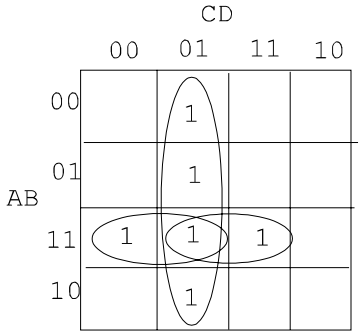
CS/EE 260M
Homework 3 Solutions

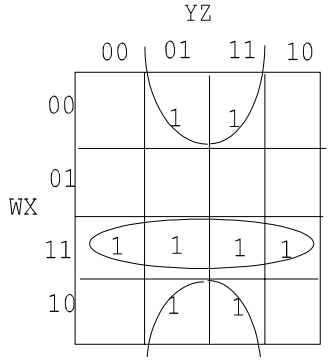
1. (MK 2-16)
Simplify the following Boolean functions by means of a four-variable map:
(a) F(A,B,C,D) = $\sum m$ (1,5,9,12,13,15)
(b) F(W,X,Y,Z) = $\sum m$ (1,3,9,11,12,13,14,15)
(c) F(A,B,C,D) = $\sum$m (0,2,4,5,6,7,8,10,13,15)

(a) F(A,B,C,D) = $\sum m$ (1,5,9,12,13,15)



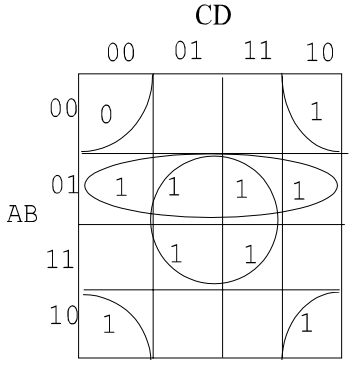
F = AB(C′ + D) + C′D

(b) F(W,X,Y,Z) = $\sum m$ (1,3,9,11,12,13,14,15)



F = WX + X′Z

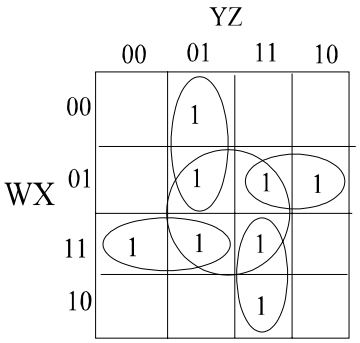
(c) F(A,B,C,D) = $\sum$m (0,2,4,5,6,7,8,10,13,15)



F = A′B + BD + B′D′

2. (MK 2-20)
   Simplify the following Boolean functions by finding all prime implicants and essential prime implicants and applying the selection rule:
   (a) F(W,X,Y,Z) = $\sum m$ (1,5,6,7,11,12,13,15)
   (b) F(A,B,C,D) = $\sum m$ (1,3,4,5,7,8,9,12)
   (c) F(W,X,Y,Z) = $\sum m$ (0,1,2,5,6,7,8,9,10,13,14,15)

(a) F(W,X,Y,Z) = $\sum m$ (1,5,6,7,11,12,13,15)

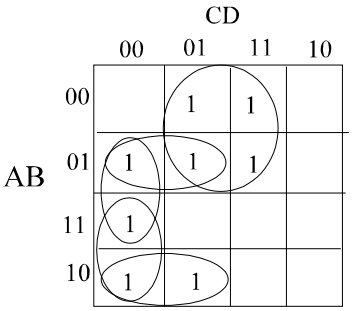


prime implicants: XZ, WXY′, W′XY, W′Y′Z, WYZ

all are essential, so

F = XZ + WXY′ + W′XY + W′Y′Z + WYZ

(b) F(A,B,C,D) = $\sum m$ (1,3,4,5,7,8,9,12)



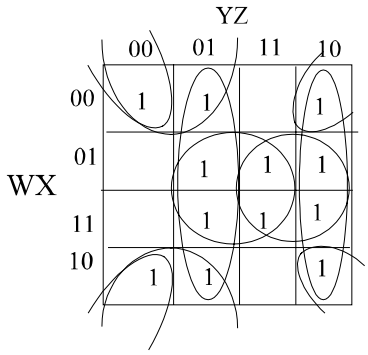
prime implicants: A′D, A′BC′, BC′D′, AC′D′, AB′C′

essential: A′D, AB′C′

so select BC′D′ to complete cover

F = A′D + AB′C′ + BC′D′

(c) F(W,X,Y,Z) = $\sum m$ (0,1,2,5,6,7,8,9,10,13,14,15)



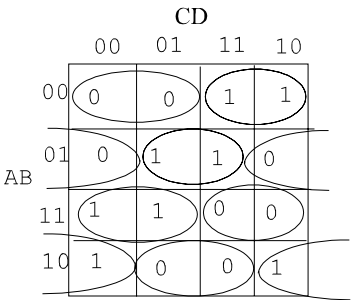
prime implicants: XZ, XY, YZ′, Y′Z, X′Z′, X′Y′

essential: none

F = XZ + YZ′ + X′Y′

3. (MK 2-23)
Simplify the follwoing functions into (1) sum-of-products and (2) product.
(a) F(A,B,C,D) = Σm (2,3,5,7,8,10,12,13)
(b) F(W,X,Y,Z) = ΠM (2,10,13)

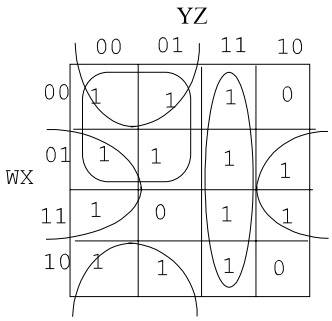
(a) F(A,B,C,D) = Σm (2,3,5,7,8,10,12,13)



1) F = A′B′C + A′BD + ABC′ + AB′D′

2) F′ = A′B′C′ + A′BD′ + ABC + AB′D
F = (A+B+C)(A+B′+D)(A′+B′+C′)(A′+B+D′)

(b) F(W,X,Y,Z) = ΠM (2,10,13)

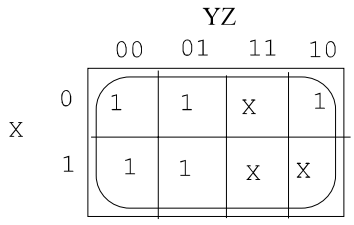


1) F = XZ′ + X′Y′ + YZ + W′Y′

2) F′ = X′YZ′ + WXY′Z
F = (X+Y′+Z)(W′+X′+Y+Z′)

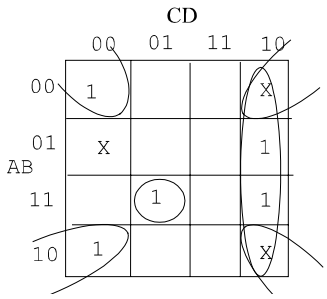
4. (MK 2-24)
Simplify the following Boolean functions *F* together with the don't-care conditions *d*:
(a) F(X,Y,Z) = Σm(0,1,2,4,5), *d*(X,Y,Z) = Σm(3,6,7)
(b) F(A,B,C,D) = Σm(0,6,8,13,14), *d*(A,B,C,D) = Σm(2,4,10)
(c) F(A,B,C,D) = Σm(1,3,5,7,9,15), *d*(A,B,C,D) = Σm(4,6,12,13)

(a) F(X,Y,Z) = Σm(0,1,2,4,5), *d*(X,Y,Z) = Σm(3,6,7)



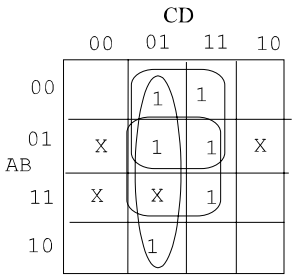
F = 1

(b) F(A,B,C,D) = $\sum m$(0,6,8,13,14), d(A,B,C,D) = $\sum$m(2,4,10)



F = CD′ + B′D′ + ABC′D

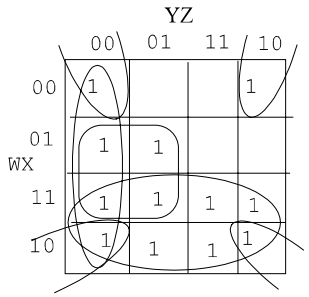
(c) F(A,B,C,D) = $\sum m$(1,3,5,7,9,15), d(A,B,C,D) = $\sum$m(4,6,12,13)



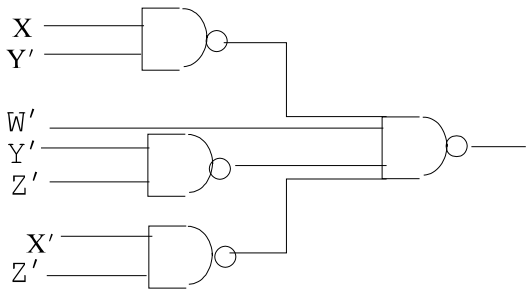
F = C′D + A′D + BD

5. (MK 2-27)
   Simplify each of the following expressions, and implement them with NAND gates. Assume that both true and complement versions of the input variables are available.
   (a) WX′ + WXZ + W′Y′Z′ + W′XY′ + WXZ′ (b) XZ + XYZ′ + WX′Y′

(a) WX′ + WXZ + W′Y′Z′ + W′XY′ + WXZ′

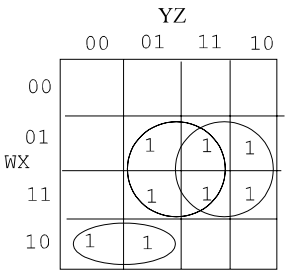


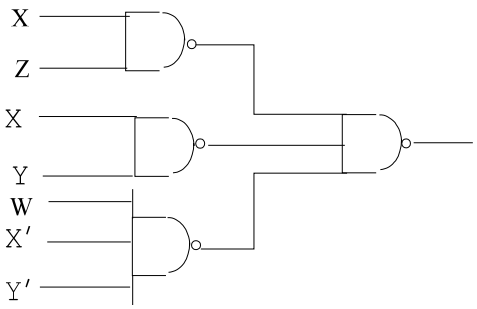
F = XY′ + W + Y′Z′ + X′Z′



(b) XZ + XYZ′ + WX′Y′

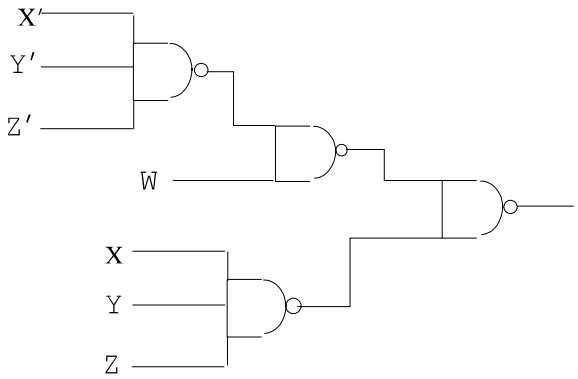
F = XZ + XY + WX′Y′



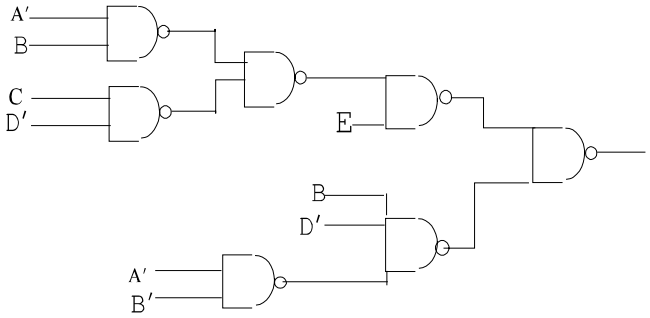


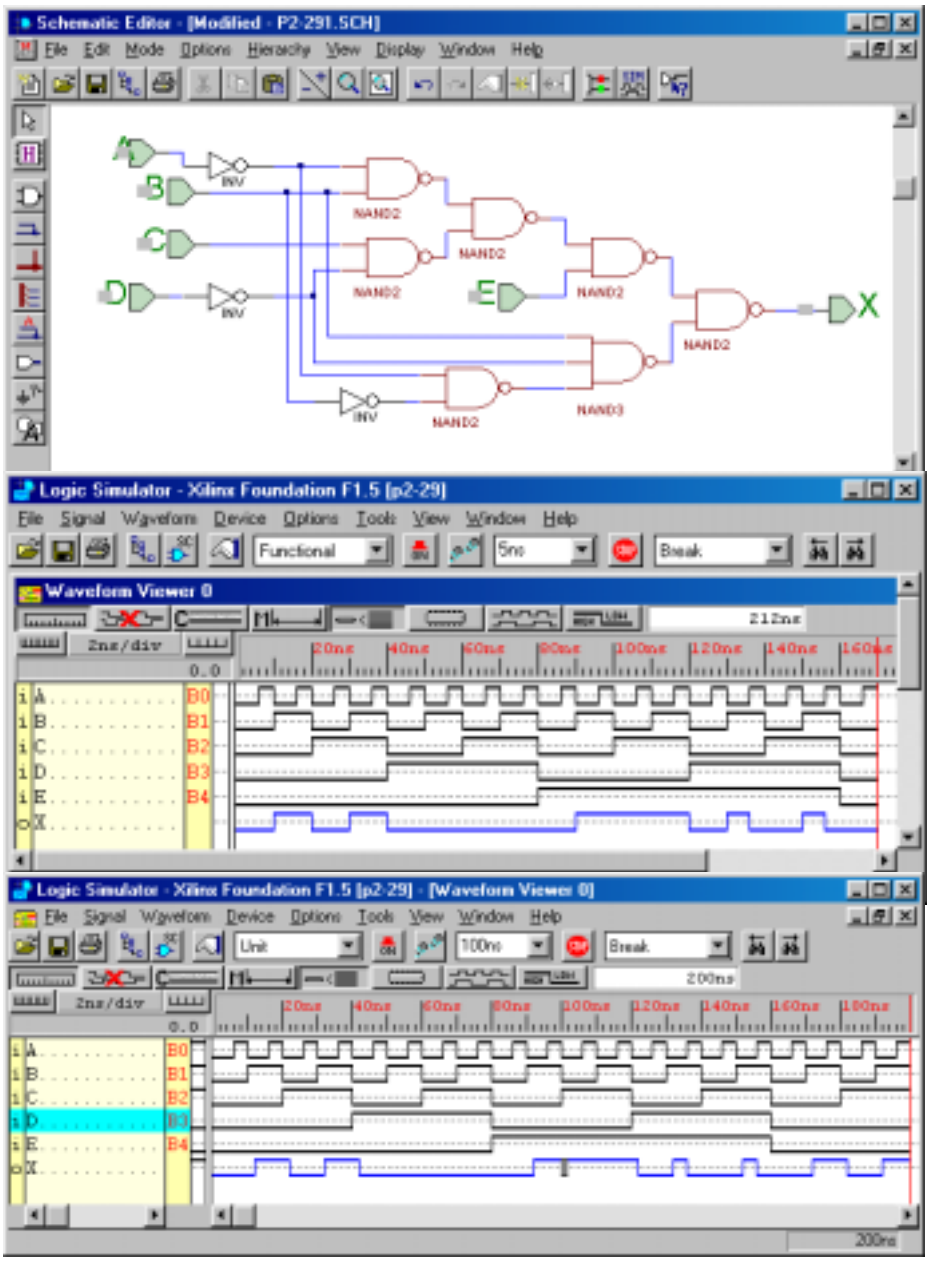
6. (MK 2-29)
   Draw the NAND logic diagram for each of the following questions using a multiple-level NAND circuit:
   (a) W(X+Y+Z) + XYZ
   (b) (A′B + CD′)E + BD′(A + B)

(a) W(X+Y+Z) + XYZ



(b) (A′B + CD′)E + BD′(A + B)


A′
B
C
D′
E
B
D′
A′
B′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File Edit Mode Options Hierarchy View Display Window Help
INV
NAND2
NAND3
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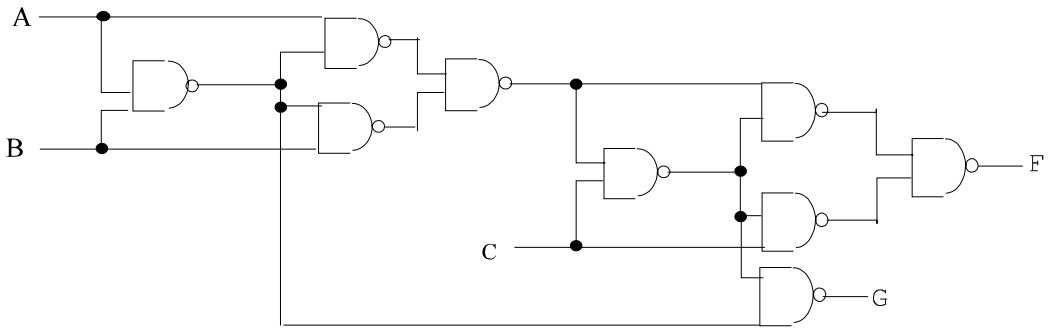
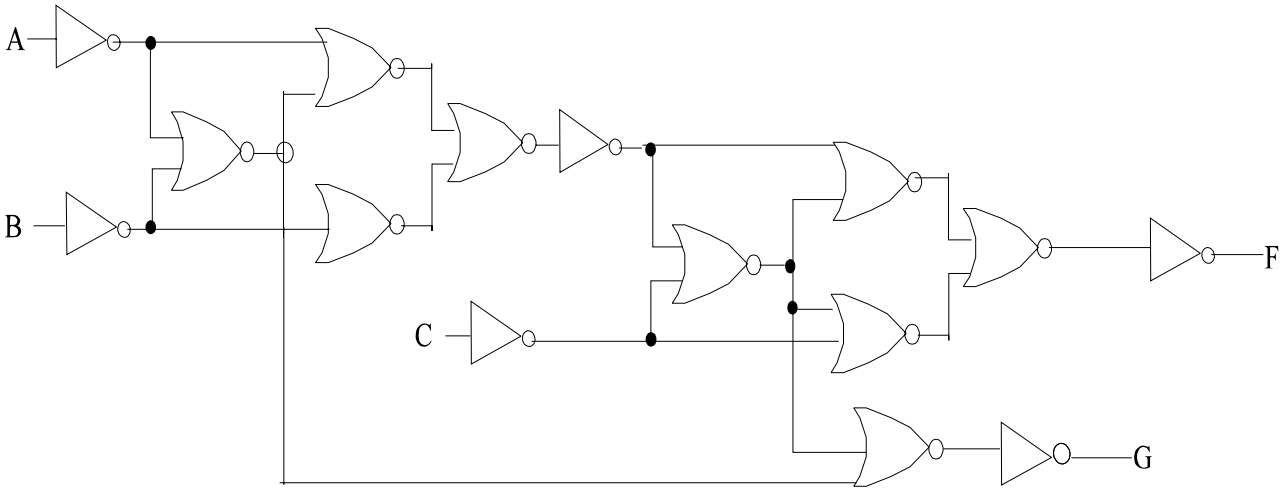
Logic Simulator - Xilinx Foundation F1.5 [p2-29]
File Signal Waveform Device Options Tools View Window Help
Functional
Break
Waveform Viewer 0
2ns/div
A
B
C
D
E
X
Logic Simulator - Xilinx Foundation F1.5 [p2-29] - [Waveform Viewer 0]
File Signal Waveform Device Options Tools View Window Help
Unit
Break
2ns/div

7. (MK 2-32)
Convert the AND/OR/NOT logic diagram in Figure 2-46 to a) a NAND logic diagram and b) a NOR logic diagram

a) a NAND logic diagram



b) a NOR logic diagram



8.

When A, B or C changes, the output can change after 3 ns. This is the minimum.

Changes in C or D can cause output changes after 6 ns. This is the maximum.