



**Programs: BC (CS), BS(SE), BS(TELC)**

**Subject: Digital Logic Design**

**Major Assignment Mid-Term**

**Course Code: CSC-201**

**EDP Code: 102007016**

**Summer Semester 2020**

**Q.1** Convert each of the following:

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

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

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

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

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

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

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

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

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

j.  $11111111_2 = \pm ( ? )_{10}$  hint: [use 2's complement form]

k.  $-12_{10} = ( ? )_2$  hint: [use 2's complement form] l.  $198 = ( ? )_{BCD}$

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

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

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

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

q.  $111000 = (?111000)_{Even\ parity}$

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Major Assignment Mid-Term.  
ID # 12938  
Subject : Digital Logic Design  
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Q1) Convert each of the following:

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

2		45	
2		22	- 1
2		11	- 0
2		5	- 1
2		2	- 1
2		1	- 0

Append  $45_{10} = 101101_2$

Now  $.25$

0		.25	
.		2	
0		5	
		2	
1		0	

$$0.25_{10} = 0.01_2$$

$$= 101101_2 + 0.01_2$$

$$= 101101.01_2$$

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

$$\text{weight: } 2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0 2^{-1} 2^{-2} 2^{-3} 2^{-4}$$

$$\text{Binary: } 10000000.1010$$

$$\begin{aligned} 10000000.1010 &= 2^7 + 2^{-1} + 2^{-3} \\ &= 128 + 0.5 + 0.125 \\ &= \boxed{128.625} \end{aligned}$$

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

$$\begin{aligned} 4D7F_{16} &= 4 \cdot 16^3 + 13 \cdot 16^2 + 7 \cdot 16^1 + 15 \cdot 16^0 \\ &= 16384 + 3328 + 112 + 15 \\ &= \boxed{19839_{10}} \end{aligned}$$

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

$$\frac{128}{16} = 8$$

$$\begin{aligned} 8/16 &= 0.5 \\ &= 0.5 \times 16 \\ &= 8 \end{aligned}$$

$$\boxed{128_{10} = (88)_{16}}$$

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

$$\begin{array}{cccc} & 3 & A & 6 & F \\ & \swarrow & | & | & \searrow \\ 0011 & & 1010 & & 0110 & & 1111 \end{array}$$

$$\boxed{3A6F_{16} = (0011101001101111)_2}$$

(3)

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

$$\begin{array}{cccc} 1100 & , & 0011 & , & 1110 & , & 0101 \\ \downarrow & & \downarrow & & \downarrow & & \downarrow \\ C & & 3 & & E & & 5 \end{array}$$

$$= (C3E5)_{16}$$

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

$$6173_8 = (6 \times 8^3) + (1 \times 8^2) + (7 \times 8) + (3 \times 8^0)$$

$$= (6 \times 512) + (1 \times 64) + (7 \times 8) + (3 \times 1)$$

$$= 3072 + 64 + 56 + 3$$

$$= 3195_{10}$$

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

$$169 \div 8 = 21.125 = 0.125 \times 8 = 1$$

$$21 \div 8 = 2.625 = 0.625 \times 8 = 5$$

$$2 \div 8 = 0.25 = 0.25 \times 8 = 2$$

$$251$$

$$169_{10} = (251)_8$$



(4)

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

$2A7D_{16} = (25175)_8$

j:  $11111111_2 = (?)_{10}$

finding weight :  $2^7 \ 2^6 \ 2^5 \ 2^4 \ 2^3 \ 2^2 \ 2^1 \ 2^0$

$1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1$

$= 2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0$

$= 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1$

$= (255)_{10}$

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

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

$-12_{10} = 0000000000001100$

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

1	9	8
0001	1001	1000

$198 = (0001 \ 1001 \ 1000)_{BCD}$

(5)

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

Answer

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

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

Answer

$$1001010_2 = (110111)_{Gray}$$

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

Answer

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

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

$$01000001 = (?)$$

Answer is (A)<sub>ASCII</sub>

$$Q: 111000 = (?)_{111000} \text{ Even parity}$$

Yes it is even parity number because it is divisible by 2 and its remainder = 0, when divided by 2

Q.2 Calculate each of the following:

- $01111111_2 - 00000111_2$  hint: [use 2's complement form]
- $01101010_2 \times 11110001_2$  hint: [use 2's complement form]
- $10001000_2 \div 00100010_2$  hint: [use 2's complement form]
- $6D_{16} - 3F_{16}$  hint: [use 2's complement form]
- $00010110_{BCD} + 0001\ 0101_{BCD} = (?)_{10}$  hint: [take care of invalid BCD code]

Q2) calculate each of following.

a.  $01111111_2 - 00000111_2$

$$\begin{array}{r} 01111111 \\ - 00000111 \\ \hline 01111000 \end{array}$$

b.  $01101010_2 \times 11110001_2$

$$\begin{array}{r} 01101010 \\ \times 11110001 \\ \hline 11000111001010_2 \end{array}$$

c.  $10001000_2 \div 00100010_2$

$$\begin{array}{r} 10001000 \quad \cancel{10001000} \quad \cancel{0010010} \\ \div 00100010 \\ \hline = 100_2 \end{array}$$

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

$\begin{array}{r} 6D_{16} \\ - 3F_{16} \\ \hline AC_{16} \end{array}$	<p>R.W</p> $D_{16} + F_{16} = 13_{10} + 15_{10} = 28_{10}$ $28_{10} - 16_{10} = 12_{10} = C_{16}$
---	---

$$= 6_{16} + 3_{16} + 1_{16}$$

$$= 6_{10} + 3_{10} + 1_{10}$$

$$= A$$

(7)

$$e_2 \quad 00010110_{BCD} + 00010101_{BCD} = (?)_{10}$$

$$\begin{array}{r} 0001 \quad 0110 \\ + 0001 \quad 0101 \\ \hline 0010 \quad 1011 \\ - 0110 \\ \hline 0011 \quad 0000 \end{array}$$

79

we have to add 6 (0110) to invalid code, carry 0001, to next -

$$00110000 = (?)_{10}$$

$$\begin{array}{r} 0011 \quad 0000 \\ \hline 3 \quad 1 \end{array}$$

$$\boxed{= (31)_{10}}$$

**Q.3** Apply CRC to the data bits  $11010011_2$  using the generator code  $1010_2$  to produce the transmitted CRC code.

**Answer:**

Binary form:  $11010011$  divided by  $1010$

$$x^7 + x^6 + x^4 + x + 1$$

$$x^3 + x$$



Binary form (added zeros): 11010011000 divided by 1010

Result is 11101001

Remainder is 010

Working is

11101001

-----

11010011000

1010

-----

1110011000

1010

-----

100011000

1010

-----

01011000

0000

-----

1011000

1010

-----

001000

0000

-----

01000

0000

-----

1000

1010

-----

010

Transmitted value is: 11010011010

**Q.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.

Q.5 The input waveforms in Figure 1 is applied to a 3-input AND gate. Show the output waveform in proper relation to the inputs with a timing diagram.

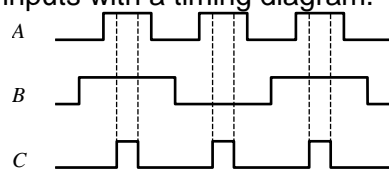
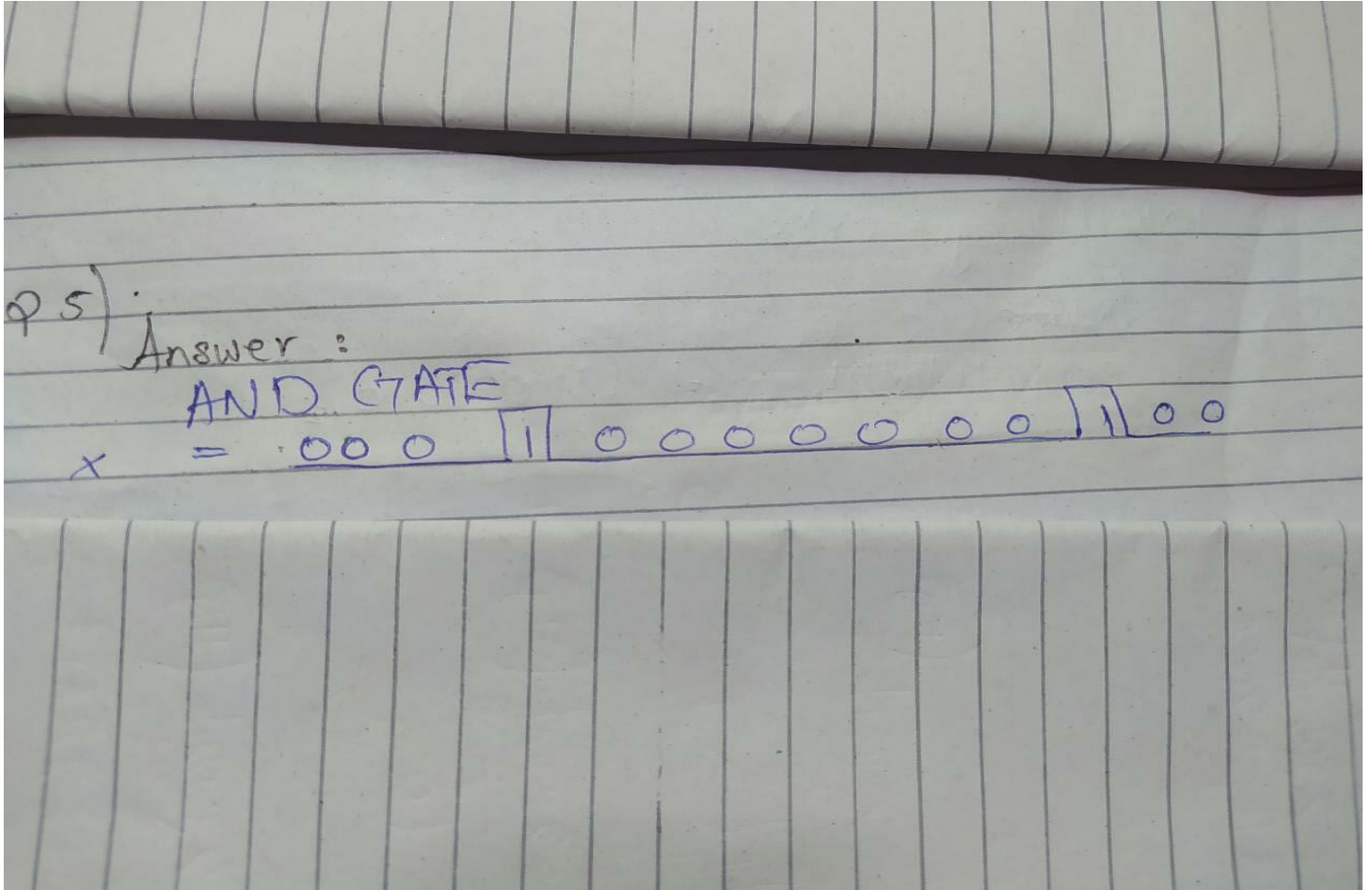
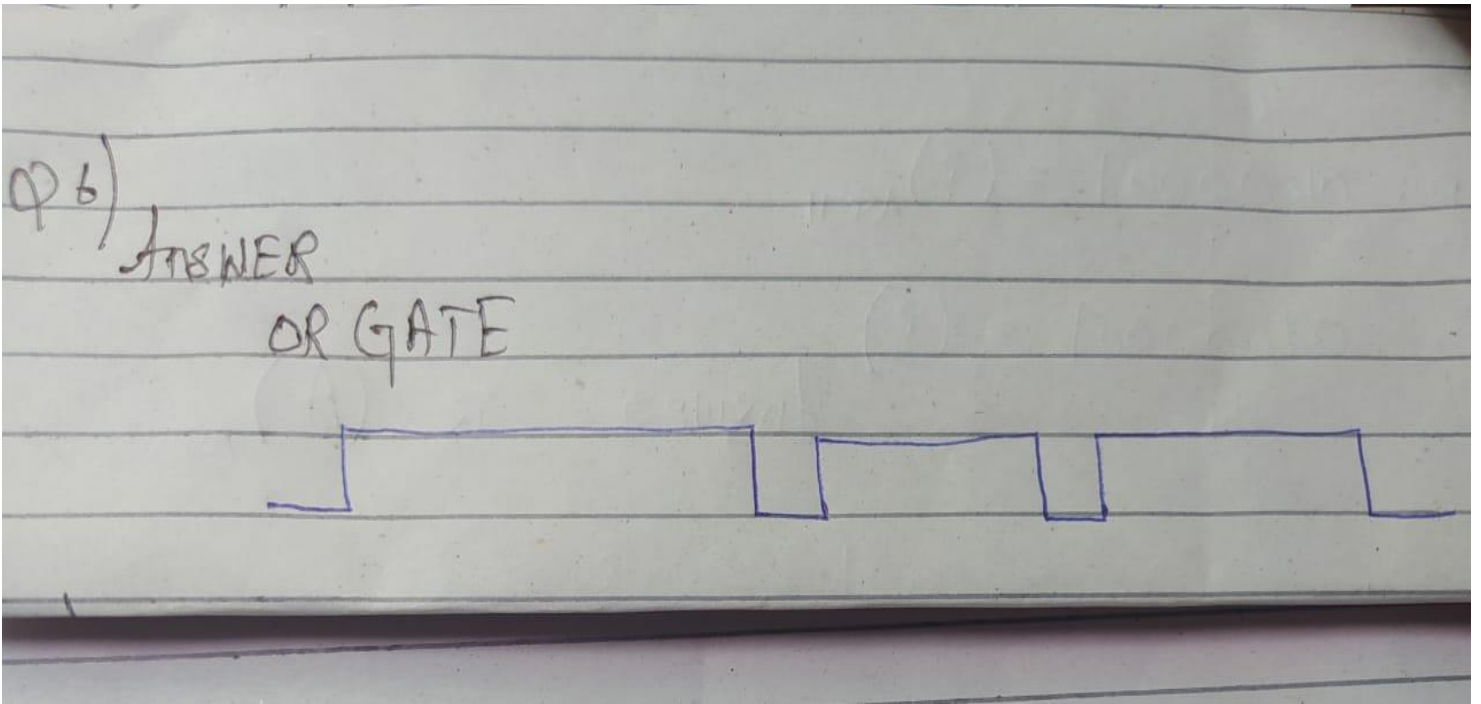


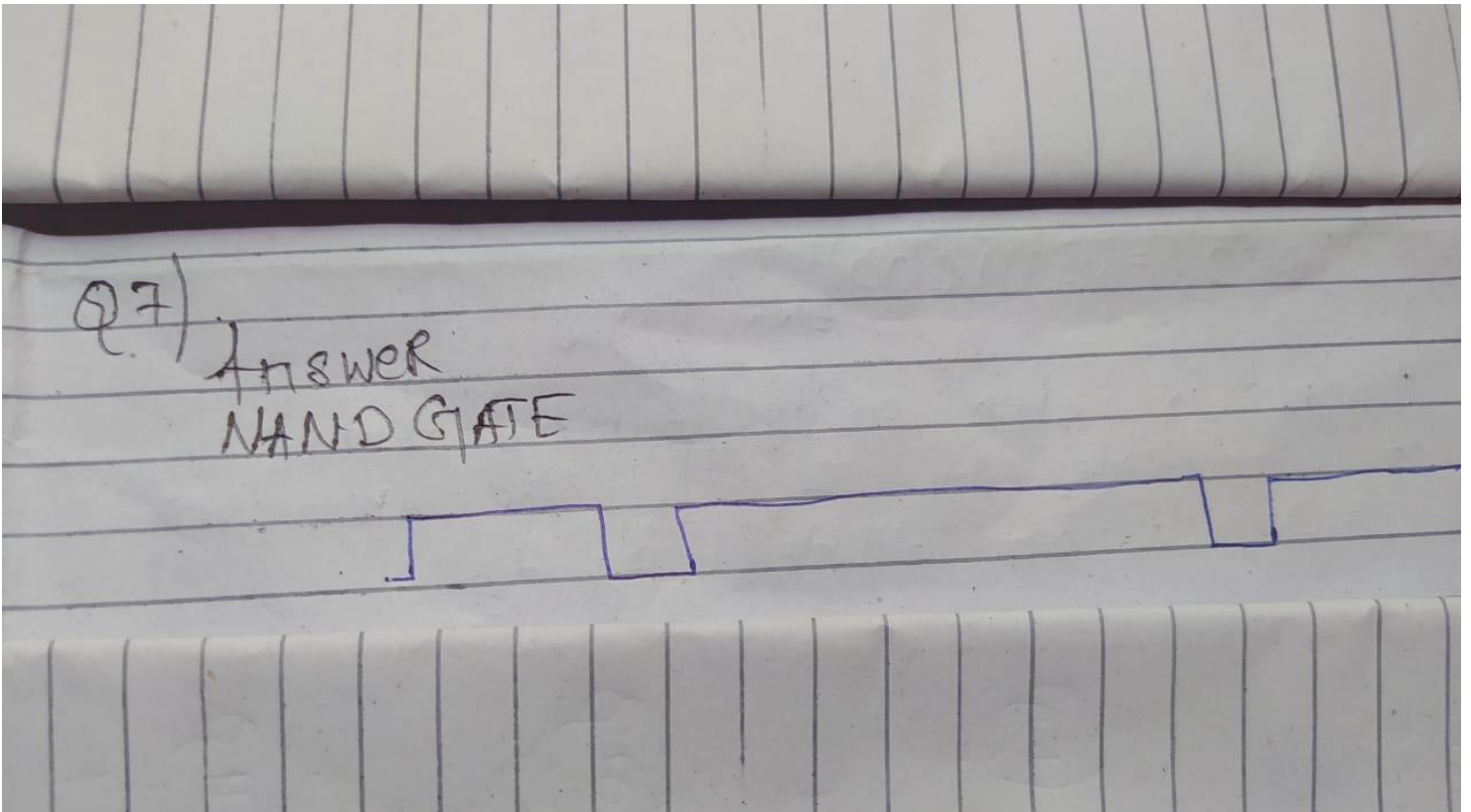
FIGURE 1



Q.6 Repeat Q.5 for a 3-input OR gate.



Q.7 Repeat Q.5 for a 3-input NAND gate.

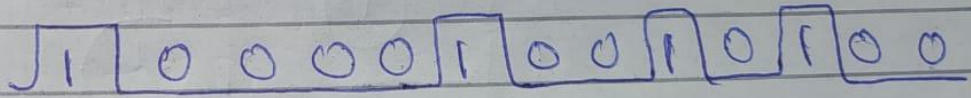




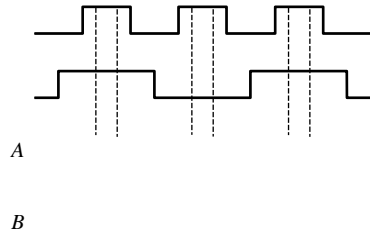
Q.8 Repeat Q.5 for a 3-input NOR gate.

(9)

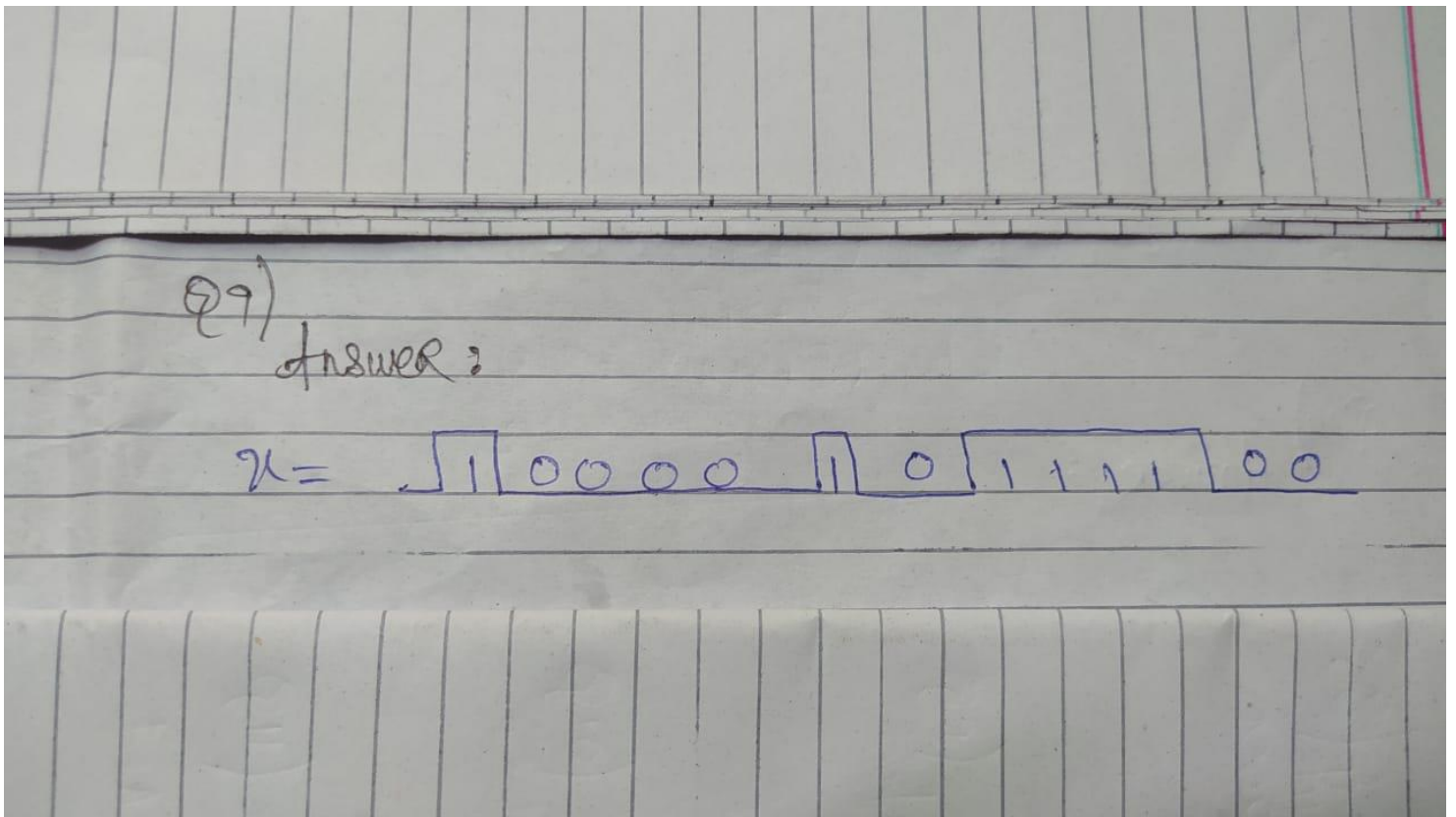
Q8) ANSWER:  
NOR-GATE

$x =$   A digital waveform diagram showing a sequence of bits: 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0. The bits are represented by rectangular pulses of varying heights and widths.

**Q.9** The input waveforms in Figure 2 is applied to a XOR gate. Show the output waveform in proper relation to the inputs with a timing diagram.



**FIGURE 2**



Q.10 Repeat Q.9 for XNOR gate.

Q10) Answer:

$x = 0 \ 1 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1$

Q.11 Using Boolean algebra techniques, simplify the following expressions as much as possible:

$$\overline{A}B + \overline{A}BC + \overline{A}BCD + \overline{A}BCDE$$

Q11) ANSWER:

$$(\overline{A}B) + \overline{A}BC + \overline{A}BCD + \overline{A}BCDE$$

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

$$= \overline{A}B\overline{C} + \overline{A}B\overline{C}C + \overline{A}B\overline{C}CD + \overline{A}B\overline{C}C\overline{D} + \overline{A}B\overline{C}CDE + \overline{A}B\overline{C}CDE\overline{E} + \overline{A}B\overline{C}CDE$$

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

$$= \overline{A}B\overline{C}D + \overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}D + \overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}DE + \overline{A}B\overline{C}D\overline{E} + \overline{A}B\overline{C}D\overline{E} + \overline{A}B\overline{C}D\overline{E} + \overline{A}B\overline{C}DE + \overline{A}B\overline{C}D\overline{E} + \overline{A}B\overline{C}D\overline{E} + \overline{A}B\overline{C}D\overline{E}$$

$$\overline{A}B\overline{C}D(E + \overline{E}) + \overline{A}B\overline{C}\overline{D}(E + \overline{E})$$



Q.12 Convert the following expressions to standard SOP forms:  $(C + D)(\bar{A} + \bar{D})$

$$\text{Q.12) } (C + D)(\bar{A} + \bar{D})$$

Solution :

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

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

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

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

Q.13 Write the standard POS expression using the standard SOP expression obtained in Q.12.

Q.13)

ANSWER:

$$\bar{A}CD + \bar{A}\bar{C}\bar{D} + ACD + \bar{A}\bar{C}D$$
$$011 \quad 010 \quad 111 \quad 001$$

There are 8 combinations  
The SOP expressions contains 4  
of these, so the POS must  
contain the other 4 which are

000, 100, 101, 110

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

Q.14 Draw a single truth for both the standard POS and standard SOP expression obtained in Q.12 and Q.13.

Q14) Answer

A	B	C	output	SOP/POS Expression
0	0	0	0	$(A+B+C)$
0	0	1	1	$\bar{A}\bar{B}C$
0	1	0	1	$\bar{A}B\bar{C}$
0	1	1	1	$\bar{A}BC$
1	0	0	0	$(\bar{A}+B+C)$
1	0	1	0	$(\bar{A}+B+\bar{C})$
1	1	0	0	$(A+B+\bar{C})$
1	1	1	1	$ABC$

Q.15 Use a Karnaugh map to simplify the following expression to a minimum SOP form:

$$\overline{A}\overline{B}\overline{C} + \overline{A}B\overline{C} + A\overline{B}\overline{C} + ABC$$

Q15)  
Answer:

		(10)	
		C	0
AB	0	0	1
0	0	0	1
0	1	1	1
1	1	1	1
1	0	1	1

=  $A\overline{B}\overline{C} + A\overline{B}C + \overline{A}B\overline{C} + \overline{A}B\overline{C}$

Q.16

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

Q16)  
Answer :

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



Q.17 Write the output expression for circuit in Figure 3.

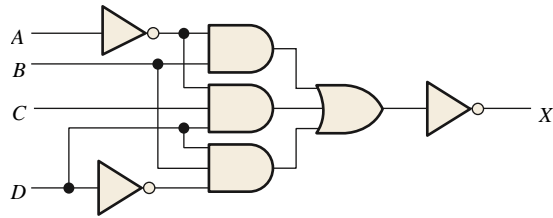
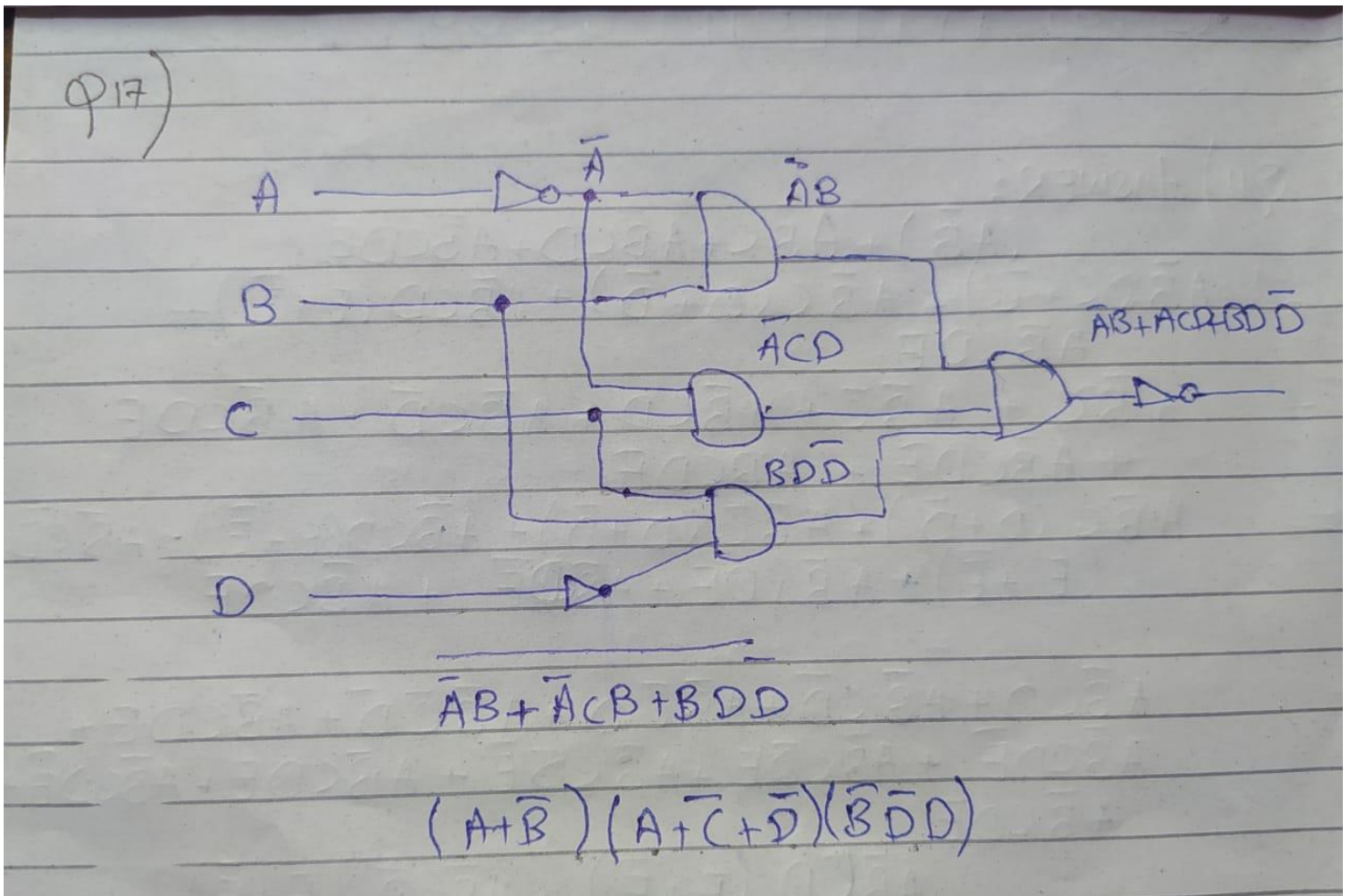


FIGURE 3



**Q.18** Implement a logic circuit for the truth table in Table 1.

**TABLE 1**

Inputs				Output
<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>X</i>
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1