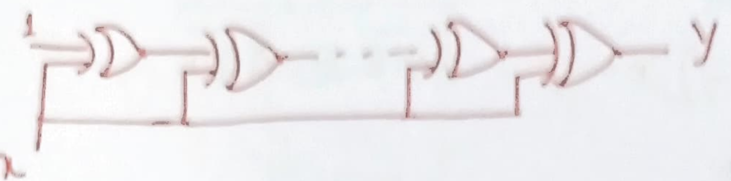
Sub:- COA

Solution of Assignment-3

Q.1



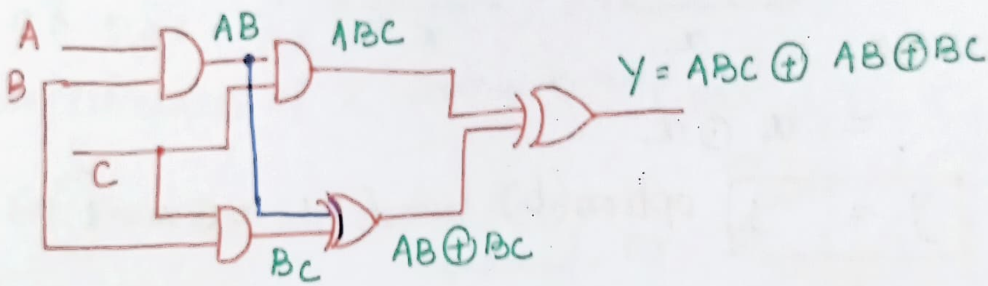
The output Y is of a circuit consisting of a cascade of 20 XOR gates.

Soln:-

The output(Y) of the digital circuit is

$\boxed{Y = 1}$ option (b) Ans

Q.2



Solution

$$Y = \underbrace{ABC}_{x} \oplus \underbrace{AB}_{y} \oplus BC$$

$$= x \oplus y \oplus BC$$

$$= (\bar{x}y + x\bar{y}) \oplus BC$$

$$= \left[(\overline{ABC})AB + ABC(\overline{AB})\right] \oplus BC$$

$$= \left[(\bar{A}+\bar{B}+\bar{C})AB + ABC(\bar{A}+\bar{B})\right] \oplus BC$$

$$= \left[\cancel{\bar{A}AB}^{0} + \cancel{\bar{B}AB}^{0} + AB\bar{C} + \cancel{ABC\bar{A}}^{0} + \cancel{ABC\bar{B}}^{0}\right] \oplus BC$$

$$= \underbrace{AB\bar{C}}_{x} \oplus \underbrace{BC}_{y}$$

$$= \bar{x}y + x\bar{y}$$

$$= (\overline{AB\bar{C}})BC + AB\bar{C}(\overline{BC})$$

$$= (\bar{A}+\bar{B}+C)BC + AB\bar{C}(\bar{B}+\bar{C}$$

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

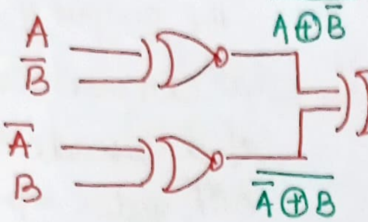
$$= BC + AB\bar{C}$$

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

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

$$\boxed{= B(A+C)}$$ option (c) Ans

Q.3 The output of the circuit



$Y = \overline{\overline{A \oplus \bar{B}} \oplus \overline{\bar{A} \oplus B}}$

Solution

$$y = \overline{\overline{A \oplus \bar{B}} \oplus \overline{\bar{A} \oplus B}}$$

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

$$= \underbrace{(\bar{A}B + A\bar{B})}_{x} \odot \underbrace{(A\bar{B} + \bar{A}B)}_{x} \quad \left[\because A \odot \bar{B} = \bar{A}\bar{\bar{B}} + A\bar{B} = \bar{A}B + A\bar{B}\right]$$

$$= x \odot x$$

$\boxed{y = 1}$ option (b) $\qquad (\because x \odot x = 1)$

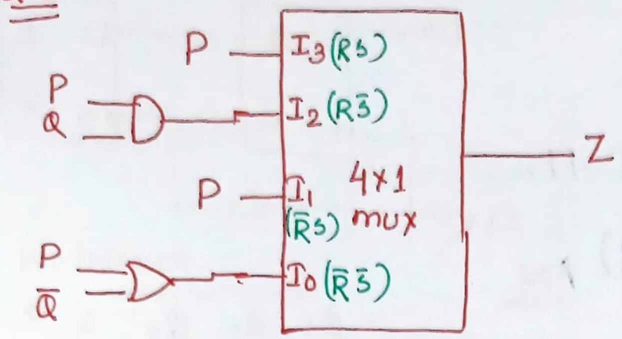
Q.4

1	0	0	1
0	d	0	0
0	0	d	1
1	0	0	1

The number of product terms in the minimized SOP expression $\boxed{= 2 \text{ option (a)}}$.

Total No of product term = 3
out of which 1 is redundant (highlighted in black)
term can be eliminated

Q.5



For 4×1 mux

R	S	Z
0	0	I_0 $(P+\bar{Q})$
0	1	I_1 (P)
1	0	I_2 (PQ)
1	1	I_3 (P)

$$Z = \bar{R}\bar{S} I_0 + \bar{R}S I_1 + R\bar{S} I_2 + RS I_3$$

$$= \bar{R}\bar{S}(P+\bar{Q}) + \bar{R}SP + R\bar{S}PQ + RSP$$

$$= P\bar{R}\bar{S} + \bar{Q}\bar{R}\bar{S} + P\bar{R}S + PQR\bar{S} + PRS$$

Simplification of Z using K-map

PQ \ RS	00	01	11	10	
00	1				$\bar{P}\bar{Q}$
01					$\bar{P}Q$
11	1	1	1	1	PQ G1
10	1	1	1		$P\bar{Q}$
	$\bar{R}\bar{S}$	$\bar{R}S$	RS	$R\bar{S}$	

G3, G2

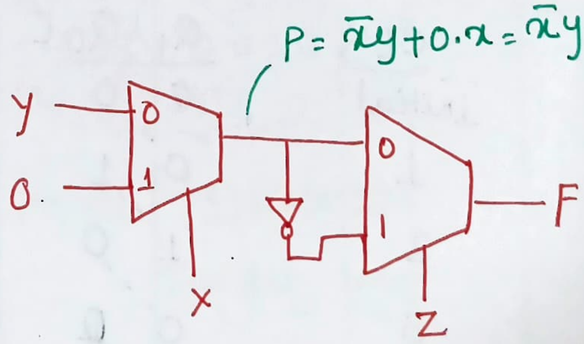
~~For~~ From G1, the product term obtained $= PQ$

G2, the product term $= P\bar{Q}S$

G3, the product term $= \bar{Q}\bar{R}\bar{S}$

So, $\boxed{Z = PQ + P\bar{Q}S + \bar{Q}\bar{R}\bar{S}}$, option (A) Ans

Q.6



$F = \bar{Z}P + Z\bar{P}$

The Boolean expression F is

$$F = \bar{z}P + z\bar{P}$$

$$= \bar{z}\,\bar{x}y + z\,\overline{\bar{x}y}$$

$$= \bar{x}y\bar{z} + z(x+\bar{y})$$

$$\boxed{F = \bar{x}y\bar{z} + xz + \bar{y}z}$$

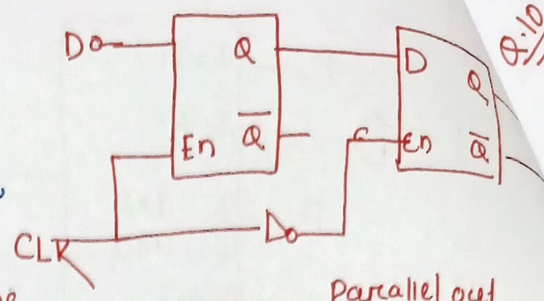
option (b) Ans

Q.7

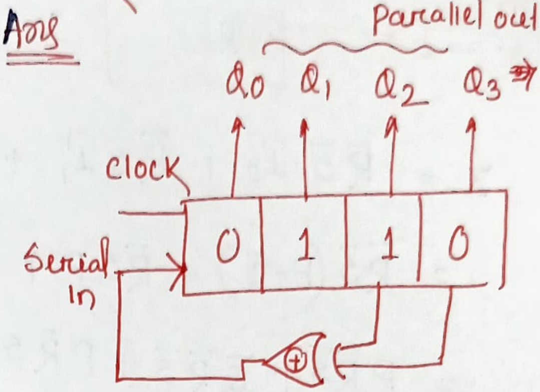
Solution

Master-slave D-FF.

option-(d) **Ans**



Q.8



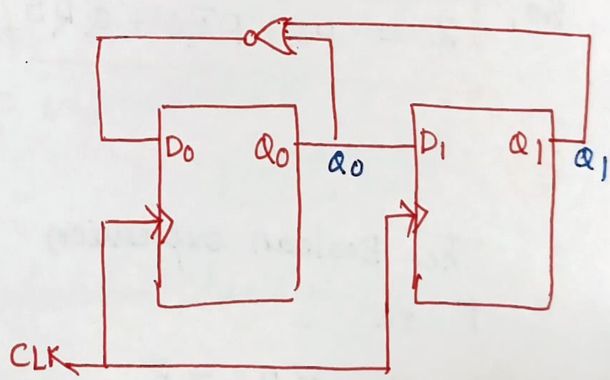
CLK	Q_0	Q_1	Q_2	Q_3
Initial	0	1	1	0
1	1	0	1	1
2	0	1	0	1
3	1	0	1	0

3rd clock pulse

option (c) **Ans**

Q.9

$Q_0 = D_0 = Q_0 \odot Q_1$



CLK	Q_1	Q_0
Initial	0	0
1	0	1
2	1	0
3	0	0
4	0	1
5	...	...

The sequence of output $(Q_1 Q_0)$ – 00, 01, 10, 00, 01 .....

option (b) **Ans**

Q.10 Briefly explain the representation: Sign-magnitude, twos complement & Biased.

Solution:- Refer Theory (Table 10.2, page no-355, 356, 357)

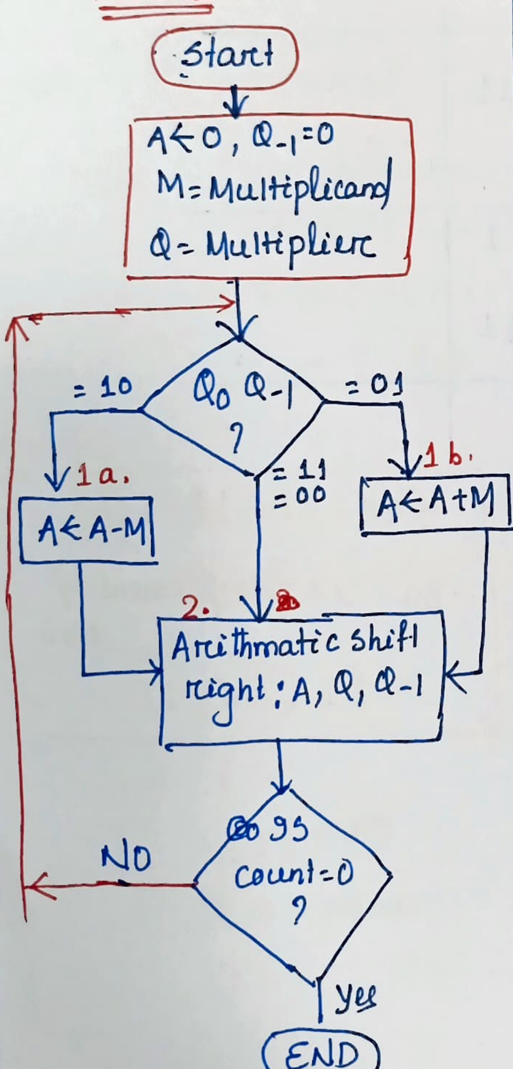
Q.11 $x = 0101$ and $y = 1010$ in two's complement notation ($x = +5$, $y = -6$)

(a) compute the product $P = x * y$ using Booth's algorithm.

Solution

$\boxed{A = 0000, \quad Q = 1010 \quad M = 0101}$

- Flow chart



Count	Steps	A	Q	Q-1	M	
C=4	Initialization	0000	1010	0	0101	$Q_0 Q_{-1} = 00$
C=3	2.	0000	0101	0	0101	$Q_0 Q_{-1} = 10$
C=2	1a. 2.	1011 1101	0101 1010	0 1	0101 0101	$Q_0 Q_{-1} = 01$
C=1	1b. 2.	0010 0001	1010 0101	1 0	0101 0101	
C=0	1a. 2	1100 1110	0101 0010	0 1	0101 0101	

END (since C=0)

Product = 11100010

$= -30_D$ Ans

b. Compute the product of $P = -x * -y$ using Booth's algorithm.

Solution

$x = 0101$

$-x =$ 2's compl of $x = 1011$ (M)

$y = 1010$, $-y = 0110$ (Q)

Count	Step	A	Q	Q_{-1}	M	
C=4	Initialization	0000	0110	0	1011	$Q_0 Q_{-1} = 00$
C=3	2.	0000	0011	0	1011	$Q_0 Q_{-1} = 10$
C=2	1a.	0101	0011	0	1011	$Q_0 Q_{-1} = 11$
	2	0010	1001	1	1011	
C=1	2.	0001	0100	1	1011	$Q_0 Q_{-1} = 01$
C=0	1b.	1100	0100	1	1011	
	2.	1110	0010	0	1011	

END

Product = 111|00010

= −30 Ans

+30 = 00011110

−30 = 2's complement of +30

= 11100010

10

12. Show the calculation of the following (assuming 8-bit twos complement representation)

ⓐ 6+13

+6 - 00000110
+13 - 00001101
10011 ⇒ +19 Ans

ⓑ -6+13

+6 = 0000110
-6 = 11111010
+13 = 00001101
~~1~~00000111 = +7 Ans

ⓒ 6-13
= 6+(-13)

+6 = 00000110
+13 = 00001101
-13 = 11110011
+6 = 00000110
11111001

= -(2's complement of the result (11111001))
= -(00000111)
= -7 Ans

ⓓ ~~+6 = 0000~~

-6 = 11111010
+ -13 = 11110011
1 11101101
+ 1
11101110

= -(2's complement of the result (11101110))
= -(00010011)
= -19 Ans

13 Perform the following difference using 2's complement method.

ⓐ 111000
-110011

Soln

111000
+ 2's complement of 110011

= 111000
+ 001101
~~1~~000101 - Ans

Discard the carry

(b) 11001100 − 101110 = 11001100 + (−(101110))

Soln

- Both the numbers should be equal length (bits)

So 2nd number = 00101110

- 2's complement of 2nd no. = 11010010

\+ 1's number = +11001100

(1) 10011110

Discard the carry

Ans is 10011110

(d) 11000011 − 11101000 ⇒ 11000011 − Minuend

+(−(11101000)) − Subtrahend

- 2's complement of Subtrahend = 00011000

\+ minuend = 11000011

= 11010011

Since carry is not generated, so ans is negative & it is in the 2's complement form

So Ans = − (2's complement of 11010011)

= − (00101101) Ans

Q. 14 Express the following numbers in IEEE 32-bit floating-point format.

ⓐ 2.5

Soln

Step 1:- Determine the sign bit

(S) Sign bit = 0 (∵ +ve number)

Step 2:- Convert to pure binary

$(2.5)_{10} = (10.1)_2$

Step 3:- Represent the number using scientific notation i.e. $(-1)^S * S * 2^{\text{Exponent}}$

$+2.5 = (-1)^0 * 10.1 * 2^0$ $\left[\begin{array}{l} \because S = 0 \\ S = 10.1 \end{array}\right]$

Step 4:- Represent the number using normalized scientific notation [normalized scientific notation - there should be one and only one nonzero element/bit before the radix point. Accordingly radix point is shifted towards left/right]

$+2.5 = (-1)^0 * \underbrace{1.01}_{\text{Mantissa}} * 2^1$

Step 5:- Determine the biased exponent.

$(-1)^0 * 1.01 * 2^{1}$ ← 1 – True exponent

True exponent = Biased exponent - 127 (bias)

⇒ Biased exponent = True exponent + 127

= 1 + 127 = 128_{10}

Binary representation of Biased exponent is

$(128)_{10} = (10000000)_2$

Step 6 :- Determine the significand field by removing the leading 1 from the mantissa.

Significand / fraction = 01

~~The~~

Step 7 :- The IEEE 754 32-bit format is

← 1 bit →	← ~~Biased exp~~ 8-bits →	← 23-bits →
Sign field	Biased exponent	Fraction / Significand

← 32-bits →

← 32-bits →

0 | 1000000000 | 01000000000000000000000

In hexadecimal :- 40100000_H

$(-1/32)$

Solution

1. Sign bit = $\cancel{s}$ = 1 (-ve number)

2. Binary representation

$$\frac{1}{32} = \frac{1}{2^5} = (0.00001)_2$$

3. Represent in scientific notation

$$(-1)^s * S * 2^E$$

$$= (-1)^s * (1+F) * 2^E$$

$$= (-1)^1 * 0.00001 * 2^0$$

4. Represent in normalized scientific notation

$$(-1)^1 * 1.0 * 2^{-5}$$

5. Determination Biased exponent

Biased exponent $= -5 + 127$
$= 122_{10}$

& in Binary $= (01111010)_2$

6. Determination of significand

Significand/fraction = 0

7. The IEEE 32-bit format

← 1bit →	← 8-bit →	← 23bit →
Sign	Biased exponent	Fraction
1	01111010	00000000000000000000000

← 32-bits →

Q.15 The following numbers use the IEEE 32-bit format. What is equivalent decimal value?

Sol: 1 10010010 01000000000000000000000

Solution

Step 1:- Identify the 3 fields from the given 32-bit format.

1-bit	8-bits	23-bits
1	10010010	01000000000000000000000

Step 2:- Determine the values of 3 fields (sign, Biased exponent & Fraction)

- Sign bit = S = 1
- Biased exponent in binary = 10010010
- Biased exponent in decimal = 146_D
- Fraction = 01

Step 3:- Substitute these values in the normalized Scientific notation

$$(-1)^{S} \times (1+F) * 2^{\text{Biased exponent} - 127}$$

$$= (-1)^1 * (1+0.01) * 2^{146-127}$$

$$= (-1)^1 * 1.01 * 2^{19}$$

$$= -(10.10000000)_2 * 2^{10}$$

$$= -640 \times 2^{10}$$ Ans