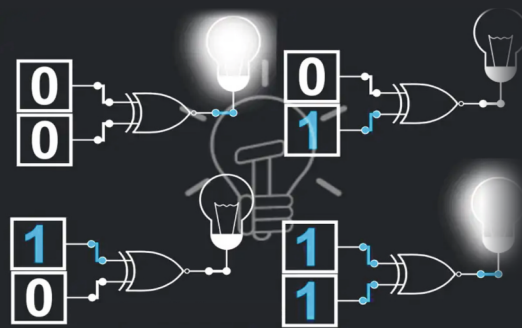




GATE | PSUs



Computer Science & Information Technology

DIGITAL LOGIC

Text Book: Theory with worked out Examples and Practice Questions

Digital Logic

(Solutions for Text Book Practice Questions)

Chapter

1

Number Systems

01. Ans: (d)

Sol: $135_x + 144_x = 323_x$

$$(1 \times x^2 + 3 \times x^1 + 5 \times x^0) + (1 \times x^2 + 4 \times x^1 + 4 \times x^0) = 3x^2 + 2x^1 + 3x^0$$

$$\Rightarrow x^2 + 3x + 5 + x^2 + 4x + 4 = 3x^2 + 2x + 3$$

$$x^2 - 5x - 6 = 0$$

$$(x-6)(x+1) = 0 \quad (\text{Base cannot be negative})$$

Hence $x = 6$.

(OR)

As per the given number x must be greater than 5. Let us consider $x = 6$

$$(135)_6 = (59)_{10}$$

$$(144)_6 = (64)_{10}$$

$$(323)_6 = (123)_{10}$$

$$(59)_{10} + (64)_{10} = (123)_{10}$$

So that $x = 6$

02. Ans: (a)

Sol: 8-bit representation of

$$+127_{10} = 01111111_{(2)}$$

1's complement representation of

$$-127 = 10000000.$$

2's complement representation of

$$-127 = 10000001.$$

No. of 1's in 2's complement of

$$-127 = m = 2$$

No. of 1's in 1's complement of

$$-127 = n = 1$$

$$\therefore m : n = 2 : 1$$

03. Ans: (b) & (d)

Sol: $(14)_{10} = (1110)_2$

$$+14 = 01110$$

$$-14 = 10010$$

Using sign extension

$$-14 = 11110010$$

04. Ans: (c)

Sol: Binary representation of $+(539)_{10}$:

$$\begin{array}{r} 2 \overline{) 539} \\ \underline{2 \ 269} \ -1 \\ 2 \overline{) 134} \ -1 \\ 2 \overline{) 67} \ -0 \\ 2 \overline{) 33} \ -1 \\ 2 \overline{) 16} \ -1 \\ 2 \overline{) 8} \ -0 \\ 2 \overline{) 4} \ -0 \\ 2 \overline{) 2} \ -0 \\ 1 \ -0 \end{array}$$

$$(+539)_{10} = (1000011011)_2$$

$$= (00100 \ 0011011)_2$$

2's complement $\rightarrow 110111100101$

Hexadecimal equivalent $\rightarrow (DE5)_H$

05. Ans: 5

Sol: Symbols used in this equation are 0, 1, 2, 3.

Hence base or radix can be 4 or higher

$$(312)_x = (20)_x (13.1)_x$$

$$3x^2 + 1x + 2x^0 = (2x+0)(x+3x^0+x^{-1})$$

$$3x^2 + x + 2 = (2x) \left(x + 3 + \frac{1}{x} \right)$$

$$3x^2 + x + 2 = 2x^2 + 6x + 2$$

$$x^2 - 5x = 0 \Rightarrow x(x-5) = 0$$

$$x = 0 \text{ (or) } x = 5$$

x must be $x > 3$, So $x = 5$

06. Ans: 3 possible solutions

Sol: $123_5 = x8_y$

$$1 \times 5^2 + 2 \times 5^1 + 3 \times 5^0 = x.y^1 + 8 \times y^0$$

$$25 + 10 + 3 = xy + 8$$

$$\therefore xy = 30$$

Possible solutions:

i. $x = 1, y = 30$

ii. $x = 2, y = 15$

iii. $x = 3, y = 10$

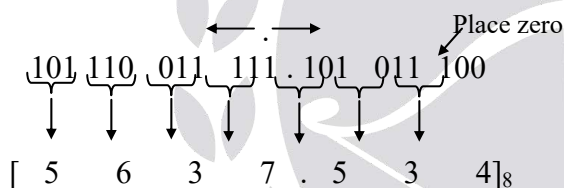
3 possible solutions

07. Ans: (b) & (d)

Sol: $[B9FAE]_{16}$

$$= [1011\ 1001\ 1111\ .\ 1010\ 1110]_2$$

Now make 3 bits as single group



08. Ans: (c)

Sol: (a) $68 = 150$

001	10 1	000
1	5	0

(b) $8C = 214$

010	00 1	100
2	1	4

(c) $4F = 117$

001	00 1	111
1	1	7

(d) $5D = 135$

001	01 1	101
1	3	5

09. Ans: (b)

Sol: (a)

$$\begin{array}{c} 75 \\ \downarrow \quad \downarrow \\ 111 \quad 101 \end{array}$$

(b)

$$\begin{array}{c} 65 \\ \downarrow \quad \downarrow \\ 110 \quad 101 \end{array}$$

(c)

$$\begin{array}{c} 37 \\ \downarrow \quad \downarrow \\ 011 \quad 111 \end{array}$$

(d)

$$\begin{array}{c} 26 \\ \downarrow \quad \downarrow \\ 010 \quad 010 \end{array}$$

10. Ans: (a), (c) & (d)

Sol: Given Number (N) = 11101

In sign magnitude, MSB is sign and remaining bits are magnitude

$$N = \underbrace{1}_{\text{sign}} \underbrace{1101}_{\text{magnitude}}$$

– [13] So option (A) is correct

and option (B) is wrong

now $N = 11101$ [Here MSB=1 So Negative number]

$$2\text{'s complement of } N = -[0011] = [-3]_{10}$$

So option (C) is also correct

$N = 11101$ [Her MSB =1 so it is Negative number]

1's complement of $N = -[00010] = (-2)_{10}$

Hence option (D) is also correct

11. Ans: (a)

Sol: Given number $\Rightarrow N = [7\ 07\ 00]_8$

Number of digits = 5.

In 6 digits $N = [0\ 7\ 07\ 00]_8$

Here radix = $r = 8$

For r 's [8] complement, write zero bits as it is at LSB, subtract 1st non zero LSB from " r " [Here 8] and remaining digits from $r-1$ [7]

$$\begin{array}{ccccccc} & 7 & 7 & 7 & 8 & & \\ N = & 0 & 7 & 0 & 7 & 0 & 0 \\ & \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow \text{ as it is} \end{array}$$

8's complement $N = [7\ 0\ 7\ 1\ 0\ 0]_8$

12. Ans: (c)

Sol: Given number $\Rightarrow N = (9900)_{10}$

In 5 digits $\Rightarrow N = [0\ 9\ 9\ 0\ 0]_{10}$

For 10's complement write LSB zero bits as it is then subtract 1st non zero bit from "10" & remaining from "9"

$$\begin{array}{ccccccc} & 9 & 9 & (10) & & & \\ N = & 0 & 9 & 9 & 0 & 0 & \\ & \underline{\hspace{1cm}} & & & & & \end{array}$$

10's complement = 9 0 1 0 0

Chapter

2

Logic Gates & Boolean Algebra

01. Ans: (b)

Sol: Truth table of XOR

A	B	o/p
0	0	0
0	1	1
1	0	1
1	1	0

Stage 1:

Given one i/p = 1 Always.

1	X	o/p
1	0	1 = $\bar{X}$
1	1	0 = X

For First XOR gate o/p = $\bar{X}$

Stage 2:

$\bar{X}$	X	o/p
0	1	1
1	0	1

For second XOR gate o/p = 1.

Similarly for third XOR gate o/p = $\bar{X}$ & for fourth o/p = 1

For Even number of XOR gates o/p = 1

For 20 XOR gates cascaded o/p = 1.

02. Ans: 1

Sol: $f = [\bar{D} + A\bar{B} + \bar{A}C + A\bar{C}D + \bar{A}\bar{C}\bar{D}]$

Let $x = \bar{D} + A\bar{B} + \bar{A}C + A\bar{C}D + \bar{A}\bar{C}\bar{D}$ [then $f = \bar{x}$]

Simplify $x \Rightarrow$

$$x = \bar{D} + A\bar{B} + \bar{A}C + \bar{C}D \underbrace{[A + \bar{A}]}_1$$

$$x = \bar{D} + D\bar{C} + A\bar{B} + \bar{A}C$$

$$x = [\overline{D} + (\overline{D})\overline{C}] + \overline{A}\overline{B} + \overline{A}\overline{C} [\because p + \overline{p}q = p + q]$$

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

$$x = \overline{D} + [\overline{C} + (\overline{C})\overline{A}] + \overline{A}\overline{B}$$

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

$$x = \overline{D} + \overline{C} + [\overline{A} + (\overline{A})\overline{B}]$$

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

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

$$f = \overline{x} = \overline{\overline{A} + \overline{B} + \overline{C} + \overline{D}} = \overline{\overline{A}} \cdot \overline{\overline{B}} \cdot \overline{\overline{C}} \cdot \overline{\overline{D}} = A \cdot B \cdot C \cdot D$$

Number of minterms are "one"

Ans: 1.

03. Ans: (c)

Sol: $f = f_1 f_2 + f_3$

04. Ans: (c)

Sol: Let $x_1 = x_2 = x_3 = x_4$

For all cases options a, b, d not satisfy.

05. Ans: (d)

Sol: (a) $\overline{A} + \overline{B}$ (b) $\overline{A} + B$

$$(c) \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}}$$

$$= A \cdot B$$

$$(d) \overline{\overline{A} \cdot \overline{B}} = A + B$$

06. Ans: (b)

Sol: $A \oplus B = 0$

(a)

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

$$A = B$$

$$(b) \overline{A + B} = 0$$

A	B	$A+B$	$\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

$$(c) \overline{A} \cdot B = 0$$

$\overline{A}$	B	$\overline{A} \cdot B$
1	0	0
1	1	1
0	0	0
0	1	0

$$(d) A \oplus B = 1$$

$A \neq 1$ (Refer option a)

07. Ans: (b)

Sol: (a) $\overline{ab + bc + ca + abc}$

$$\overline{ab} \cdot \overline{bc} \cdot \overline{ca} \cdot \overline{abc}$$

$$(\overline{a} + \overline{b}) \cdot (\overline{b} + \overline{c}) \cdot (\overline{c} + \overline{a}) \cdot (\overline{a} + \overline{b} + \overline{c})$$

$$(\overline{a} \overline{b}) + (\overline{a} \overline{c}) + \overline{b} + (\overline{b} \overline{c}) \cdot (\overline{c} + \overline{a}) \cdot (\overline{a} + \overline{b} + \overline{c})$$

$$\overline{a} \overline{b} + \overline{a} \overline{c} + \overline{b} + (1 + \overline{c}) \cdot (\overline{c} + \overline{a}) \cdot (\overline{a} + \overline{b} + \overline{c})$$

$$\overline{a} \overline{b} + \overline{a} \overline{c} + \overline{b} \overline{c} + \overline{b} \cdot \overline{a} \cdot (\overline{a} + \overline{b} + \overline{c})$$

$$\overline{a} \overline{b} + \overline{a} \overline{c} + \overline{b} \overline{c} + \overline{a} \overline{b} + \overline{a} \overline{b} + \overline{a} \overline{b} \overline{c}$$

$$\overline{a} \overline{b} + \overline{a} \overline{c} + \overline{b} \overline{c} + \overline{a} \overline{b} + \overline{a} (1 + \overline{c})$$

$$\overline{a} \overline{b} + \overline{b} \overline{c} + \overline{c} \overline{a}$$

$$(b) \overline{ab + \overline{a} \overline{b} + \overline{c}}$$

$$\overline{ab} \cdot \overline{\overline{a} \overline{b}} \cdot \overline{\overline{c}}$$

$$\overline{a} + \overline{b} \cdot \overline{\overline{a} \overline{b}} \cdot \overline{\overline{c}}$$

$$(\overline{a} + \overline{b}) \cdot (a + b) \cdot c$$

$$(\overline{a} \overline{b} + \overline{b} \overline{a}) \cdot c$$

$$(A \oplus B)C$$

(c) $\overline{a + bc}$

$\overline{a}.bc$

$\overline{a}(\overline{b} + \overline{c})$

(d) $\overline{(a + \overline{b} + \overline{c})}(\overline{a + \overline{b} + \overline{c}})(\overline{a + \overline{b} + \overline{c}})$

$\overline{(a + \overline{b} + \overline{c})} + (\overline{a + \overline{b} + \overline{c}}) . (\overline{a + \overline{b} + \overline{c}})$

$\overline{\overline{a}.b.c} + (\overline{\overline{a}.b.c})(\overline{\overline{a}.b.c})$

$abc + \overline{a}bc + ab\overline{c}$

08. Ans: (c)

09. Ans: (a) & (d)

Sol: $(x + y)(x + \overline{y}) + \overline{x} + x\overline{y}$

using Distributive Law

$$F = (x + y.\overline{y}) + (\overline{x} + \overline{y}) = x + xy = x$$

10. Ans: (b) & (c)

Sol: Let $B \odot B$ [Here no. of XOR=1 $\Rightarrow$ odd]

$$\overline{B}\overline{B} + B.B = \overline{B} + B = 1$$

Let $B \odot B \odot B$ [Here no. of XOR=2 $\Rightarrow$ even]

$$= 1 \odot B = \overline{1}.B + 1B = B = \text{remain same as given variable}$$

11. Ans: (a), (b) & (c)

Sol: (a) Consensus theorem rule

$$AB + \overline{A}C + BC = AB + \overline{A}C \rightarrow \text{Correct}$$

(b) R.H.S $(Y + Z)(X + \overline{Y}) = XY + \overline{Y}Z + XZ$

By using Consensus theorem we can write

$$Y.X + \overline{Y}Z + XZ = YX + \overline{Y}Z = \text{L.H.S}$$

(b) Also correct

(c) $\overline{\overline{A}\overline{B}\overline{C}} = \overline{\overline{A}} + \overline{\overline{B}} + \overline{\overline{C}} = A + B + C \Rightarrow \text{Correct}$

(d) Simplification of

$$(P + \overline{Q})(\overline{Q} + R + \overline{S})(\overline{P} + \overline{Q} + S) \text{ is } \overline{Q} + PRS$$

but given $\overline{Q} + \overline{P}RS$

12. Ans: (a), (b) & (d)

Sol: Given $C = A * B$ but $A * B = AB + \overline{A}\overline{B}$

$$\text{So } C = A * B = AB + \overline{A}\overline{B} = A \oplus B \dots\dots\dots (1)$$

$$\text{Now } \overline{C} = \overline{AB + \overline{A}\overline{B}} = \overline{A \oplus B} = A \oplus B = A\overline{B} + \overline{A}B \dots\dots\dots (2)$$

Verification

Option (a) R. H. S $\Rightarrow B * C = BC + \overline{B}\overline{C}$

Sub equations (1) & (2)

$$B * C = B[AB + \overline{A}\overline{B}] + \overline{B}[\overline{A}\overline{B} + AB]$$

$$= AB + 0 + A\overline{B} + 0$$

= A; hence option (a) is True

Now option (b)

$$A * C = \overline{A}\overline{C} + AC$$

$$= \overline{A}[\overline{AB} + \overline{AB}] + A[\overline{A}\overline{B} + AB]$$

$$= 0 + \overline{A}\overline{B} + AB = B[\overline{A} + A] = B$$

hence option (b) is True

Now $A * B * C$

$$= [A * B] * C \text{ [But given } A * B = C]$$

$$= C * C$$

$$= \overline{C}\overline{C} + C.C = \overline{C} + C = 1$$

So option (d) $\Rightarrow A * B * C = 1$ is also True.

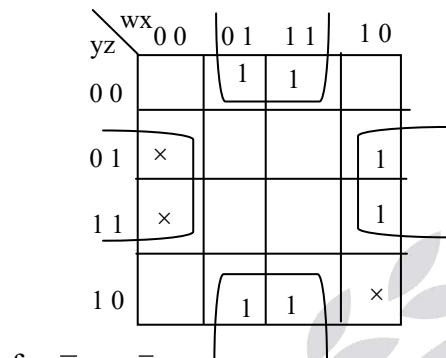
Chapter

3

K-Maps

01. Ans: (b)

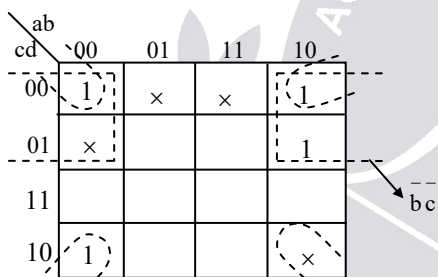
Sol:



$$f = \bar{x}z + x\bar{z}$$

02. Ans: (b)

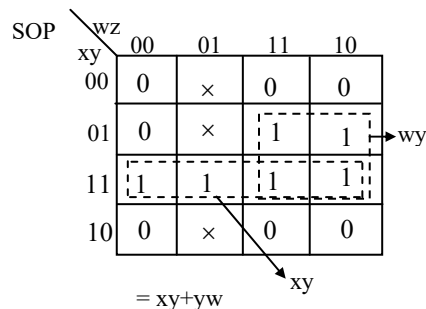
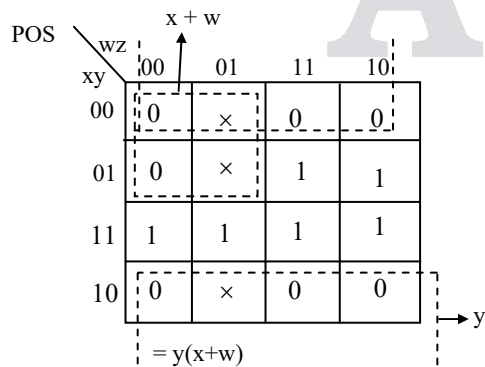
Sol:



$$f = \bar{b}d + \bar{b}\bar{c}$$

03.

Sol:



$$= xy + yw$$

$$\text{SOP: } x y + y w$$

$$\text{POS: } y(x + w)$$

04. Ans: (a)

Sol: For n-variable Boolean expression,

$$\text{Maximum number of minterms} = 2^n$$

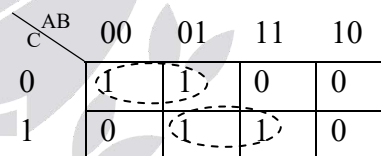
$$\text{Maximum number of implicants} = 2^n$$

Maximum number of

$$\text{Essential prime implicants} = \frac{2^n}{2} = 2^{n-1}$$

05. Ans: (c)

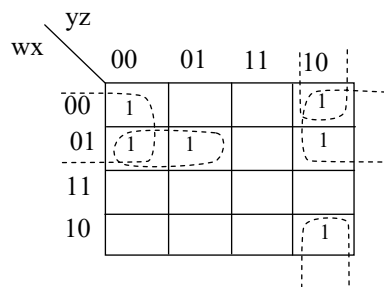
Sol:



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

06. Ans: 3

$$\text{Sol: } \bar{w}\bar{z} + \bar{w}x\bar{y} + \bar{x}y\bar{z}$$



Chapter

4

Combinational Circuits

01. Ans: (d)

Sol: Let the output of first MUX is “F₁”

$$F_1 = AI_0 + AI_1$$

Where A is selection line, I₀, I₁ = MUX Inputs

$$F_1 = \bar{S}_1 \cdot W + S_1 \cdot \bar{W} = S_1 \oplus W$$

Output of second MUX is

$$F = \bar{A} \cdot I_0 + A \cdot I_1$$

$$F = \bar{S}_2 \cdot F_1 + S_2 \cdot \bar{F}_1$$

$$F = S_2 \oplus F_1$$

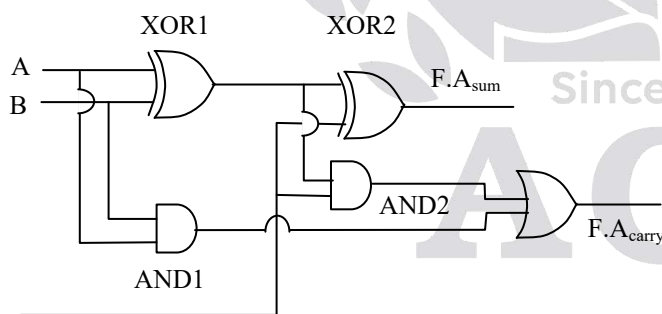
$$\text{But } F_1 = S_1 \oplus W$$

$$F = S_2 \oplus S_1 \oplus W$$

$$\text{i.e., } F = W \oplus S_1 \oplus S_2$$

02. Ans: 19.2

Sol: F.A using H.A



$$t_{\text{AND}} = 1.2\mu\text{s} ; t_{\text{OR}} = 1.2\mu\text{sec}$$

$$\text{XOR} = 2 \times 1.2 = 2.4 \mu\text{sec}$$

$$\begin{aligned} \text{Time for addition} &= \text{XOR1} + \text{XOR2} = 2.4 + 2.4 \\ &= 4.8\mu\text{sec} \end{aligned}$$

$$\begin{aligned} \text{Time for carry} &= \text{XOR1} + \text{AND2} + \text{OR} \\ &= 2.4 + 1.2 + 1.2 = 4.8\mu\text{sec} \end{aligned}$$

for n-bit total time required

$$= (n-1) t_c + \text{Max}[t_c, t_s]$$

⇒ for 4 bit

$$(4-1) \times 4.8 + \text{Max}[4.8, 4.8]$$

$$3 \times 4.8 + 4.8 = 19.2\mu\text{sec}$$

03. Ans: 6

Sol: T = 0 → NOR → MUX 1 → MUX 2

$$2\text{ns} \quad 1.5\text{ns} \quad 1.5\text{ns}$$

$$\text{Delay} = 2\text{ns} + 1.5\text{ns} + 1.5\text{ns} = 5\text{ns}$$

T = 1 → NOT → MUX 1 → NOR → MUX 2

$$1\text{ns} \quad 1.5\text{ns} \quad 2\text{ns} \quad 1.5\text{ns}$$

$$\text{Delay} = 1\text{ns} + 1.5\text{ns} + 2\text{ns} + 1.5\text{ns} = 6\text{ns}$$

Hence, the maximum delay of the circuit is 6ns

04. Ans: 195

Sol: Given $t_{\text{carry}} = 12\text{ns}$

$$t_{\text{sum}} = 15\text{ns}$$

$$n = 16 \text{ bit}$$

$$\begin{aligned} \text{Time required} &= (16-1) \times 12 + \max(15, 12) \\ &= 15 \times 12 + 15 = 195\text{nsec.} \end{aligned}$$

05. Ans: (b), (c) & (d)

Sol: For “n” bit number addition we require

$$\begin{aligned} &= \text{“n” F.A (or) 1 H.A, (n-1) F.A (or)} \\ &\quad (2n-1) \text{ H.A, (n-1) OR Gates} \end{aligned}$$

06. Ans: (a) & (c)

Sol: Output = $Y = \sum m(0, 1, 2, 6) + \bar{C}$

BC	00	01	11	10
A				
0	1	1		1
1				1

$$\begin{aligned}
 Y &= \bar{A} \bar{B} + B \bar{C} + \bar{C} \\
 &= \bar{A} \bar{B} + \bar{C}[B + 1] = \bar{C} + \bar{A} \bar{B} \rightarrow \text{Option (c)} \\
 \Rightarrow Y &= \bar{C} + \bar{A} \bar{B} = (\bar{C} + \bar{A})(\bar{C} + \bar{B}) = (\bar{A} + \bar{C})(\bar{B} + \bar{C}) \\
 &\rightarrow \text{Option (a)}
 \end{aligned}$$

07. Ans: (b)

Sol: In n-bit magnitude comparator the number of combinations for

$$A > B \text{ (or) } A < B = \frac{2^{2n} - 2^n}{2}$$

Here given 8 bit. So, $n = 8$

So total number of combinations for

$$\begin{aligned}
 A > B &= \frac{2^{2 \times 8} - 2^8}{2} = \frac{2^{16} - 2^8}{2} = \frac{2^8 \cdot 2^8 - 2^8}{2} \\
 &= \frac{2^8 \cdot [2^8 - 1]}{2} = 255 \times 2^7.
 \end{aligned}$$

08. Ans: (d)

Sol: As per the definition of MUX, output equation is

$$f = \bar{S}_1 \bar{S}_0 [I_0] + \bar{S}_1 S_0 [I_1] + S_1 \bar{S}_0 [I_2] + S_1 S_0 [I_3]$$

Here $S_1 = P$; $S_0 = Q$; $I_0 = 0$; $I_1 = 1$; $I_2 = R$; $I_3 = \bar{R}$

$$f = \bar{P} \bar{Q} [0] + \bar{P} Q [1] + P \bar{Q} [R] + P Q [\bar{R}]$$

$$f = 0 + \bar{P} Q [\bar{R} + R] + P \bar{Q} R + P Q \bar{R}$$

$$f = \bar{P} Q \bar{R} + \bar{P} Q R + P \bar{Q} R + P Q \bar{R}$$

$$\begin{array}{cccc}
 \underbrace{0 \ 1 \ 0}_{m_2} & \underbrace{0 \ 1 \ 1}_{m_3} & \underbrace{1 \ 0 \ 1}_{m_5} & \underbrace{1 \ 1 \ 0}_{m_6}
 \end{array}$$

$$F = \Sigma m = [2, 3, 5, 6]$$

09. Ans: (b), (c) & (d)

Sol: For “n” bit number addition we require = “n” F.A (or) 1 H.A, (n-1) F.A (or) (2n-1) H.A, (n-1) OR Gates

10. Ans: (a), (b), (c) & (d)

Sol: Output of MUX1 is $F_1 = \bar{X} I_0 + X I_1 =$

$$\bar{X} (0) + X (1) \Rightarrow F_1 = X$$

$$\text{output of MUX2} = F_2 = \bar{Y} I_0 + Y I_1$$

$$F_2 = \bar{Y} X + Y X \quad [\text{Here } I_1 = F_1 = X]$$

$$F_2 = X [\bar{Y} + Y] = X$$

$$\text{output of MUX3} = F = \bar{Z} I_0 + Z I_1$$

$$F = Y \bar{Z} + X Z \quad \text{convert into standard form}$$

$$F = (X + \bar{X}) Y \bar{Z} + X (Y + \bar{Y}) Z$$

$$\begin{aligned}
 F &= X Y \bar{Z} + X \bar{Y} \bar{Z} + X Y Z + \bar{X} Y \bar{Z} \\
 &= \Sigma m(2, 5, 6, 7)
 \end{aligned}$$

11. Ans: 3

Sol:

Decimal	Inputs			Output Y
	A	B	C	
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	1

Output $\Rightarrow Y [A, B, C] = \Sigma m [3, 5, 6, 7]$
 simplify using k map

A	BC			
	00	01	11	10
0	0	1	1	2
1	4	1	5	1

$$Y = \underbrace{A B}_{1^{\text{st}}} + \underbrace{B C}_{2^{\text{nd}}} + \underbrace{C A}_{3^{\text{rd}}}$$

Here number of 2 input terms are "3"

Chapter
5

Sequential Circuits

01. Ans: 4

Sol: In the given first loop of states, zero has repeated 3 times. So, minimum 4 number of Flip-flops are needed.

02. Ans: (b)

Sol:

CLK	Serial in= $B \oplus C \oplus D$	A B C D
0		1 0 1 0
1	1 →	1 1 0 1
2	0 →	0 1 1 0
3	0 →	0 0 1 1
4	0 →	0 0 0 1
5	1 →	1 0 0 0
6	0 →	0 1 0 0
7	1 →	1 0 1 0

03. Ans: (b)

Sol:

J	K	Q_n	$\bar{Q}_n$	$T = (J + Q_n) (K + \bar{Q}_n)$	Q_{n+1}
0	0	0	1	$0.1 = 0$	$1 \left\{ \begin{matrix} 0 \\ 1 \end{matrix} \right\} Q_n$
0	0	1	0	$1.0 = 0$	
0	1	0	1	$0.1 = 0$	$0 \left\{ \begin{matrix} 0 \\ 1 \end{matrix} \right\} 0$
0	1	1	0	$1.1 = 1$	
1	0	0	1	$1.1 = 1$	$1 \left\{ \begin{matrix} 1 \\ 0 \end{matrix} \right\} 1$
1	0	1	0	$1.0 = 0$	
1	1	0	1	$1.1 = 1$	$0 \left\{ \begin{matrix} 1 \\ 0 \end{matrix} \right\} \bar{Q}_n$
1	1	1	0	$1.1 = 1$	

	KQ_n	00	01	11	10
J	0			1	
	1	1		1	1

$$T = J \overline{Q_n} + KQ_n = (J + Q_n)(K + \overline{Q_n})$$

04. Ans: (c)

Sol: Asynchronous sequential circuit does not use any clock so it is false.

05. Ans: (d)

Sol: Master-slave JK-flip-flop is preferred to an level triggered JK flip-flop. Hence it is false.

06. Ans: 3

Sol:

Q_2	Q_1	Q_0	
0	0	0	→0
1	0	0	→0
0	0	1	→1
1	0	1	→1
0	1	0	→2
1	1	0	→2
0	1	1	→3
1	1	1	→3

It is mod 8 counter So, no. of flip flops required is 3.

07. Ans: (c)

Sol: From circuit we can write

$$D = X \oplus Q$$

$$\text{but for D FF} \Rightarrow Q_{n+1} = D$$

$$Q_{n+1} = D = X \oplus Q$$

$$Q_{n+1} = \overline{X}Q + X\overline{Q}$$

[This is same as T FF output]

$$\text{T FF output } Q_{n+1} = \overline{T}Q + TQ$$

Therefore given circuit act as T Flip-Flop

08. Ans: (d)

$$\text{Sol: } D_A = Q_B \odot Q_C ; D_B = Q_A ; D_C = Q_B$$

Given initially $Q_A = Q_B = Q_C = 0$

CLOCK	D_A	D_B	D_C	Q_A	Q_B	Q_C
0	-	-	-	0	0	0
1	1	0	0	1	0	0
2	1	1	0	1	1	0
3	0	1	1	0	1	1
4	1	0	1	1	0	1
5	0	1	0	0	1	0
6	0	0	1	0	0	1

The output observed at Q_A is 0110100-----

09. Ans: (b) & (d)

$$\text{Sol: Total states in 'n' bit Johnson counter} = 2^n$$

$$\text{number of used states} = 2 \times n$$

Here $n = 4$ bits

$$\text{So, total number of states} = 2^4 = 16$$

$$\text{number of used states} = 2 \times 4 = 8$$

$$\text{unused states} = \text{Total states} - \text{used states}$$

$$\text{Unused states} = 16 - 8$$

$$= 8$$