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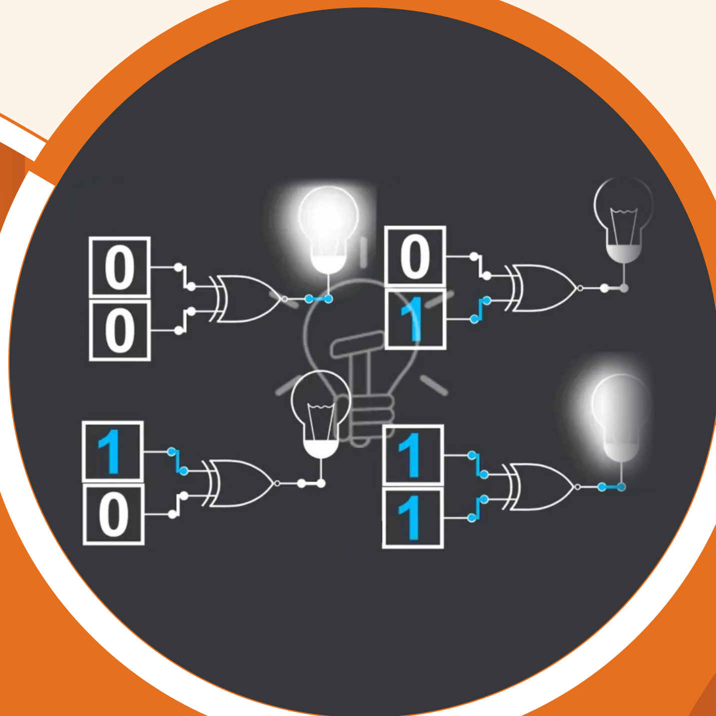


Computer Science & Information Technology

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: $135_x + 144_x = 323_x$

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

$= 3x^2 + 2x^1 + 3x^0$

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

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

$(x-6)(x+1) = 0$ (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 $+(539)_{10}$:

2	539	
2	269	–1
2	134	–1
2	67	–0
2	33	–1
2	16	–1
2	8	–0
2	4	–0
2	2	–0
	1	–0

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

$= (00100\ 0011011)_2$

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 (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: $[B\ 9\ F.\ AE]_{16}$

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

Now make 3 bits as single group

← . → Place zero

101 110 011 111 . 101 011 100

↓ ↓ ↓ ↓ ↓ ↓ ↓

$[\ 5\ \ 6\ \ 3\ \ 7\ .\ 5\ \ 3\ \ 4]_8$

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)

75

↓ ↓

111 101

(b)

65

↓ ↓

110 101

(c)

37

↓ ↓

011 111

(d)

26

↓ ↓

010 010

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

Sol: Given Number (N) = 11101

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

N = 1 1101

sign magnitude

⇓ ⇓

– [13] So option (A) is correct

and option(B) is wrong

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

2'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 ⇒ 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]

```
        7  7  7  8
   N=   0  7  0  7  0  0
        ↓  ↓  ↓  ↓     ↓ as it is
```

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

12. Ans: (c)

Sol: Given number ⇒ N = $(9900)_{10}$

In 5 digits ⇒ 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"

```
         9  9 (10)
   N =  0  9  9  0  0
```

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	$= \overline{X}$
1	1	0	$= \overline{X}$

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

Stage 2:

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

For second XOR gate o/p = 1.

Similarly for third XOR gate o/p = $\overline{X}$ & 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: $f = \overline{[\overline{D} + A\overline{B} + \overline{A}C + A\overline{C}D + \overline{A}\,\overline{C}D]}$

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

Simplify x ⇒

$x = \overline{D} + A\overline{B} + \overline{A}C + \overline{C}D\underbrace{[A + \overline{A}]}_{1}$

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

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

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

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

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

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

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

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

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

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) $\overline{\overline{A} + \overline{B}} = \overline{\overline{A}}.\overline{\overline{B}}$

$= A.B$

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

06. Ans: (b)

Sol: $A \oplus B = 0$

(a)

A	B	A⊕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) $\overline{A}.B = 0$

$\overline{A}$	B	$\overline{A}.B$
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) $\overline{ab + bc + ca + abc}$

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

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

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

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

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

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

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

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

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

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

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

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

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

$(A \oplus B)C$

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

$\bar{a}.\overline{bc}$

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

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

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

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

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

08. Ans: (c)

09. Ans: (a) & (d)

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

using Distributive Law

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

10. Ans: (b) & (c)

Sol: Let B ⊙ B [Here no. of XOR=1 ⇒odd]

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

Let B⊙B⊙B [Here no. of XOR=2 ⇒even]

= 1⊙ B = $\bar{1}.\bar{B}$+1B = B = remain same as given variable

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

Sol: (a) Consensus theorem rule

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

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

By using Consensus theorem we can write

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

(b) Also correct

(c) $\overline{\bar{A}\,\bar{B}\,\bar{C}}=\bar{\bar{A}}+\bar{\bar{B}}+\bar{\bar{C}}$ = A+B+C ⇒ Correct

(d) Simplification of

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

but given $\bar{Q}+P\bar{R}S$

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

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

So C = A*B = AB + $\bar{A}\bar{B}$ = A ⊙B…….. (1)

Now $\bar{C}=\overline{AB+\bar{A}\bar{B}}=\overline{A\odot B}$ = A⊕B

= $A\bar{B}+\bar{A}B$ ………(2)

Verification

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

Sub equations (1) & (2)

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

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

= A; hence option (a) is True

Now option (b)

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

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

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

hence option (b) is True

Now A * B * C

= [A*B]*C [But given A*B=C]

= C * C

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

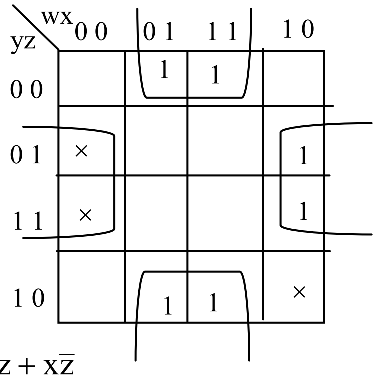
So option (d) ⇒ A * B * C =1 is also True.

Chapter 3

K-Maps

01. Ans: (b)

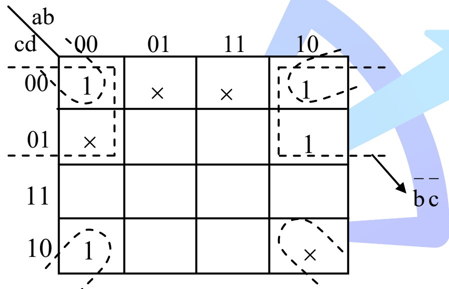
Sol:



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

02. Ans: (b)

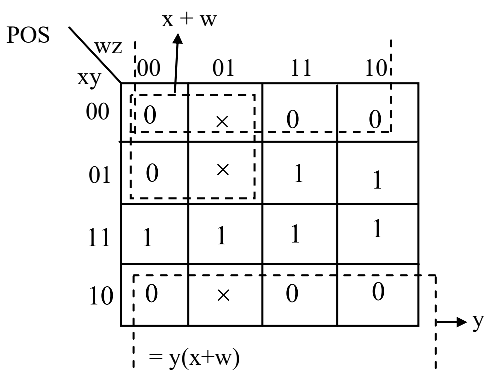
Sol:

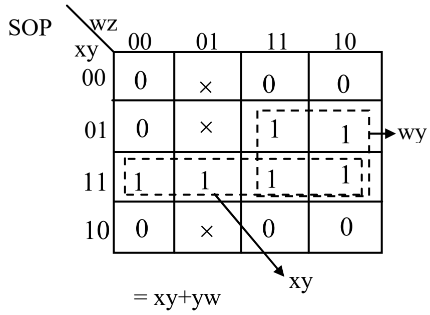


$f = \overline{b}\,\overline{d} + \overline{b}\,\overline{c}$

03.

Sol:





SOP: x y + y w

POS: y(x + w)

04. Ans: (a)

Sol: For n-variable Boolean expression,

Maximum number of minterms = 2^n

Maximum number of implicants = 2^n

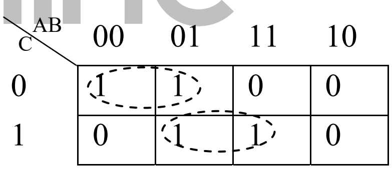
Maximum number of

Essential prime implicants $= \dfrac{2^n}{2}$

$= 2^{n-1}$

05. Ans: (c)

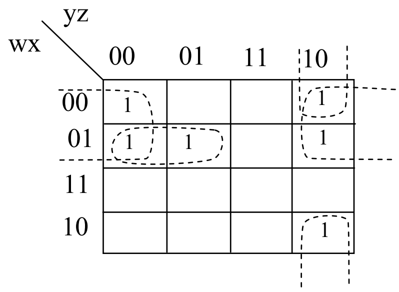
Sol:



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

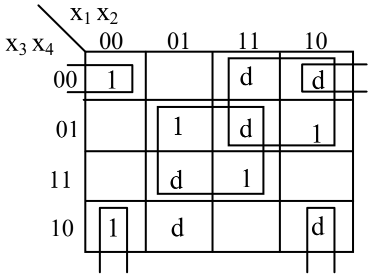
06. Ans: 3

Sol: $\overline{w}\,\overline{z} + \overline{w}\,x\overline{y} + \overline{x}\,y\overline{z}$



07. Ans: (c)

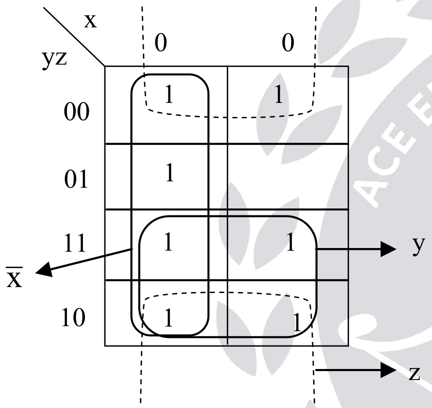
Sol:



$x_2x_4 + \bar{x}_3 x_1 + \bar{x}_4 \bar{x}_2$

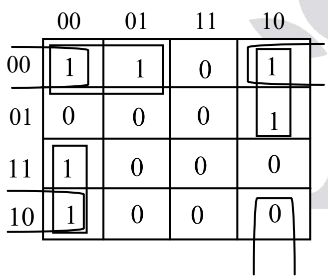
08. Ans: (a)

Sol:



09. Ans: (a)

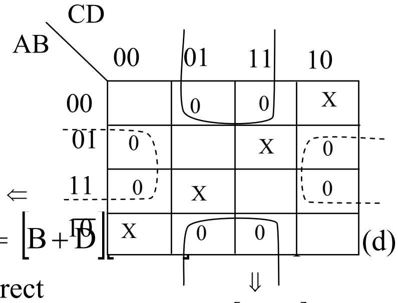
Sol:



E.P.I = 4

10. Ans: (b) & (d)

Sol: Given f = ΠM [1,3,4,6,9,11,12,14]+d[2,7,8,13]



$[\bar{B}+D] \Leftarrow$

$f_{pos} = [B+\bar{D}][\bar{B}+D]$ (d) is correct

$$f_{sop} = \underbrace{B.\bar{B}}_{0} + BD + \bar{B}\bar{D} + \underbrace{D.\bar{D}}_{0} = BD + \bar{B}\bar{D}$$

So option (c) is wrong

$$\left.\begin{aligned} f_{sop} &= B.D + \bar{B}\bar{D} \\ f_{pos} &= [B+\bar{D}][\bar{B}+D] \end{aligned}\right\}$$ Both cases variables A, C are absent so Independent of "2" variables

Hence option (b) is correct

Chapter 4

Combinational Circuits

01. Ans: (d)

Sol: Let the output of first MUX is "F_1"

$F_1 = AI_0+AI_1$

Where A is selection line, I_0, I_1 = MUX Inputs

$F_1 = \overline{S}_1.W + S_1.\overline{W} = S_1 \oplus W$

Output of second MUX is

$F = \overline{A}.I_0 + A.I_1$

$F = \overline{S}_2.F_1 + S_2.\overline{F}_1$

$F = S_2 \oplus F_1$

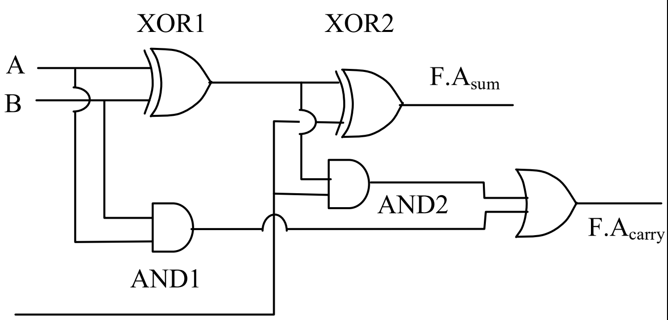
But $F_1 = S_1 \oplus W$

$F = S_2 \oplus S_1 \oplus W$

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

02. Ans: 19.2

Sol: F.A using H.A



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

XOR = 2×1.2= 2.4 μsec

Time for addition=XOR1 +XOR2 = 2.4+2.4 =4.8μsec

Time for carry = XOR1+AND2+OR = 2.4+1.2+1.2=4.8μsec

for n-bit total time required

= (n–1) tc+Max[tc, ts]

⇒for 4 bit

(4–1) ×4.8+ Max [4.8, 4.8]

3×4.8+4.8=19.2μsec

03. Ans: 6

Sol: T = 0 → NOR → MUX 1 → MUX 2

2ns 1.5ns 1.5ns

Delay = 2ns + 1.5ns + 1.5ns = 5ns

T = 1 → NOT → MUX 1→NOR→ MUX 2

1ns 1.5ns 2ns 1.5ns

Delay = 1ns + 1.5ns + 2ns + 1.5ns = 6ns

Hence, the maximum delay of the circuit is 6ns

04. Ans: 195

Sol: Given t_{carry}= 12ns

t_{sum}= 15ns

n= 16 bit

Time required = (16–1) × 12 + max(15, 12)

15×12+15=195nsec.

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

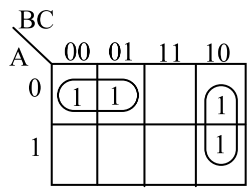
Sol: For "n" bit number addition we require

= "n" F.A (or) 1 H.A, (n–1) F.A (or)

(2n–1) H.A, (n–1) OR Gates

06. Ans: (a) & (c)

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



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

$$= \overline{A}\,\overline{B} + \overline{C}[B+1] = \overline{C} + \overline{A}\,\overline{B} \rightarrow \text{Option (c)}$$

$$\Rightarrow Y = \overline{C} + \overline{A}\,\overline{B} = (\overline{C}+\overline{A})(\overline{C}+\overline{B}) = (\overline{A}+\overline{C})(\overline{B}+\overline{C})$$
$\rightarrow$Option (a)

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

$$A > B = \frac{2^{2\times 8} - 2^8}{2} = \frac{2^{16} - 2^8}{2} = \frac{2^8.2^8 - 2^8}{2}$$

$$= \frac{2^8.[2^8 - 1]}{2} = 255 \times 2^7.$$

08. Ans: (d)

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

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

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

$$f = \overline{P}\,\overline{Q}[0] + \overline{P}Q[1] + P\overline{Q}[R] + PQ[\overline{R}]$$

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

$$f = \underbrace{\overline{P}Q\overline{R}}_{\substack{0\,1\,0\\ m_2}} + \underbrace{\overline{P}QR}_{\substack{0\,1\,1\\ m_3}} + \underbrace{P\overline{Q}R}_{\substack{1\,0\,1\\ m_5}} + \underbrace{PQ\overline{R}}_{\substack{1\,1\,0\\ m_6}}$$

F = Σm = [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 $= F_1 = \overline{X}\,I_0 + X.I_1 = \overline{X}(0) + X(1) \Rightarrow F_1 = X$

output of MUX2 $= F_2 = \overline{Y}.I_0 + Y.I_1$

$F_2 = \overline{Y}.X + YX$ [Here $I_1 = F_1 = X$]

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

output of MUX3 $= F = \overline{Z}.I_0 + Z I_1$

$F = Y\overline{Z} + XZ$ convert into standard form

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

$$F = XYZ + X\overline{Y}Z + XY\overline{Z} + \overline{X}Y\overline{Z}$$

$= \Sigma m(2, 5, 6, 7)$

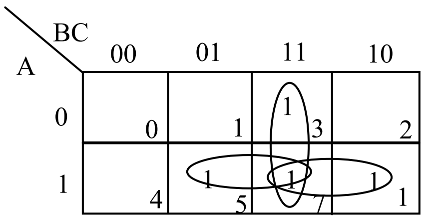
11. Ans: 3

Sol:

Decimal	**Inputs**			**Output**
	A	**B**	**C**	**Y**
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 ⇒ Y [A, B, C] = Σm [3, 5, 6, 7]

simplify using k map



$$Y = \underbrace{AB}_{1^{st}} + \underbrace{BC}_{2^{nd}} + \underbrace{CA}_{3^{rd}}$$

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	$\overline{Q}_n$	$T = (J + Q_n)(K + \overline{Q}_n)$	Q_{n+1}
0	0	0	1	0.1 = 0	0, 1 } Q_n
0	0	1	0	1.0 = 0	
0	1	0	1	0.1 = 0	0, 0 } 0
0	1	1	0	1.1 = 1	
1	0	0	1	1.1 = 1	1, 1 } 1
1	0	1	0	1.0 = 0	
1	1	0	1	1.1 = 1	1, 0 } $\overline{Q}_n$
1	1	1	0	1.1 = 1	

J \ KQ_n	00	01	11	10
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

$D = X \oplus Q$

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]

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

Therefore given circuit act as T Flip-Flop

08. Ans: (d)

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)

Sol: Total states in 'n' bit Johnson counter = 2^n

number of used states = $2 \times n$

Here n = 4 bits

So, total number of states = $2^4 = 16$

number of used states = $2 \times 4 = 8$

unused states = Total states – used states

Unused states = 16 – 8

= 8