Digital Logic Design - Chapter 2

1S. Write the truth table for each of the following functions.

a) $F(X,Y) = X + X.Y$

b) $F(X,Y,Z) = X.Y + X.Z$

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

Solution

a) $F(X,Y) = X + X.Y$

X	Y	F(X,Y,Z)
0	0	0
0	1	0
1	1	1
1	0	1

b) $F(X,Y,Z) = X.Y + X.Z$

X	Y	Z	F(X,Y,Z)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

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

X	Y	Z	F(X,Y,Z)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

1U. Write the truth table for each of the following functions.

a) $F(S,R) = S + \overline{S}.R$

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

c) $F(A,B,C,D) = A.B.C.D + A.\overline{B} + \overline{A}.C.\overline{D} + A.B.C$

Solution

2S. Expand the function, $F(M,R,S) = \overline{S} + \overline{M}.R$, to its canonical or standard Sum-Of-Product(SOP) form:

Solution

M	R	S	F(M,R,S)	Min-term, m
0	0	0	1	0
0	0	1	0	1
0	1	0	1	2
0	1	1	1	3
1	0	0	1	4
1	0	1	0	5
1	1	0	1	6
1	1	1	0	7

F (M, R, S) = Σ(0, 2, 3, 4, 6) = $\overline{M}.\overline{R}.\overline{S} + \overline{M}.R.\overline{S} + \overline{M}.R.S + M.\overline{R}.\overline{S} + M.R.\overline{S}$

2U. Expand the function, $F(P,Q,T,U) = \overline{P}.Q.\overline{T} + \overline{Q}.T.\overline{U}$, to its canonical or standard Sum-Of-Product(SOP) form:

Solution

3S. Expand the function, $F(M,R,S) = \overline{S}.R + \overline{M}.R$, to its canonical or standard Product-Of-Sum (POS) form:

Solution:

M	R	S	F(M,R,S)	Max-term, M
0	0	0	0	0
0	0	1	0	1
0	1	0	1	2
0	1	1	1	3
1	0	0	0	4
1	0	1	0	5
1	1	0	1	6
1	1	1	0	7

F (M, R, S) = π(0,1, 4, 5, 7) = (M+R+S). (M+R+S'). (M'+R+S). (M'+R+S').(M'+R'+S').

3U. Expand the function, $f(A_3, A_2, A_1, A_0) = A_3A_2 + (A_1' + A_0).A_3'$ to its canonical or standard Product-Of-Sum (POS) and Sum-Of-Product (SOP) forms:

Solution:

4S. Write the corresponding compact min-terms for each of the functions (f1, f2 and f3) shown in the following truth table:

X	Y	Z	F1	F2	F3	F4	Minterm
0	0	0	0	0	1	0	0
0	0	1	0	1	1	0	1
0	1	0	0	0	1	1	2
0	1	1	1	1	0	1	3
1	0	0	1	1	0	1	4
1	0	1	1	0	1	1	5
1	1	0	0	1	0	1	6
1	1	1	1	0	0	0	7

Solution:

$F_1(X,Y,Z) = \Sigma(3, 4, 5, 7)$
$F_2(X,Y,Z) = \Sigma(1, 3, 4, 6)$
$F_3(X,Y,Z) = \Sigma(0, 1, 2, 5)$
$F_4(X,Y,Z) = \Sigma(2, 3, 4, 5, 6)$

4U. Write the corresponding compact min-terms for each of the functions (Fa, Fb and Fc) shown in the following truth table:

A	B	C	Fa	Fb	Fc
0	0	0	1	0	1
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	1	1	1
1	0	0	1	1	0
1	0	1	0	0	1
1	1	0	0	0	0
1	1	1	1	0	1

Solution:

5S. Each of the following functions is written in a form that is equivalent to the complement of the standard POS form of F. Write each function in a standard POS form of F and also in a standard SOP form of F. Leave each result in a compact or list form.

a) $\overline{F}(P,Q,R,S) = \Sigma(0, 5, 9, 13)$
b) $\overline{F}(P,Q,R,S) = \Sigma(3,6,8,14)$
c) $\overline{F}(P,Q,R,S) = \Sigma(4,5,6,7)$
d) $\overline{F}(P,Q,R,S) = \Sigma(12,13,14,15)$

Solution:

a) $\overline{F}(P,Q,R,S) = \Sigma(0, 5, 9, 13)$
$F(P,Q,R,S) = \pi(0, 5, 9, 13)$
$F(P,Q,R,S) = \Sigma(1,2,3,4,6,7,8,10,11,12,14,15)$

b) $\overline{F}(P,Q,R,S) = \Sigma(3,6,8,14)$
$F(P,Q,R,S) = \pi(3,6,8,14)$
$F(P,Q,R,S) = \Sigma(0,1,2,4,5,7,9,10,11,12,13,15)$

c) $\overline{F}(P,Q,R,S) = \Sigma(4,5,6,7)$
$F(P,Q,R,S) = \pi(4,5,6,7)$
$F(P,Q,R,S) = \Sigma(0,1,2,3,8,9,10,11,12,13,14,15)$

d) $\overline{F}(P,Q,R,S) = \Sigma(12,13,14,15)$
$F(P,Q,R,S) = \pi(12,13,14,15)$
$F(P,Q,R,S) = \Sigma(0,1,2,3,4,5,6,7,8,9,10,11)$

5U. Each of the following functions is written in a form that is equivalent to the complement of the standard POS form of F. Write each function in a standard POS form of F and also in a standard SOP form of F. Leave each result in a compact or list form.

a) $\overline{F}$ (R, S, T, U) = Σ (0, 1, 4, 9, 13)

b) $\overline{F}$ (R, S, T, U) = Σ (4, 5, 10, 11, 15)

Solution:

6S. Write the expression for each of the following functions in terms of the independent variables.

a) $F(V,W,X,Y,Z) = m_0 + m_6 + m_{23}$

b) $F(U,V,W,X,Y,Z) = m_{19} + m_{22} + m_{30}$

c) $F(U,V,W,X,Y,Z) = m_{25} + m_{35} + m_{47}$

d) $F(T,U,V,W,X,Y,Z) = m_{55} + m_{67} + m_{93}$

Solution:

a) $F(V,W,X,Y,Z) = m_0 + m_6 + m_{23}$

$F(V,W,X,Y,Z) = \overline{V}.\overline{W}.\overline{X}.\overline{Y}.\overline{Z} + \overline{V}.\overline{W}.X.Y.\overline{Z} + V.\overline{W}.X.Y.Z$

b) $F(U,V,W,X,Y,Z) = m_{19} + m_{22} + m_{30}$

$F(U,V,W,X,Y,Z) = \overline{U}.V.\overline{W}.\overline{X}.Y.Z + \overline{U}.V.\overline{W}.X.Y.\overline{Z} + \overline{U}.V.W.X.Y.\overline{Z}$

c) $F(U,V,W,X,Y,Z) = m_{25} + m_{35} + m_{47}$

$F(U,V,W,X,Y,Z) = \overline{U}.V.W.\overline{X}.\overline{Y}.Z + U.\overline{V}.\overline{W}.\overline{X}.Y.Z + U.\overline{V}.W.X.Y.Z$

d) $F(T,U,V,W,X,Y,Z) = m_{55} + m_{67} + m_{93}$

$F(T,U,V,W,X,Y,Z) = \overline{T}.U.V.\overline{W}.X.Y.Z + T.\overline{U}.\overline{V}.\overline{W}.\overline{X}.Y.Z + T.\overline{U}.V.W.X.\overline{Y}.Z +$

6U. Write the expression for each of the following functions in terms of the independent variables.

a) $F(A,B,C,D,E) = m_3 + m_{12} + m_{24} + m_{31}$

b) $F(A,B,C,D,E,F) = m_8 + m_{14} + m_{29} + m_{39} + m_{53} + m_{62}$

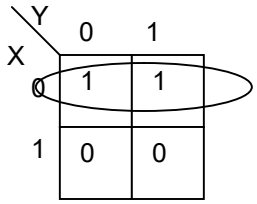
Solution:

7S. Enter each of the following functions on a K-map and find a minimum SOP form for each function. Identify each product term by circling adjacent groups of 1s.

a) F(X,Y)= Σ(0,1)
b) F(X,Y)= Σ(1,3)
c) F(X,Y)= Σ(2,3)
d) F(X,Y)= π (1,3)

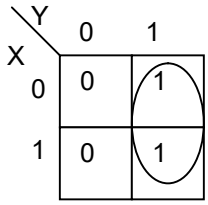
Solution:

a) F(X,Y)= Σ(0,1)



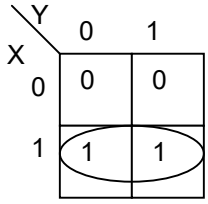
$$F(X,Y) = \overline{X}$$

b) F(X,Y)= Σ(1,3)



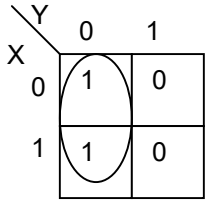
$$F(X,Y) = Y$$

c) F(X,Y)= Σ(2,3)



$$F(X,Y) = X$$

d) F(X,Y)= π (1,3)



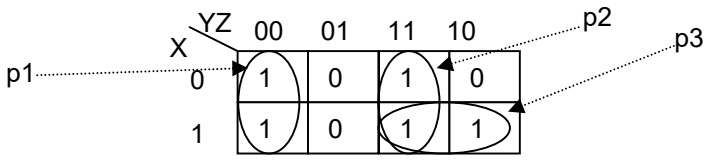
$$F(X,Y) = Y'$$

7U. Enter each of the following functions on a K-map and find a minimum SOP form for each function. Identify each product term by circling adjacent groups of 1s.

a) F(P, Q, R, S)= Σ(0, 2, 3, 6, 7, 10,11)
b) F(P, Q, R, S)= Σ(0, 1, 3, 5, 7, 14, 15)

Solution:

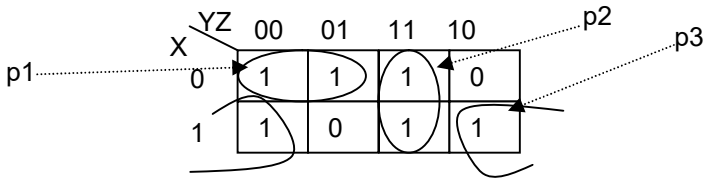
8S. Obtain the product terms of p1, p2 and p3 circled in the following figure and verify that each product term evaluates to 1 for its respective input combinations. Use the p-terms to write the functions in sum-of-products form.



Solution:

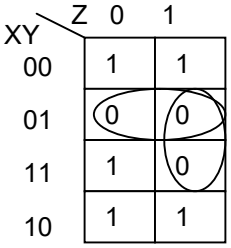
F(X,Y,Z) = Y'.Z' + Y.Z + X.Y

8U. Obtain the product terms of p1, p2 and p3 circled in the following figure and verify that each product term evaluates to 1 for its respective input combinations. Use the p-terms to write the functions in sum-of-products form.



Solution:

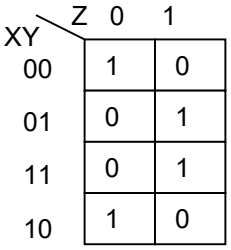
9S. Write all the essential prime implicants for the 0s of the function in the map shown in figure below. Use these implicants to obtain a minimum SOP expression for the complement of the function.



Solution:

f(X,Y,Z) = X'.Y + Y.Z SOP of complement of the function

9U. Write all the essential prime implicants for the 0s of the function in the map shown in figure below. Use these implicants to obtain a minimum SOP expression for the complement of the function.

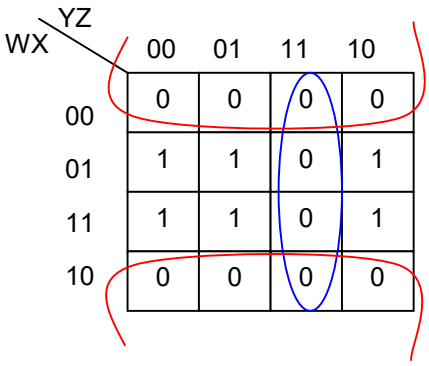


Solution:

10S. Using a K-map, obtain the minimum POS expression for the following Boolean function.

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

Solution:



F(W,X,Y,Z) = (X) . (Y' + Z')

10U. Using a K-map, obtain the minimum POS expression for the following Boolean function.

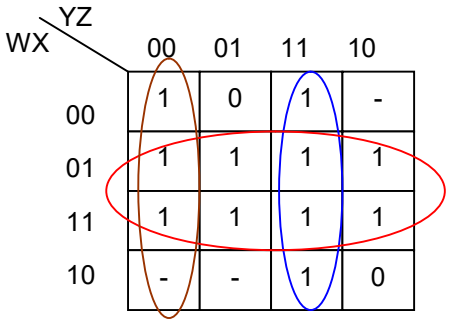
F(A, B, C, D)= $A.\overline{B}C.\overline{D} + A.\overline{B}.\overline{C}.\overline{D} + A.\overline{B}D + \overline{A}.\overline{B}C.\overline{D} + \overline{A}.\overline{B}.\overline{C}.\overline{D}$

Solution:

11S. Obtain the minimum SOP expression for the following Boolean function using a K-map and SAR.

F(W,X,Y,Z)= Σ(0,3,4,5,6,7,11,12,13,14,15) + Σ md(2,8,9)

Solution



F(W,X,Y,Z) = Y'.Z' + Y.Z + X

11U. Obtain the minimum SOP expression for the following Boolean function using a K-map and SAR.

F(A, B, C, D)= Σ(0,4,5,7,8,10,12,13,14,15) + Σ md(9,11)

Solution