سؤ ۱)

الف) $f(A,B,C,D) = (A+C)+((A'+B+C')D)' = (A+C)+(AB'C+D') = A+C+D'+AB'C =$

$A(B+B')(C+C')(D+D')+C(A+A')(B+B')(D+D')+D'(A+A')(B+B')(C+C')+AB'C(D+D') =$

$ABCD+ABCD'+ABC'D+ABC'D'+AB'CD+AB'CD'+AB'C'D+AB'C'D'+A'BCD+A'BCD'+A'B'CD+$

$A'B'CD'+A'BC'D'+A'B'C'D'+AB'CD$

ب) $f(A,B,C,D) = (A\oplus B)'+((A'+B)+CD')' = AB+A'B'+(AB')\cdot(C'+D) = AB+A'B'+AB'C'+AB'D$

$= AB(C+C')(D+D')+A'B'(C+C')(D+D')+AB'C'(D+D')+AB'D(C+C') =$

$ABCD+ABCD'+ABC'D+ABC'D'+A'B'CD+A'B'CD'+A'B'C'D+A'B'C'D'+AB'C'D+AB'C'D'+$

$AB'CD$

ج) $f(A,B,C) = [(B+C)\oplus A'B]'[C\oplus(AB')] = [(B+C)A'B+B'C'(A+B')][C'(A+B')+C(A'B)]$

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

$= A'BC+AB'C'+A'B'C'$

سؤ ۲)

الف) $f(x,y,z) = \underbrace{xyz'}_{a}+(\underbrace{xyz'}_{a}+\underbrace{x'z}_{b})\underbrace{[(x+z)y+xy'z'+y'z]}_{c} \xrightarrow{a+(a+b)c=a+bc}$

$xyz'+x'z[xy+yz+xy'z'+y'z] = xyz'+x'z[z+x(y+y'z')] =$

$xyz'+x'z[z+xy+xz'] = xyz'+x'z[xy+z+x] = xyz'+x'z[x+z] =$

$\underline{xyz'+x'z}$ commutative, distributive, associative, absorption

ب) $f(A,B,C) = (A\oplus C)(B\oplus C)+(A\oplus B)(B\oplus C) = (A'C+AC')(B'C+BC')+(A'B+AB')(B'C+BC') =$

$A'B'C+ABC'+A'BC'+AB'C = B'C+BC' = \underline{B\oplus C}$ commutative, distributive, associative

ج) $f(A,B,C) = \overline{(B+A')(AB+C)+AA'B+A'B'C+(A+B)(A'+C)} = \overline{AB+BC+A'C+A'B'C+AC+A'B} =$

$\overline{B+C+BC+A'B'C} = \overline{B+C(1+B+A'B')} = \underline{\overline{B+C}} \to B'C'$ commutative, distributive, associative

د) $f(A,B,C) = \overline{(\bar A+\bar B)}(A+\bar A B)+(\bar A+\bar B+\bar A\bar B C)+\overline{(A+B)(\bar A+C)} = \overline{(AB)(A+A'B)+(A'+B'+A'B'C)}+$

$\overline{A'B'+AC'} = \overline{AB+A+B'+A'B'C+A'B'+AC'} = \overline{AB+A'B'+A+B+AC'} = \overline{AB+A'+B'+AC'} =$

$(A'+B')(A)(B)(A'+C) = 0$

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س۳) الف) $\frac{df}{dA} = f(0,B,C) \oplus f(1,B,C) = B' \oplus BC' = BC' + B'(B'+C) =$

$BC' + B' + B'C = BC' + B'(1+C) = \underline{B' + BC'}$

$\frac{df}{dB} = f(A,0,C) \oplus f(A,1,C) = A' \oplus AC' = AC' + A'(A'+C) = AC' + A' + A'C = \underline{A' + AC'}$

$\frac{df}{dC} = f(A,B,0) \oplus f(A,B,1) = (AB + A'B') \oplus A'B' = (A'+B')(A+B)(A'B') + (AB+A'B')(A+B) =$

$(A'B + AB')(A'B') + AB = \underline{AB}$

ب) $\frac{df}{dA} = f(0,B,C) \oplus f(1,B,C) = B' \oplus 0 = B \cdot 0 + B' = \underline{B'}$

$\frac{df}{dB} = f(A,0,C) \oplus f(A,1,C) = A' \oplus 0 = A \cdot 0 + A' = \underline{A'}$

$\frac{df}{dC} = f(A,B,0) \oplus f(A,B,1) = A'B' \oplus A'B' = (A+B)(A'B') + A'B'(A+B) = 0 \Rightarrow$ f مستقل از c است

س۴) $f(x,y,z) = x(x \oplus y) + xz(x+y') = x(xy' + x'y) + xz + xy'z = xy' + xz =$

$xy'(z+z') + xz(y+y') = \underline{xy'z + xy'z' + xyz} = m_5 + m_4 + m_7 \longrightarrow$ sum of Products

$\longrightarrow$ Product of sum $= M_0 \cdot M_1 \cdot M_2 \cdot M_3 \cdot M_6 = (x+y+z)(x+y+z')(x+y'+z)(x+y'+z') \times (x'+y'+z)$

$f(w,x,y,z) = xy' + y'z' + x'z' = xy'(z+z') + y'z'(x+x') + x'z'(y+y') =$

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

$wxy'z + w'xy'z + wxy'z' + w'xy'z' + wx'y'z' + w'x'y'z' + wx'yz' + w'x'yz' =$

$m_{13} + m_5 + m_{12} + m_4 + m_8 + m_0 + m_{10} + m_2 \longrightarrow$ sum of products $\longrightarrow$

$M_1 \cdot M_3 \cdot M_6 \cdot M_7 \cdot M_9 \cdot M_{11} \cdot M_{14} \cdot M_{15} = (W+x+y+z')(W+x+y'+z')(W+x'+y'+z) \times$

$(W+x'+y'+z')(W'+x+y+z')(W'+x+y'+z')(W'+x'+y'+z)(W'+x'+y'+z') \longrightarrow$

Product of sums

س۵) $[(B'+E')+A'][C'E' + D'A] = 1 \begin{cases} \to C'E' + D'A = 1 \\ \to [(B'+E')+A']' = 1 \to B' + A' + E' = 0 \to \boxed{A=1,\ B=1,\ E=1} \to \end{cases}$

$C'E' + D'A = 1 \xrightarrow{C'E' = 0} D'A = 1 \to \boxed{D=0}$

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$F = A \oplus B \oplus C$

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

$G = (D')(A'+B')(A'+(C \oplus D)+(A \oplus B \oplus C)')'$

A	B	C	D	G
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$H = A'+B'$

A	B	H
0	0	1
0	1	1
1	0	1
1	1	0