

**Sheet 3**  
**Function Optimization**

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1. For the Boolean function F and its complement , do the following:

- Optimize using map into SoP form.
- Optimize using map into PoS form.
- Optimize using Tabular (Quine-McCluskey) method.
- Find the minterms and maxterms.
- Draw its logic diagram by two different ways.

a.  $F(A,B) = \sum_m (1,2)$

b.  $F(A,B) = \prod_M (0,1,3)$

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

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

e.  $F(A,B,C) = \sum_m (0,1,7)$

f.  $F(A,B,C) = \sum_m (2,4,6)$

g.  $F(X,Y,Z) = \sum_m (0,1,3,5,6)$

h.  $F(A,B,C) = \prod_M (0,1,5,6)$

i.  $F(A,B,C) = \prod_M (3,6,7)$

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

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

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

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

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

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

p.  $F(A,B,C,D) = \sum_m (0,1,2,5,6)$

q.  $F(A,B,C,D) = \sum_m (0,1,2,3,4,6,8,9,10,11)$

r.  $F(A,B,C,D) = \sum_m (0,5,8,9,11,12,13,14)$

s.  $F(W,X,Y,Z) = \sum_m (1,3,6,7,10,11,13,15)$

t.  $F(W,X,Y,Z) = \sum_m (0,1,4,5,10,12,14)$

u.  $F(W,X,Y,Z) = \prod_M (0,1,2,4,7,8,9,10,12,15)$

v.  $F(W,X,Y,Z) = \prod_M (0,2,5,6,9,11,12,15)$

w.  $F(W,X,Y,Z) = \prod_M (3,5,7,11,13,15)$

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

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- y.  $F(A,B,C,D) = \overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}D + \overline{A}BC\overline{D} + \overline{A}BCD + A\overline{B}\overline{C}\overline{D}$
- z.  $F(A,B,C,D) = ABC\overline{C} + \overline{B}C\overline{D} + BC + ACD + \overline{A}BC + \overline{A}\overline{B}\overline{C}D$
- aa.  $F(A,B,C,D) = B\overline{C} + \overline{A}B + BCD + \overline{A}BD + \overline{A}\overline{B}\overline{C}D$
- bb.  $F(A,B,C,D) = \overline{A}\overline{B} + \overline{B}\overline{C} + CD + \overline{A}D$
- cc.  $F(A,B,C,D) = (A \oplus B).C + \overline{A}(\overline{B} \oplus C)$
- dd.  $F(W,X,Y,Z) = (W + X + \overline{Y} + \overline{Z})(\overline{X} + \overline{Y} + Z)(\overline{W} + Y + \overline{Z})$
- ee.  $F(V,W,X,Y,Z) = \overline{V}WX + W\overline{X}\overline{Y} + WZ + \overline{X}\overline{Z}$
- ff.  $F(A,B,C,D,E) = \overline{A}\overline{B}C\overline{E} + \overline{A}\overline{B}\overline{C}\overline{D} + \overline{B}C\overline{D} + C\overline{D}\overline{E} + B\overline{D}\overline{E}$
- gg.  $F(A,B,C,D,E) = ABE(\overline{C}D + \overline{D}) + \overline{A}(\overline{C}E + \overline{B}D)$
- hh.  $F(V,W,X,Y,Z) = \sum m(1,3,9,13,26,27,30,31)$
- ii.  $F(V,W,X,Y,Z) = \sum m(0,2,4,6,9,10,13,14,15,16,17,21,26,28,30,31)$
- jj.  $F(A,B,C,D,E) = \prod M(0,1,5,7,11,16,18,22,25,29,31)$
- kk.  $F(A,B,C,D,E) = \prod M(0,4,8,12,16,20,24,28)$
- ll.  $F(V,W,X,Y,Z) = \sum m(6,7,8,9,12,13,18,22,23,24,25,28,29)$
- mm.  $F(A,B,C,D,E) = \sum m(0,2,4,6,9,13,21,23,25,29,31)$
- nn.  $F(A,B,C,D,E) = (A + \overline{B} + \overline{C})(\overline{A} + D + \overline{E})(\overline{C} + \overline{D} + E)(B + \overline{C})$
- oo.  $F(A,B,C) = \sum m(4,5) + d(0,6,7)$
- pp.  $F(A,B,C) = \prod M(0,1,2,4,5) + d(3,6,7)$
- qq.  $F(W,X,Y,Z) = \sum m(1,4,8,9,13,14,15) + d(2,3,11,12)$
- rr.  $F(A,B,C,D) = ACD + B\overline{D} + \overline{B}C + \overline{B}\overline{C} + \overline{B}D + \overline{C}\overline{D} + d(\overline{A}B\overline{C}D)$
- ss.  $F(A,B,C,D) = B\overline{C}\overline{D} + \overline{A}\overline{B}D + A\overline{C}D + \overline{A}BC + \overline{A}\overline{B}\overline{C}D$   
 $+ d(\overline{A}\overline{B}\overline{C}\overline{D} + ABC + A\overline{B}C\overline{D})$
- tt.  $F(A,B,C,D) = \sum m(0,2,3,5,6,7,8,10,11) + d(14,15)$
- uu.  $F(A,B,C,D) = \prod M(1,3,5,9,12,14) + d(4,11,15)$
- vv.  $F(V,W,X,Y,Z) = \prod M(0,1,2,3,4,5,6,8,10,26) + d(14,16,17,18,19,20,21,23,30)$

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2. A logic circuit implements the following Boolean function:  $F(A, B, C, D) = \bar{A}C + A\bar{C}D$ , It is found that the circuit input combination  $A=C=1$  can never occur. Find a simpler expression for F.
  
3. Draw the logic diagram of the following Boolean function using only the mentioned gates (note that simplification must be done first).
 

a. $F(X, Y) = \sum_m (0, 3)$	ANDs - OR - NOTs
b. $F(A, B, C) = \sum_m (0, 1, 2, 4, 6)$	ORs – AND - NOTs
c. $F(X, Y, Z) = \prod_M (2, 3, 4, 7)$	ANDs – OR - NOTs
d. $F(A, B, C) = \sum_m (0, 1, 3, 5, 6)$	NORs only
e. $F(A, B, C) = (A\bar{B} + C)(\bar{A} + B)(A + \bar{C})$	ORs – AND - NOTs
f. $F(A, B, C) = AB + BC + \bar{A}C + \bar{A}\bar{B}C$	ORs - AND - NOTs
g. $F(X, Y, Z) = (X + \bar{Y} + X\bar{Y})(XY + \bar{X}Z + YZ)$	NORs only
h. $F(A, B, C, D) = \sum_m (0, 2, 5, 6, 9, 11, 12, 15)$	ANDs – OR - NOTs
i. $F(A, B, C, D) = \sum_m (0, 5, 8, 9, 11, 12, 13, 14)$	ANDs – OR - NOTs
j. $F(W, X, Y, Z) = \sum_m (0, 4, 6, 10, 11, 13)$	NANDs only
k. $F(W, X, Y, Z) = \prod_M (1, 3, 4, 5, 6, 7, 9, 10, 11, 14)$	ANDs - OR - NOTs
l. $F(W, X, Y, Z) = \prod_M (1, 5, 9, 13, 14, 15)$	NORs only
m. $F(A, B, C, D) = \sum_m (1, 3, 10, 12, 13, 14)$	ORs - NANDs
n. $F(A, B, C, D) = AD + \bar{A}CD + ABC\bar{D}$	NORs only
o. $F(A, B, C, D) = \bar{A}D + BD + \bar{B}C + A\bar{B}D$	ANDs – NORs
p. $F(W, X, Y, Z) = W\bar{X} + \bar{Y}\bar{Z} + \bar{W}YZ$	ANDs - OR - NOTs
q. $F(W, X, Y, Z) = W(X + Y + Z) + WYZ$	ORs – AND – NOTs
r. $F(W, X, Y, Z) = (W + X + Z)(W + \bar{X})(\bar{W} + Y + \bar{Z})$	ORs-NANDs
s. $F(A, B, C, D) = (AB + C)(B + \bar{C}D)$	NANDs only
t. $F(A, B, C, D) = (\bar{A} + C)(\bar{A} + \bar{C})(A + B + C + \bar{D})$	AND - ORs – NOTs
u. $F(A, B, C, D, E) = \sum_m (0, 2, 3, 6, 7, 8, 9, 13)$	ORs - AND - NOTs
v. $F(A, B, C, D, E) = \sum_m (0, 4, 18, 19, 22, 23, 25, 29)$	NORs only
w. $F(V, W, X, Y, Z) = \prod_M (3, 10, 12, 17, 22, 31)$	ANDs - OR - NOTs
x. $F(V, W, X, Y, Z) = \bar{V}WX + W\bar{X}\bar{Y} + WZ + \bar{X}\bar{Z}$	ANDs - OR – NOTs
y. $F(A, B, C) = \sum_m (4, 5) + d(0, 1, 7)$	ORs – AND – NOTs
z. $F(A, B, C, D) = \prod_M (1, 3, 5, 9, 12, 14) + d(4, 11, 15)$	ANDs – NORs

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aa.  $F(V,W,X,Y,Z) = \sum_m(3,10,28,29,30)$   
 $+ d(18,25,13,14,15)$

NORs only

4. Draw the logic diagram of the following Boolean functions using:

- NANDs only
- NORs only

a.  $F(A,B,C) = \bar{A} + (BC + \bar{C})(ABC + \bar{B})$

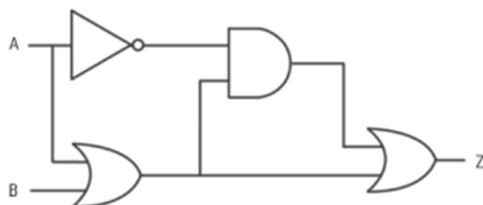
b.  $F(X,Y,Z) = X + Y(X + Z)(\bar{X} + \bar{Z})$

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

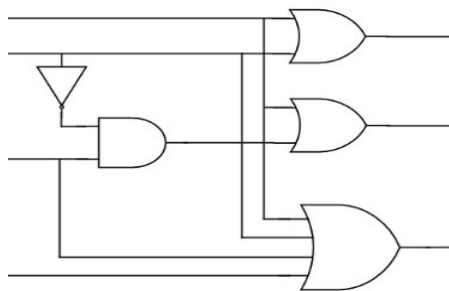
d.  $F(A,B,C,D) = \bar{A}D + BD + \bar{B}C + A\bar{B}D$

e.  $F(A,B,C,D,E) = (A + \bar{B} + \bar{C})(\bar{A} + D + \bar{E})(\bar{C} + \bar{D} + E)(B + \bar{C})$

f.

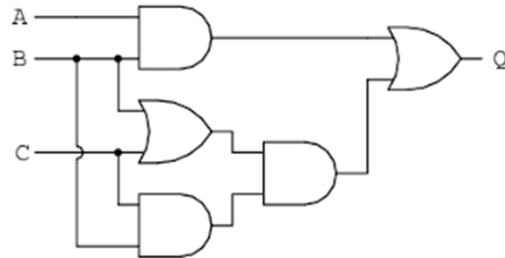


h.

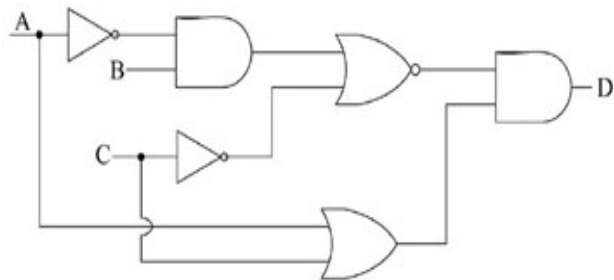


j.

g.

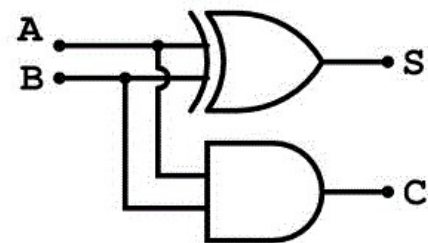
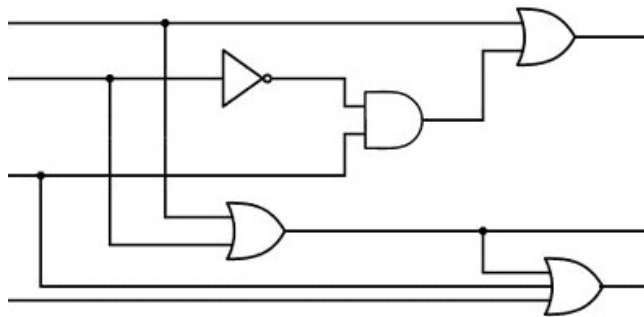


i.

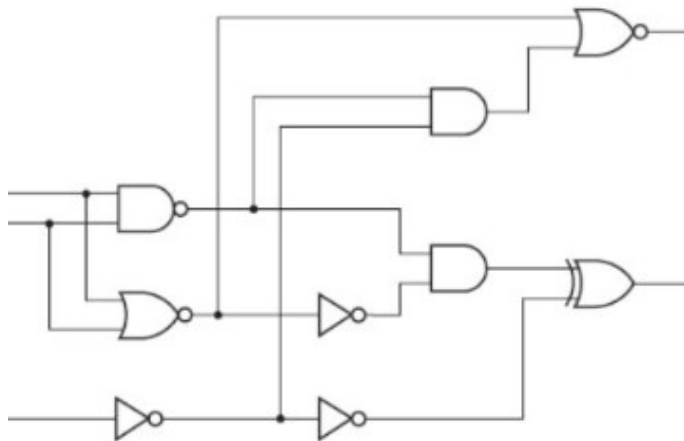


k.

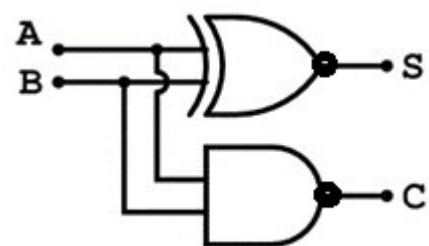
### Sheet 3 Function Optimization



1. .



m.



n.

