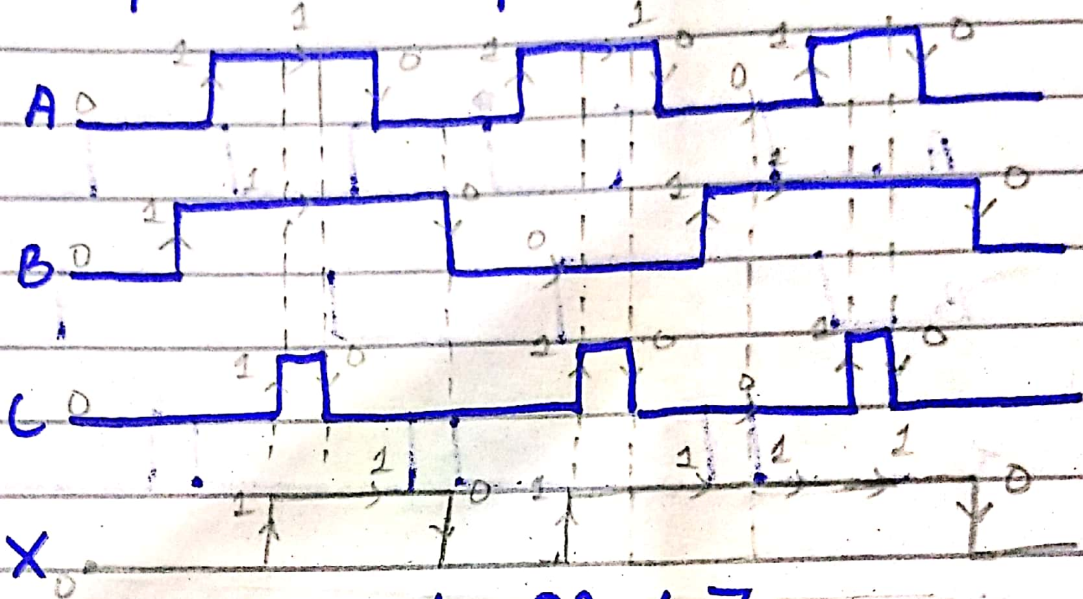
QUESTION: 6:

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

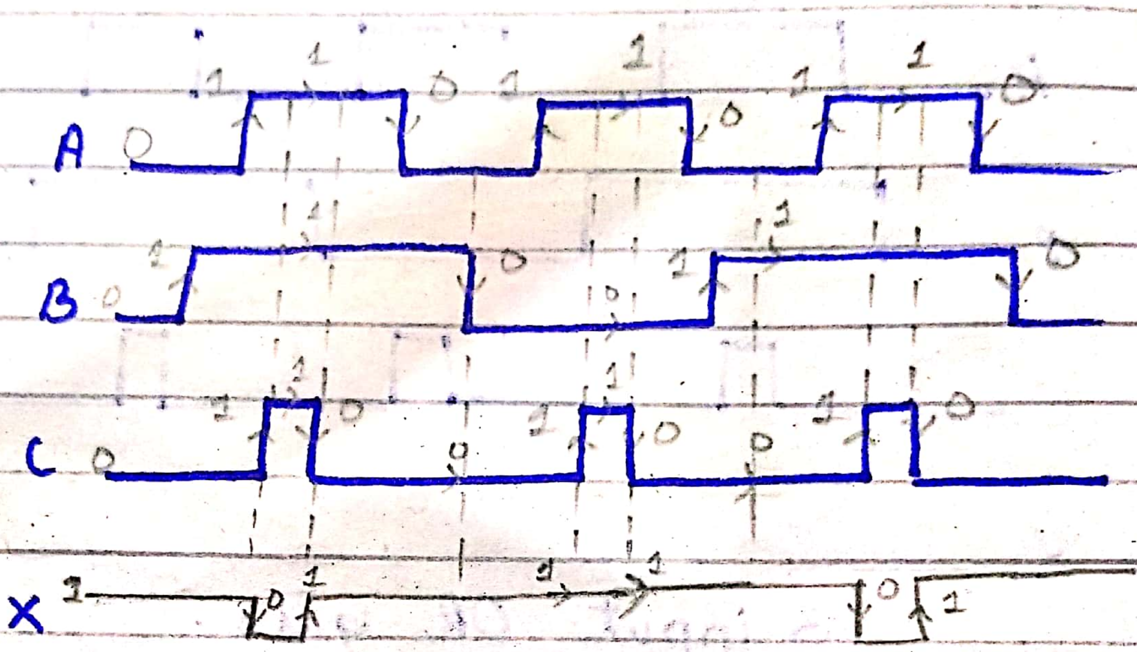


3 input OR Gate.

A	B	C	X
0	0	0	0
1	1	1	1
1	1	0	1
0	0	0	0
1	0	1	1
1	0	0	1
0	1	0	1
1	1	1	1
1	1	0	1
0	0	0	0

QUESTION: 7:

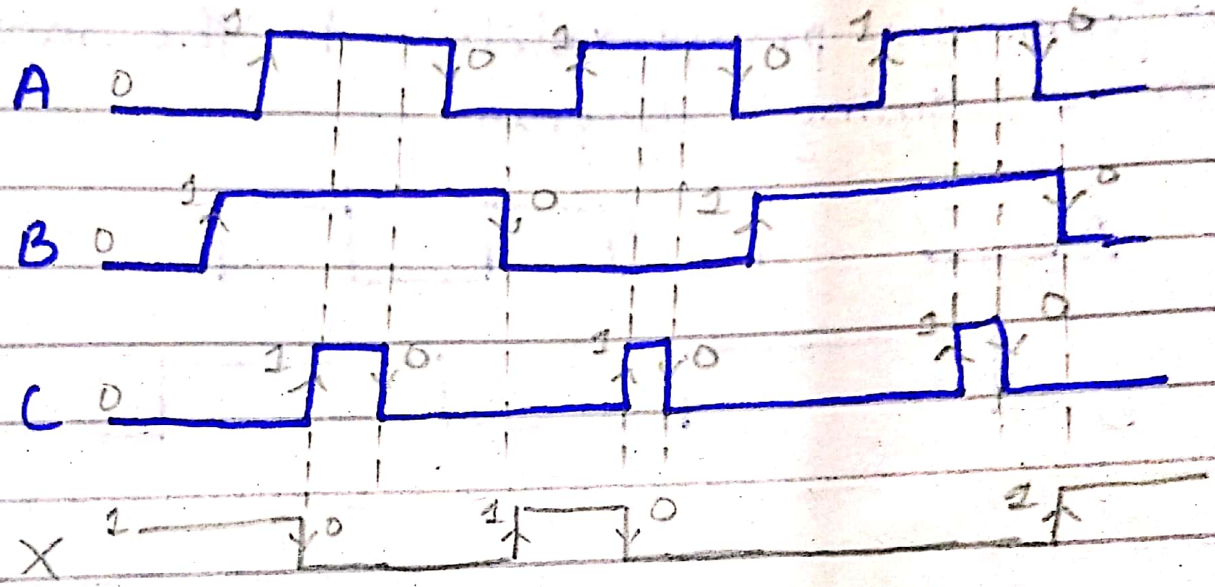
Repeat Q.5 for a 3-input NAND gate.



A	B	C	X.
0	0	0	1
1	1	1	0
1	1	0	1
0	0	0	1
1	0	1	1
1	0	0	1
0	1	0	1
1	1	1	0
1	1	0	1

QUESTION: 8:

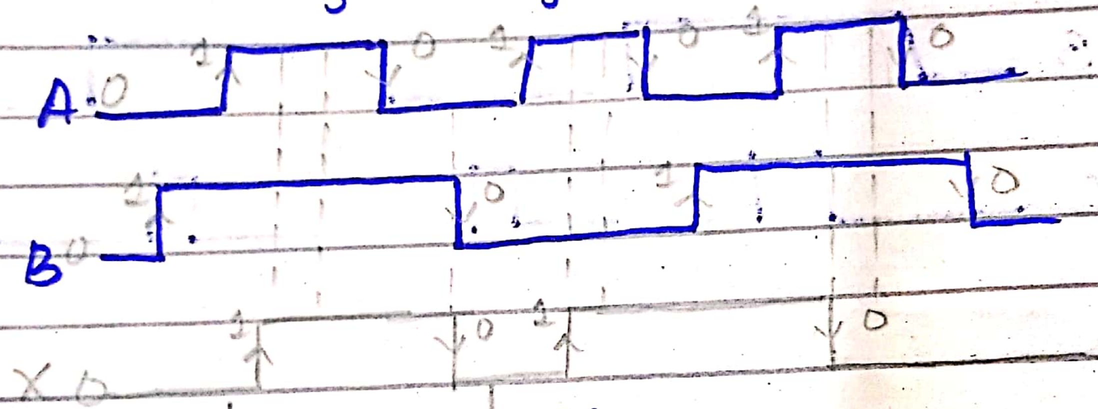
Repeat Q.5 for a 3-input NOR gate.



A	B	C	X
0	0	0	1
1	1	1	0
1	1	0	0
0	0	0	1
1	0	1	0
1	0	0	0
0	1	0	0
1	1	1	0
1	1	0	0
0	0	0	1

QUESTION: 9:

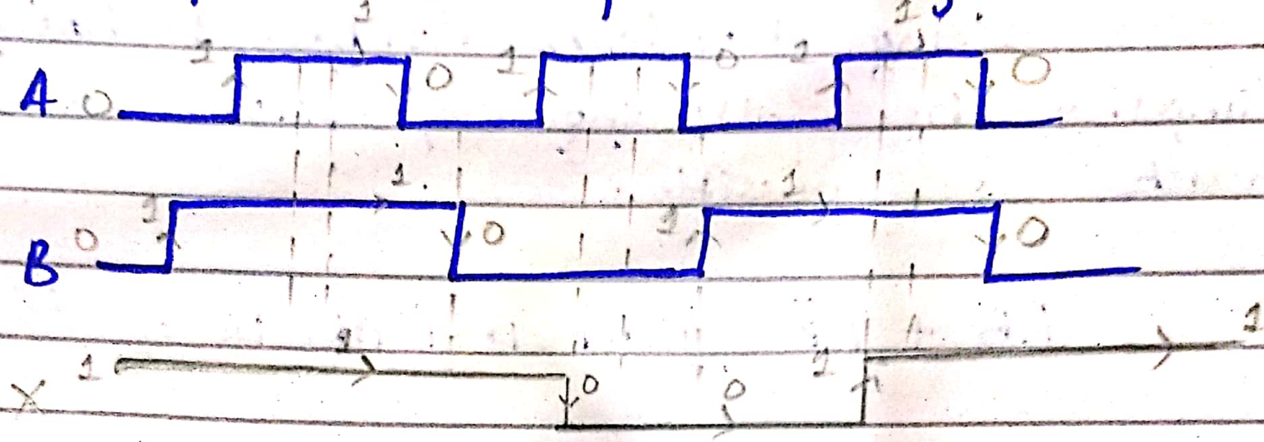
The input waveforms in Figure 2 is applied to a XOR gate. Show the output waveform in proper relation to the input with a timing diagram.



A	B	X
0	0	0
1	1	0
1	1	0
0	0	0
1	0	1
1	0	1
0	1	1
1	1	0
1	1	0
0	0	0

QUESTION : 10

Repeat Q:9 for XNOR gate.



A	B	X
0	0	1
1	1	1
1	1	1
0	0	1
1	0	0
0	1	0
1	1	1
1	1	1
0	0	1

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QUESTION: 11:

Using boolean algebra techniques. Simplify the following expressions as much as possible.

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

SOLUTION:-

Using boolean Algebra Rules:

$$\Rightarrow \underbrace{A\bar{B} + A\bar{B}C}_{(A + AB = A)} + A\bar{B}CD + A\bar{B}CDE.$$

$$\Rightarrow \underbrace{A\bar{B} + A\bar{B}CD}_{A + AB = A} + A\bar{B}CDE.$$

$$\Rightarrow \underbrace{AB + A\bar{B}CDE}_{A + AB = A}$$

$(A\bar{B})$ **Answer.**

*

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

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

$A+1 = 1$

$A\bar{B}(1)$

$(A\bar{B})$

QUESTION: 12:

Convert the following expressions into standard SOP form.

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

SOLUTION:-

First convert the given expression to SOP form:

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

Distributing:

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

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

Domain of this SOP is ACD.

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

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

Term DA and $D\bar{A}$ is missing C.

$\Rightarrow DA = DA(C+\bar{C}) = DAC + DA\bar{C}$

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

Hence Resulting SOP form is

$A + A = A$.

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

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

Answer.

QUESTION: 13.

Write Standard POS expression using Standard SOP expression from Q: 12.

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

SOLUTION:-

Evolution of the POS expression is
$(101) + (100) + (110) + (111)$.

* since there are three vertices in the domain of this expression, there are $2^3 = 8$ possible combinations. Four of which are contained by this expression the rest are:

000, 010, 011, 001.

hence the equivalent POS expression is

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

Answer.

QUESTION : 14 :

Draw a single truth for both standard POS and Standard SOP expressions 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	$(A+\bar{C}+D)$
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 Expressions:-

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

QUESTION : 15 :

· Use karnaugh map to simplify the following expressions to a minimum SOP form :

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

Answer :

$\bar{A}\bar{B}\bar{C}$	$\bar{A}BC$	$A\bar{B}C$	$AB\bar{C}$
000	011	101	110

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

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

QUESTION : 16 :

Obtain the minimum POS expression from the karnaugh map used in Q.15.

ANSWER :-

AB	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	→ $(A+B+C)$

(P.T.O)

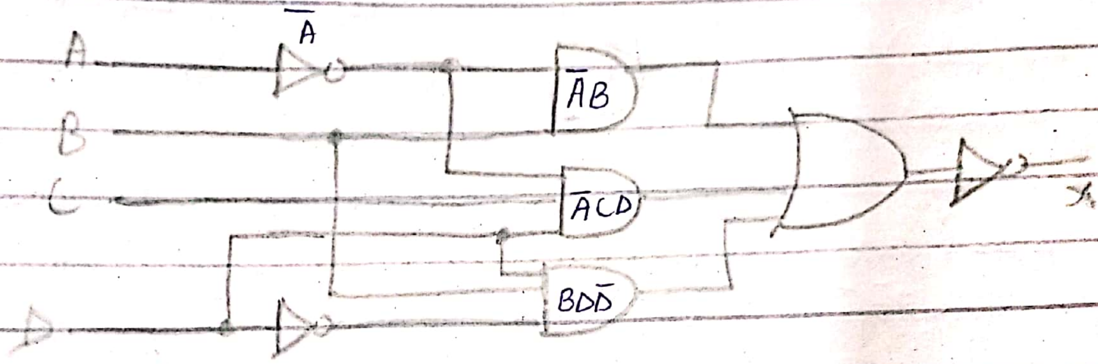
Hence.

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

is the maximum POS expression.

QUESTION: 17:

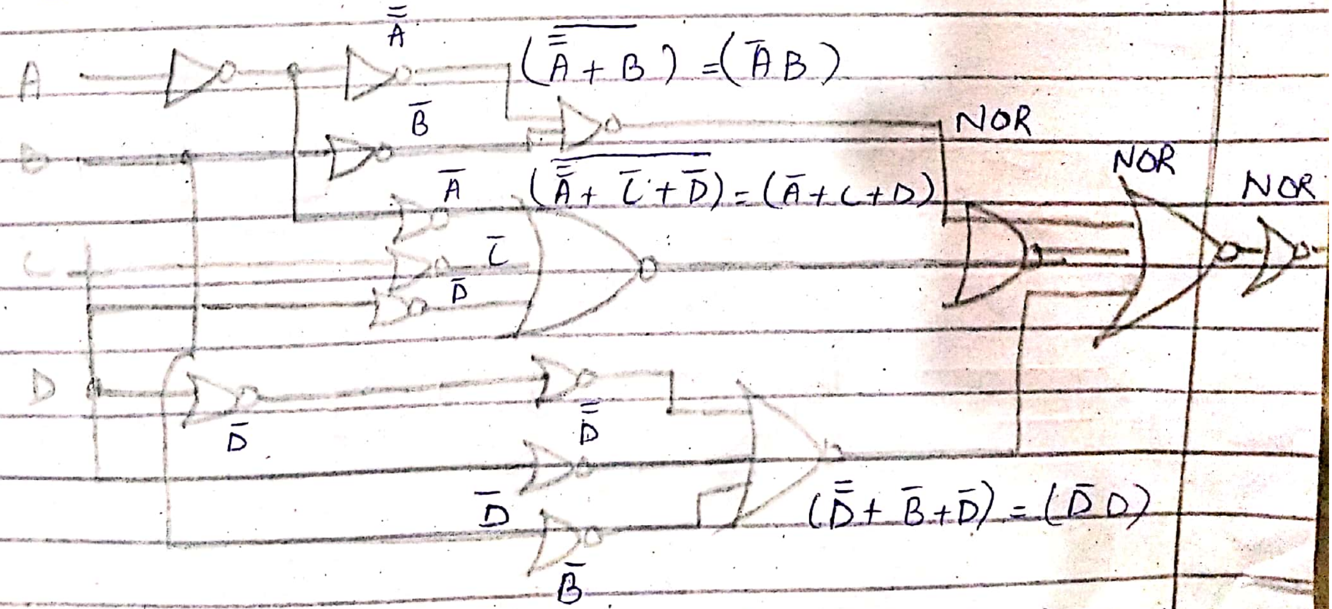
Write the output expression for circuit in Figure 3.



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

QUESTION: 18:-

Implement the logic circuits in Figure 3 using only NOR gates.



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

Answer.

QUESTION : 19 :-

Same as Q : 18 . Questions are same.

QUESTION : 20 :-

Implement a logic circuit for truth table in Table : 1.

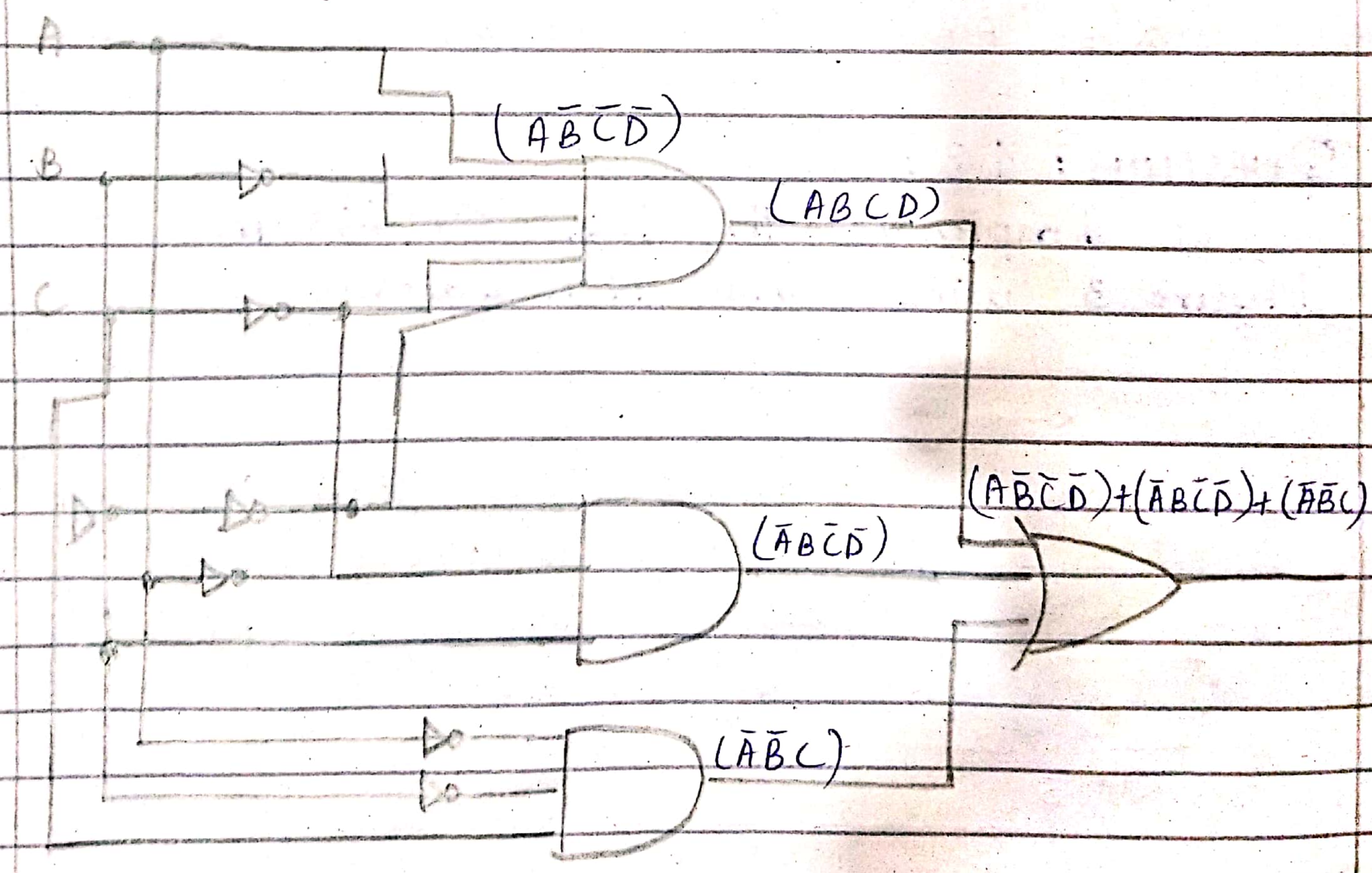
Sol :-

Obtained expression from truth table is

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

By reducing the expression using boolean laws and rules we get.

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



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