

Q1

$$\begin{array}{r}
 a) \quad A = 1001 \ 0111 \\
 \quad \quad B = 0111 \ 0110 \\
 \hline
 0001 \ 0000 \ 1101 \\
 \quad \quad 0110 \ 0110 \quad +6 \\
 \hline
 0001 \ 0111 \ 0011
 \end{array}$$

b) $n=9$ $B=13$

$$\begin{array}{r}
 4 \ 1 \\
 2 \ 0 \\
 1 \ 0 \\
 0 \ 1 \\
 A_2 = 01001 \\
 \uparrow \\
 \text{sign bit}
 \end{array}$$

$$\begin{array}{r}
 6 \ 1 \\
 3 \ 0 \\
 1 \ 1 \\
 0 \ 1 \\
 B_2 = 01101 \\
 \uparrow \\
 \text{sign bit}
 \end{array}$$

A-B
2's complement of B

$$\begin{array}{r}
 10010 \\
 \underline{1} \\
 10011 \leftarrow -B
 \end{array}$$

$$\begin{array}{r}
 01001 \\
 \underline{10011} \\
 11100 \\
 \uparrow \\
 \text{Sign -ve}
 \end{array}$$

$$= 00100 = -4$$

$$\begin{aligned}
 Q2 \ a) \quad & \overline{A}\overline{B}\overline{C} + \overline{A}C\overline{D} + A\overline{B}C\overline{D} + A\overline{B}\overline{C} \\
 & \overline{B}\overline{C}(\overline{A}+A) + \overline{A}C\overline{D} + A\overline{B}C\overline{D} \\
 & \overline{B}\overline{C} + \overline{A}C\overline{D} + A\overline{B}C\overline{D} \\
 & \overline{B}(\overline{C} + A\overline{C}\overline{D}) + \overline{A}C\overline{D} \\
 & \overline{B}(\overline{C} + A\overline{D}) + \overline{A}C\overline{D} \\
 & \overline{B}\overline{C} + A\overline{B}\overline{D} + \overline{A}C\overline{D}
 \end{aligned}$$

Q2 b



$$\text{Delay } D = 15 + 20 + 15 = 50 \text{ ns}$$

$$\text{Frequency} = f = \frac{1}{D} = \frac{10^9}{50} = 20 \text{ MHz}$$

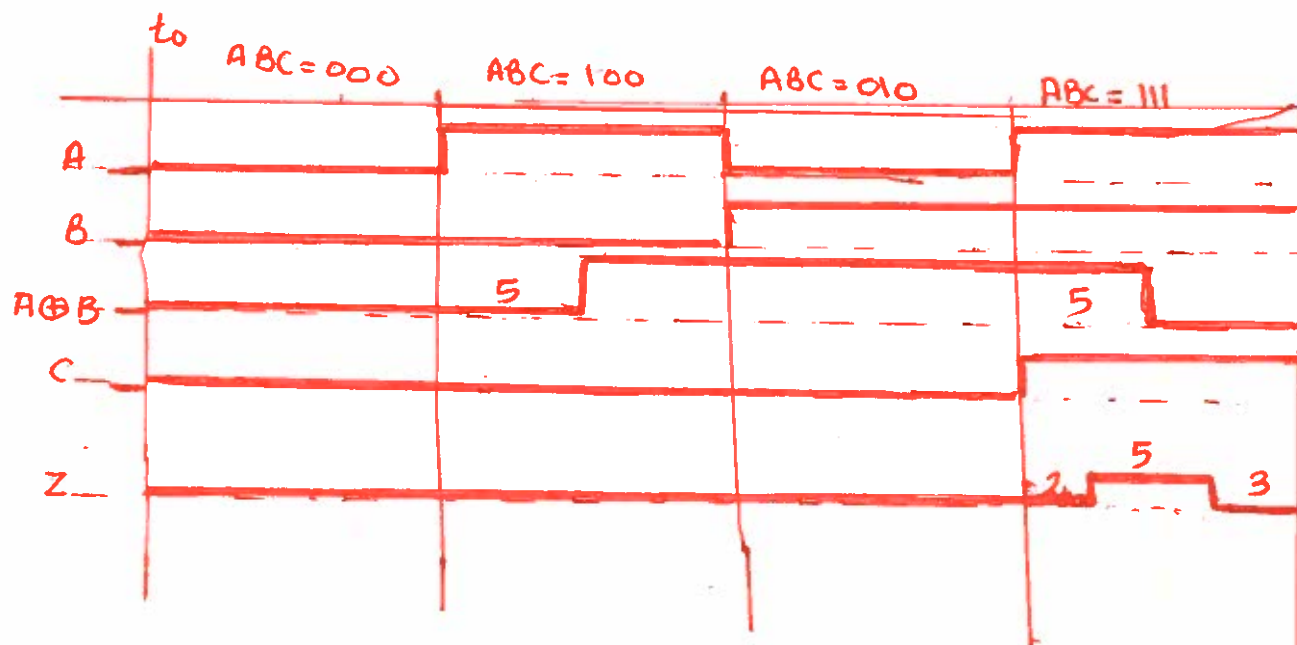
$$\begin{aligned}
 Q2 \ c) \quad F &= (\overline{a}\overline{b} \oplus \overline{c}\overline{d}) + d \\
 &= \overline{a}\overline{b} \cdot \overline{c}\overline{d} + \overline{a}\overline{b} \cdot c\overline{d} + \overline{a}b \cdot \overline{c}\overline{d} + \overline{a}b \cdot c\overline{d} + d \\
 &= (\overline{a} + \overline{b})\overline{c}\overline{d} + \overline{a}\overline{b}(\overline{c}\overline{d} + c\overline{d}) \\
 &= \overline{a}\overline{c}\overline{d} + \overline{b}\overline{c}\overline{d} + \overline{a}\overline{b}\overline{c} + \overline{a}\overline{b}c + d \\
 &= \overline{a}\overline{c}\overline{d} + \overline{b}\overline{c}\overline{d} + \overline{a} \\
 &= \overline{c}\overline{d} + \overline{b}\overline{c}\overline{d} + \overline{a} \\
 &= \overline{a} + \overline{c}\overline{d}
 \end{aligned}$$



$$\text{Delay} = 12 + 15 = 27 \text{ ns}$$

$$\text{Frequency} = \frac{1}{27 \text{ ns}} = \frac{10^9}{27} \approx 37 \text{ MHz}$$

Q3



Critical Path 7ms. Timing Period selected 10ms

Q4

a)

cd \ ab	00	01	11	10
00	X	4	12	8 X
01	1	5	13	9
11	3	7	15	11
10	2	6	14	10 X

$$PI1 \text{ } \Sigma M(4, 6, 12, 14) + d(0, 2, 8, 9) = d \text{ EPI}$$

$$PI2 \text{ } \Sigma M(0, 9) + d(0, 8) = (b+c) \text{ EPI}$$

$$PI3 \text{ } \Sigma M(6, 7, 15) + d(14) = (\bar{b} + \bar{c})$$

$$F(a, b, c, d) = d(b+c)(\bar{b} + \bar{c}) \text{ --- Equ 1}$$

b) From K-map

$$PI1 = \Sigma m(5, 13) = b\bar{c}d \text{ EPI}$$

$$PI2 = \Sigma m(3, 11) = \bar{b}cd \text{ EPI}$$

$$F = b\bar{c}d + \bar{b}cd$$

$$F = \overline{\overline{b\bar{c}d + \bar{b}cd}} = \overline{\overline{b\bar{c}d} \cdot \overline{\bar{b}cd}}$$



c) Equ. 1 = $d(b+c)(\bar{b} + \bar{c})$

$$F = \overline{\overline{d(b+c)(\bar{b} + \bar{c})}}$$

$$F = \overline{d + (\bar{b} + \bar{c}) + (\bar{b} + \bar{c})}$$

