

Question 1

$$\text{LHS : } A'BC'D' + (A' + BC).(A + C'D') + BC'D + A'BC'$$

$$= A'BC'D' + ((A.A') + (A'C'D') + (ABC) + (BCC'D')) + BC'D + A'BC' \rightarrow (X.Y) + (W.Z) = (XW) + (XZ) + (YW) + (YZ)$$

$$= A'BC'D' + (0 + (A'C'D') + (ABC) + 0) + BC'D + A'BC' \rightarrow X + X' = 0$$

$$= A'BC'D' + A'C'D' + ABC + BC'D + A'BC'$$

$$= A'BC'D' + A'BC'.1 + A'C'D' + ABC + BC'D \rightarrow X.1 = X$$

$$= A'BC'(D' + 1) + A'C'D' + ABC + BC'D \rightarrow X.Y + X.1 = X.(Y + 1)$$

$$= A'BC'.1 + A'C'D' + ABC + BC'D \rightarrow X + 1 = 1$$

$$= A'BC' + A'C'D' + ABC + BC'D \rightarrow X.1 = X$$

$$\text{Delete } A'BC' \text{ by consensus theorem} \rightarrow x.y + x'.z + y.z = x.y + x'.z$$

$$= A'C'D' + ABC + BC'D$$

$$\text{RHS : } ABCD + A'C'D' + ABD + ABCD' + BC'D$$

$$= ABCD + ABCD' + A'C'D' + BC'D + ABD$$

$$= ABC(D + D') + A'C'D' + BC'D + ABD \rightarrow X.Y + X.Z = X.(Y + Z)$$

$$= ABC.1 + A'C'D' + BC'D + ABD \rightarrow X + X' = 1$$

$$= ABC + A'C'D' + BC'D + ABD \rightarrow X.1 = X$$

$$\text{Delete } ABD \text{ by consensus theorem} \rightarrow x.y + x'.z + y.z = x.y + x'.z$$

$$= A'C'D' + ABC + BC'D$$

Question 2

$$=ab'cd'e+acd+acf'gh'+abcd'e+acde'+e'h'$$

$$=ab'cd'e+abcd'e+acd+acde'+acf'gh'+e'h'$$

$$=acd'e(b+b')+acd(1+e')+acf'gh'+e'h'$$

$$=acd'e+acd+e'h'+acf'gh'$$

Question 3

a.

Decimal Digit	A	B	C	D	F
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

b.

$$F(A,B,C,D) = \sum_m (2,6,10,13,14,15)$$

$$= m_2 + m_6 + m_{10} + m_{13} + m_{14} + m_{15}$$

$$F(A,B,C,D) = A'B'CD' + A'BCD' + AB'CD' + ABCD' + ABC'D + ABCD$$

$$\text{C. } F(A,B,C,D) = A'B'CD' + A'BCD' + AB'CD' + ABCD' + ABC'D + ABCD$$

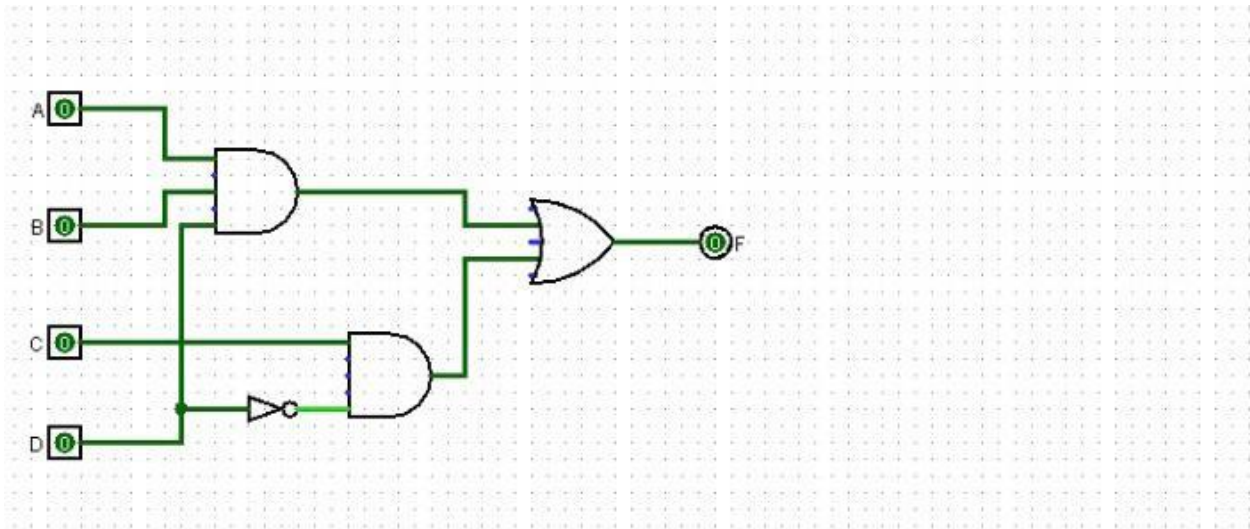
$$= A'CD'(B+B') + ACD'(B+B') + ABD(C+C')$$

$$= A'CD' + ACD' + ABD$$

$$= CD'(A'+A) + ABD$$

$$F(A,B,C,D) = CD' + ABD$$

d.



Question 4

a.

$$F(a,b,c,d) = a'(b'+d) + acd'$$

$$= a'b.(d+d') + a'd.(c+c') + acd'(b+b')$$

$$a'b'd + a'b'd' + a'dc + a'dc' + abcd' + ab'cd'$$

$$= a'b'd(c+c') + a'b'd'(c+c') + a'dc(b+b') + a'dc'(b+b') + abcd' + ab'cd'$$

$$= a'b'cd + a'b'c'd + a'b'cd' + a'b'c'd' + a'bcd + a'b'cd + a'bc'd + a'b'c'd + abcd' + ab'cd' =$$

$$m_0 + m_1 + m_2 + m_3 + m_5 + m_7 + m_{10} + m_{14}$$

$$= \sum_m (0,1,2,3,5,7,10,14) \rightarrow \text{minterm expansion}$$

b. other terms are maxterms

$$\prod_M (4,6,8,9,11,12,13,15) \rightarrow \text{maxterm expansion}$$

Question 5

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

$$AB' + A'C'D' + A'B'(D+CD') \rightarrow (X.Y + X.Z) = X.(Y+Z)$$

$$AB' + A'C'D' + A'B'((D+C).(D+D')) \rightarrow X+(Y.Z) = X+Y . X+Z$$

$$AB' + A'C'D' + A'B'((D+C).(1)) \rightarrow X+X' = 1$$

$$AB' + A'C'D' + A'B'C + A'B'D \rightarrow X.(Y+Z) = X.Y + X.Z$$

$$AB'(C.C') + A'B'C + A'C'D' + A'B'D \rightarrow X.0 = X$$

$$AB'C + AB'C' + A'B'C + A'C'D' + A'B'D \rightarrow X.(Y+Z) = X.Y + X.Z$$

$$AB'C' + B'C(A+A') + A'C'D' + A'B'D \rightarrow X.0 = X$$

$$AB'C' + B'C + A'C'D'(B+B') + A'B'D(C+C') \rightarrow X.0 = X$$

$$AB'C' + B'C + A'BC'D' + A'B'C'D' + AB'CD + A'B'C'D \rightarrow X.(Y+Z) = X.Y + X.Z$$

$$AB'C' + B'C + A'BC'D' + A'B'C'(D+D') + AB'CD \rightarrow X+X' = 1$$

$$B'C(1 + CD) + AB'C' + A'BC'D' + A'B'C' \rightarrow (X.Y + X.Z) = X.(Y+Z)$$

$$B'C(1) + AB'C' + A'BC'D' + A'B'C' \rightarrow X+1 = 1$$

$$B'C + A'B'C' + AB'C' + A'BC'D' \rightarrow$$

$$B'C + B'C'(A'+A) + A'BC'D' + A'B'C' \rightarrow X+X' = 1$$

$$B'C + B'C' + A'BC'D' + A'B'C' \rightarrow X.Y + X.Z = X.(Y+Z)$$

$$B'(C+C') + A'BC'D' + A'B'C' \rightarrow X+X' = 1$$

$$B' + A'BC'D' + A'B'C' \rightarrow X.Y + X.Z = X.(Y+Z)$$

$$B' + A'C'(B' + BD') = B' + A'C'((B'+B).(B'+D'))$$

$$B' + A'C'(B'+D') = B' + A'B'C' + A'C'D' = B' \cdot (1+A'C') + A'C'D'$$

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

Question 6

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

$$(C'+D') \cdot (A'+B) \cdot (A'+C') \cdot (A+C) \cdot (A+B') \cdot (C+D) \rightarrow \text{DeMorgan's theorem}$$

$$(C'+D') \cdot (C+D) \cdot (A'+C') \cdot (A+C) \cdot (A'+B) \cdot (A+B') \rightarrow \text{re-arrange}$$

$$((C' \cdot C) + (C'D) + (CD') + (D \cdot D')) \cdot ((A' \cdot A) + (A'B') + (AB) + (B \cdot B')) \rightarrow (X+Y) \cdot (W+Z) = XW + XZ + YW + YZ$$

$$(C'D + CD') \cdot (A'B' + AB) \cdot (A'C + AC') \rightarrow X \cdot X' = 0$$

$$(C'D + CD') \cdot (A'C + AC') \cdot (A'B' + AB) \rightarrow \text{re-arrange}$$

$$(A'CC'D + A'CD'C + AC'C'D + AC'DC) \cdot (A'B' + AB) \rightarrow (X+Y) \cdot (W+Z) = XW + XZ + YW + YZ$$

$$(A'CD' + AC'D) \cdot (A'B' + AB) \rightarrow X \cdot X' = 0$$

$$(A'CD'A'B') + (A'CD'AB) + (AC'DA'B') + (AC'DAB) \rightarrow (X+Y) \cdot (W+Z) = XW + XZ + YW + YZ$$

$$(A'CD'A'B') + 0 + 0 + (AC'DAB) \rightarrow X \cdot X' = 0 / X \cdot 0 = 0$$

$$A'B'CD' + ABC'D \rightarrow X \cdot X = X$$

$$(A'+B'+C+D') + (A+B+C'+D) \rightarrow \text{DeMorgan's theorem}$$

Question 7

a. $xy + x'y z' + yz$

$$x.y + x'y z' + yz.(x+x') \rightarrow x.1 = x$$

$$x.y + x'y z' + x.y.z + x'y z \rightarrow x.(y+z) = x.y + x.z$$

$$x'y z' + x'y z + x.y + x.y.z$$

$$x'y.(z+z') + x.y.1 + x.y.z \rightarrow x.y + x.z = x.(y+z) / x.1 = 1$$

$$x'.y.1 + x.y(z+1) \rightarrow x+x' = 1 / x.y + x.z = x.(y+z)$$

$$x'.y + x.y(z+1) \rightarrow x.1 = x$$

$$x'.y + x.y \rightarrow x+1 = 1$$

$$y(x+x') \rightarrow x.y + x.z = x.(y+z)$$

$$y.1 = 1 \rightarrow x+x' = 1$$

$$= y \rightarrow (x.1 = x)$$

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

$$xy'(z+z') + z + z'x'+z'y \rightarrow x.1 = x$$

$$xy'z + xy'z' + z + x'z'+yz' \rightarrow x.(y+z) = x.y + x.z$$

$$xy'z + xy'z' + z + x'z'(y+y') + yz'(x+x') \rightarrow x.1 = x$$

$$xy'z + xy'z' + z + x'yz' + x'y'z' + xy'z' + x'y'z' \rightarrow x.(y+z) = x.y + x.z$$

$$xy'z' + x'yz' + x'y'z' + x'y'z' + xy'z + z + x'yz'$$

$$x.z'(y+y') + x'z'(y+y') + z + x'yz' + xy'z \rightarrow x.y + x.z = x.(y+z)$$

$$x.z' + x'z' + z + x'yz' + xy'z \rightarrow x+x' = 1$$

$$z'(x+x') + z + x'yz' + xy'z \rightarrow x.y + x.z = x.(y+z)$$

$$z'.1 + z + x'yz' + xy'z \rightarrow x.1 = x$$

$$1 + x'yz' + xy'z \rightarrow x+x' = 1$$

$$= 1 \rightarrow x+1 = 1$$

c. $(xy' + z)(x+y')z$

$$=(xy' + z).(xz + y'z) \rightarrow X.(Y+Z) = X.Y + X.Z$$

$$xy'xz + xy'y'z + x.z.z + z.y'.z \rightarrow (X+Y).(W+Z) = X.W+X.Z+Y.W+Y.Z$$

$$xy'z + x.y'.z + x.z + z.y' \rightarrow X.X=X$$

$$xy'z + x.z.1 + x.y'.z + z.y' \rightarrow X.1=X$$

$$x.z(y'+1) + zy'(x+1) \rightarrow X.Y + X.Z = X.(Y+Z)$$

$$x.z + z.y' \rightarrow X+1=1$$

$$z(x+y')$$

Question 8

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

$$((a+b).a'b') + (a+b.c) + (c'.a'.b') + (c'.c) \rightarrow (x+y).(w+z) = x.z+x.w+y.w+yz$$

$$a'.b.a + a'b'.b + a.c + b.c + a'.b'.c' + 0 \rightarrow x.x' = 0$$

$$0 + 0 + a.c + b.c + a'.b'.c' \rightarrow x.x'=0$$

$$a.c + b.c + a'.b'.c' \rightarrow x+0=x$$

b. $a'.b'.c + a.b'.c + a.b.c + a'.b.c$

$$b'.c(a+a') + b.c(a+a') \rightarrow x.y+x.z=x.(y+z)$$

$$b'.c.1 + b.c.1 \rightarrow x+x'=1$$

$$b'.c + b.c \rightarrow x.1=x$$

$$c.(b+b') \rightarrow x.y+x.z=x.(y+z)$$

$$c.1 \rightarrow x+x'=1$$

$$=c \rightarrow x.1=x$$

Question 9

$$F = A.C + BD$$

$$F' = (A.C + BD)' = (A' + C') \cdot (B' + D')$$

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

$$F F' = 0$$

$$(A.C + BD) \cdot (A'B' + A'D' + B'C' + C'D')$$

$$ACA'B' + ACA'D' + BDA'B' + A'BDD' + ACC'B' + ACC'D' + BDC'B' + BDC'D' = 0$$

$$F + F' = 1$$

$$\text{Let } AC = M \quad BD = N \quad F = M+N \quad F' = M'.N'$$

$$M+N+M'.N' = (M+N+M').(M+N+N') = 1.1 = 1$$

Question 10

$$z + z'(v'w + xy)$$

$$(z + z'(v'w + xy))' = z'.z + (v'w + xy)'$$

$$= z'.z + ((v+w').(x'+y'))$$

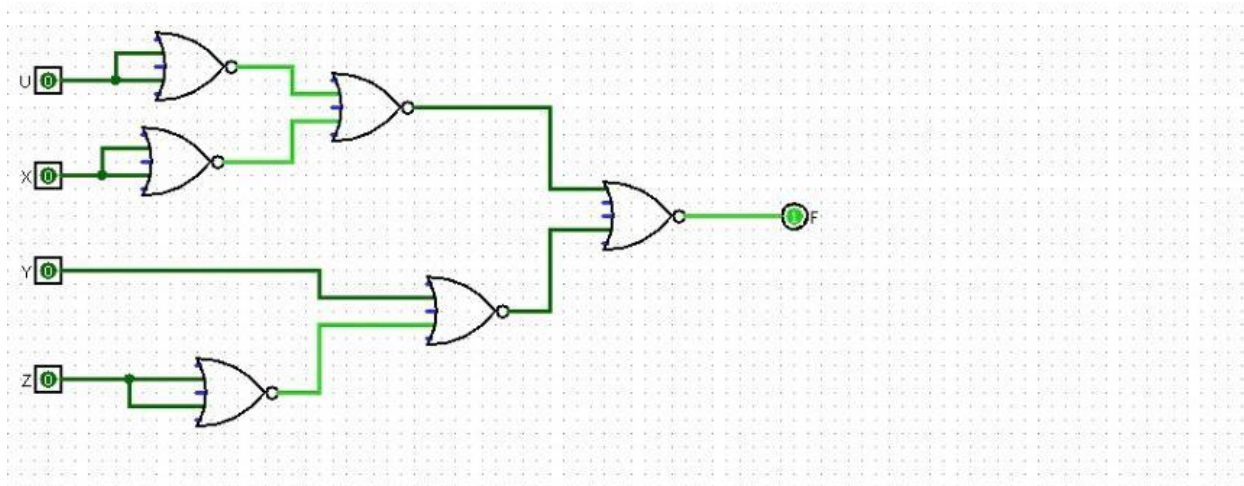
$$= (z'.z) + (z'.(v+w').(x'+y'))$$

$$= 0 + (z'.(v+w').(x'+y'))$$

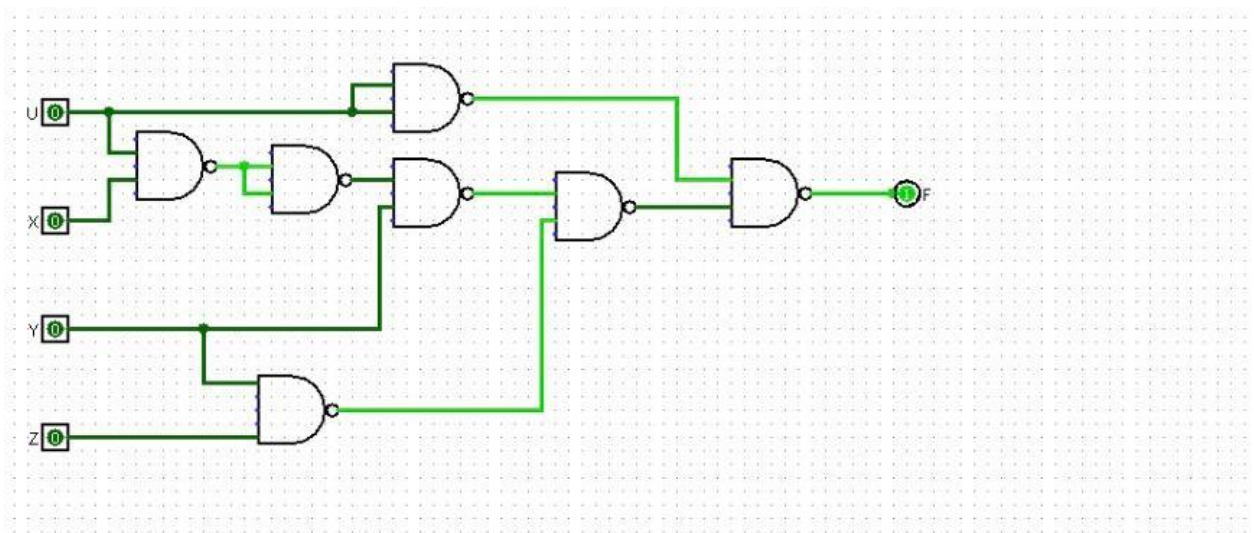
$$= z'(v+w')(x'+y')$$

Question 11

$$a. (u' + x') \cdot (y + z')$$



b. $F = u + (yz + uxy)'$



Question 12

A	B	C	D	$ad+bcd+ab'c'+b'c'd'$
0	0	0	0	1
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	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

$$ad+bcd+ab'c'+b'c'd'$$

$$ad(b+b').(c+c') + bcd(a+a') + ab'c'(d+d') + b'c'd'(a+a')$$

$$= abcd + abc'd + ab'cd + ab'c'd + abcd + a'bcd + ab'c'd + ab'c'd' + ab'c'd' + a'b'c'd'$$

$$= m_{15} + m_{13} + m_{11} + m_9 + m_{15} + m_7 + m_9 + m_8 + m_0$$

$$= \sum_m (0, 7, 8, 9, 11, 13, 15) \rightarrow \text{sum of minterms}$$

$$\prod_M (1, 2, 3, 4, 5, 6, 10, 12, 14) \rightarrow \text{sum of maxterms}$$