by: Parv Agrawal

Ans 1

(a) $(4231)_5 \rightarrow (\quad)_{10}$

$$(\quad)_{10} = 4\times5^3 + 2\times5^2 + 3\times5^1 + 1\times5^0$$

$$= 500 + 50 + 15 + 1$$

$$= (566)_{10}$$

(b) $(129)_{10} \rightarrow (\quad)_2$

$$\begin{array}{r|rr} 2 & 129 & \\ \hline 2 & 64 & 1 \\ \hline 2 & 32 & 0 \\ \hline 2 & 16 & 0 \\ \hline 2 & 8 & 0 \\ \hline 2 & 4 & 0 \\ \hline 2 & 2 & 0 \\ \hline & 1 & 0 \end{array}$$

$$= (10000001)_2$$

(c) $(35.33)_{10} \rightarrow (\quad)_2$

$$\begin{array}{r|rr} 2 & 35 & \\ \hline 2 & 17 & 1 \\ \hline 2 & 8 & 1 \\ \hline 2 & 4 & 0 \\ \hline 2 & 2 & 0 \\ \hline & 1 & 0 \end{array}$$

$$(35)_{10} \rightarrow (100011)_2$$

$$\begin{array}{lll} 0.33 \times 2 = 0.66 & & 0 \\ 0.66 \times 2 = 1.32 & & 1 \\ 0.32 \times 2 = 0.64 & & 0 \\ 0.64 \times 2 = 1.28 & & 1 \\ 0.28 \times 2 = 0.56 & & 0 \\ 0.56 \times 2 = 1.12 & & 1 \\ 0.12 \times 2 = 0.24 & & 0 \\ 0.24 \times 2 = 0.48 & & 0 \\ 0.48 \times 2 = 0.96 & & 0 \\ \vdots & & \vdots \end{array}$$

$$(35.33)_{10} = (100011.010101000\ldots\ldots)_2$$

(d) $(11001011.001101)_2 \rightarrow (\ )_8$

$(\underline{011}\ \underline{001}\ \underline{011}.\underline{001}\ \underline{101})_2$

$\downarrow$

$(313.15)_8$

(e) $(23.21)_8 \rightarrow (\ )_{16}$

first we will convert to binary & then to hexadecimal

$(23.21)_8$

$(\underbrace{010}\ \underbrace{011}.\underbrace{010}\ \underbrace{001})_2$

$(010011.010001)_2$

$(\underbrace{0001}\ \underbrace{0011}.\underbrace{0100}\ \underbrace{0100})_2$

$(13.\cancel{88}\ 44)_{16}$

Ans 2 $n = 11010$ $m = 101011$

(a) $n+m$

$$\begin{array}{r} 011010 \leftarrow n \\ 101011 \leftarrow m \\ \hline 1000101 \\ \hline \end{array}$$

$\boxed{\text{Ans: } 1000101}$

(b) $n-m$

$$\begin{array}{rr} & 101011 \leftarrow m \\ & 010100 \leftarrow \text{1st complement of } m \\ + & 011010 \leftarrow n \\ \hline & 101110 \leftarrow \text{Sum (MSB=1), no carry.} \end{array}$$

$\boxed{\text{Ans: } -010001}$

(c) $m - n$

$$\begin{array}{rl}
011010 & \leftarrow n \\
100101 & \leftarrow \text{1s complement of } n \\
+\ 101011 & \leftarrow m \\
\hline
1\,010000 & \\
\hookrightarrow 1 & \\
\hline
010001 & \leftarrow \text{sum (MSB = 0)}
\end{array}$$

$\boxed{\text{Ans: } 010001}$

Ans 3

$F = ab + cd$

$F' = \overline{ab + cd} = \cancel{\overline{ab} + \overline{c}}\ \overline{ab} \cdot \overline{cd} = (\bar{a} + \bar{b})(\bar{c} + \bar{d})$

$FF' = (ab + cd)(\bar{a} + \bar{b})(\bar{c} + \bar{d})$

$= (ab\bar{a} + ab\bar{b} + cd\bar{a} + cd\bar{b})(\bar{c} + \bar{d})$

$= (0 + 0 + cd\bar{a} + cd\bar{b})(\bar{c} + \bar{d})$ (as $A\bar{A} = 0$)

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

$= 0 + 0 + 0 + 0$ (as $A\bar{A} = 0$)

$= 0$

$F + F' = (ab + cd) + (\bar{a} + \bar{b})(\bar{c} + \bar{d})$

$= \cancel{ab + cd + \bar{a}\bar{c} + \bar{a}\bar{d} + \bar{b}\bar{c} + \bar{b}\bar{d}}$

$= (ab + cd + \bar{a} + \bar{b}) \cdot (ab + cd + \bar{c} + \bar{d})$

$= (ab + \bar{a} + \bar{b} + cd) \cdot (cd + \bar{c} + \bar{d} + ab)$

$= (\underbrace{(\bar{a} + a)}_{1}(\bar{a} + b) + \bar{b} + cd) \cdot (\underbrace{(c + \bar{c})}_{1}(d + \bar{c}) + \bar{d} + ab)$

$= (\bar{a} + \underbrace{b + \bar{b}}_{1} + cd) \cdot (\underbrace{d + \bar{c} + \bar{d}}_{1} + ab)$

$= 1 \cdot 1 = 1$

Ans 4

(a) $(x+y'z)(xz+y)$

SOP : $xxz + xy + y'zxz + y'zy$

$xz + xy + y'xz + 0$

$\Rightarrow$ $\boxed{\text{Ans: } xz + xy + xy'z}$

POS : $(x+y'z)(xz+y)$

$\Rightarrow$ $\boxed{\text{Ans: } (x+y')\cdot(x+z)\cdot(y+x)\cdot(y+z)}$

(b) $(ab+bc)(a'+bc')$

SOP : $aba' + ab\cdot bc' + bca' + bcbc'$

$0 + abc' + bca' + 0$

$\Rightarrow$ $\boxed{\text{Ans: } abc' + a'bc}$

POS : $(ab+bc)(a'+bc')$

$(ab+b)(ab+c)(a'+b)\cdot(a'+c')$

$(b+a)(b+b)(c+a)(c+b)(a'+b)(a'+c')$

POS : $\boxed{\text{Ans. } (b)\cdot(a+b)(a+c)(b+c)(a'+b)(a'+c')}$

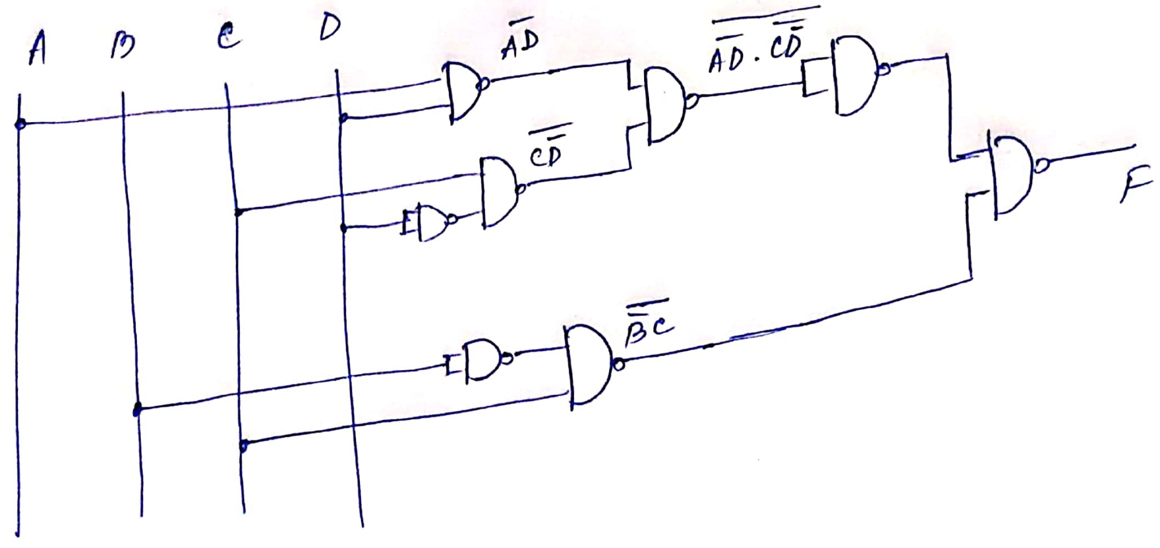
Q.5. $F(A,B,C,D) = \sum(2,3,6,9,10,11,13,14,15)$

AB \ CD	00	01	11	10
00	0	1	1 (3)	1 (2)
01	4	5	7	1 (6)
11	12	1 (13)	1 (15)	1 (14)
10	8	1 (9)	1 (11)	1 (10)

$$F = AD + C\bar{D} + \bar{B}C$$

$$F = \overline{\overline{AD + C\bar{D} + \bar{B}C}}$$

$$= \overline{\overline{AD} \cdot \overline{C\bar{D}} \cdot \overline{\bar{B}C}}$$



Ans 6. a) $\overline{\overline{(a+d)} \cdot \overline{(\bar{b}+c)}}$

by Raghav

Let $a+d = A$

$\bar{b}+c = B$

$\therefore \quad \overline{\bar{A} \cdot \bar{B}} = A + B$

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

b) $\overline{\overline{ab\bar{c}} + \overline{\bar{c}d}}$

Let $ab\bar{c} = A$

$\bar{c}d = B$

$\therefore \quad \overline{\bar{A}+\bar{B}} = A \cdot B$

$= ab\bar{c} \cdot \bar{c}d$

$= ab\bar{c}d$

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

Let $\bar{a}+d = A$

$b+\bar{c} = B$

$\bar{c}+d = C$

$\therefore \quad \bar{A} \cdot \bar{B} \cdot \bar{C} = a\bar{d} \cdot \bar{b}c \cdot c\bar{d}$

$= a\bar{b}c\bar{d}$

Ans 7. a) $x'y(w'+z'w) + y(x+x'zw)$

$= x'y(w'+z')\underbrace{(w'+w)}_{=1} + y\underbrace{(x+x')}_{=1}(x+zw)$

$= y[x'(w'+z') + x + zw]$

$= y[x + x'w' + z'x' + zw]$

$= y[\underbrace{(x+x')}_{=1}(x+w') + x'z' + zw]$

$= y[x + x'z' + w' + zw]$

$= y[(x+x')(x+z') + (w'+z)(w'+w)]$

$= y[x+z' + w' + z]$

$= y[x + w' + \underbrace{z+z'}_{=1}] = y[x+w'+1]$

$= y$

b) $(x+z)(x'+y)(z+y)$

$= (x+z)(x'+y)(z+y+\underbrace{xx'}_{=0})$

$= (x+z)(x'+y)(z+y+x)(z+y+x')$

$= [(x+z)(x+z+y)][(x'+y)(x'+y+z)]$

{using $A(A+B) = A$}

$= (x+z)(x'+y)$

c) $x'+y'+xyz'$

$= x'+xyz'+y'$

$= (x'+x)(x'+yz')+y'$

$= x'+y'+yz'$

$= x'+(y'+y)(y'+z')$

$= x'+y'+z'$

d) $xy'+y'z'+x'z'$

$= xy'+x'z'+y'z'(x+x')$

$= xy'+x'z'+xy'z'+x'y'z'$

$= xy'(1+z')+x'z'(1+y')$

$= xy'+x'z'$

Ans 8. a) $n=3$

$$F(A,B,C) = A'B'C' + A'B'C + A'BC' + A'BC + AB'C' + AB'C + ABC' + ABC$$

$$= A'(B'C'+BC'+B'C+BC) + A(B'C'+BC'+B'C+BC)$$

$$= \underbrace{(A+A')}_{=1}(B'C'+BC'+B'C+BC)$$

$$= B'(C+C') + B(C+C') = (B+B')(C+C') = 1$$

b) Proof by Induction

Let F_n be sum of all minterms of a Boolean function of n variables $\{x_1, x_2 \ldots x_n\}$

$$F_1 = x_1 + x_1' = 1 \quad \text{—— (1)}$$

Let F_n be 1

Then $F_{n+1} = x_{n+1}(F_n) + x_{n+1}'(F_n)$

$$= (x_{n+1} + x_{n+1}') F_n$$

$$= F_n = 1$$

Hence, proved.

Ans 9. $F = A'C + B'C + AB' + ABC$

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

a) $F = \Sigma(1, 3, 4, 5, 7)$

b) $F = C + AB'$

Ans. 10. $F = \Sigma(7, 9, 11, 12, 13, 15)$

AB \ CD	00	01	11	10
00	0	1	3	2
01	4	5	7: 1	6
11	12: 1	13: 1	15: 1	14
10	8	9: 1	11: 1	10

a) $F = AD + ABC' + BCD$

b)

AB \ CD	00	01	11	10
00	0: 0	1: 0	3: 0	2: 0
01	4: 0	5: 0	7	6: 0
11	12	13	15	14: 0
10	8: 0	9	11	10: 0

$F' = A'C' + A'B' + CD' + B'C'D'$

$F = (A + C) \cdot (A + B) \cdot (C' + D) \cdot (B \cancel{+ C} + D)$