Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG115/INFE115 Introduction to Logic Design

EENG211/INFE211 Digital Logic Design I

Spring 2009-10

<u>Instructors:</u>

M. K. Uyguroğlu

H. Demirel

Midterm EXAMINATION

Apr. 15, 2010

Duration : 100 minutes

Number of Problems: 5

Good Luck

STUDENT'S	
NUMBER	
NAME	SOLUTIONS
SURNAME	
GROUP NO	

Problem	Achieved	Maximum
1		20
2		20
3		20
4		20
5		20
TOTAL		100

Question 1 (20 points)

a. Convert the following octal number $(270.4)_8$ to decimal. (5 pts.)

$270.4 = 2 \times 8^2 + 7 \times 8^1 + 0 \times 8^0 + 4 \times 8^{-1} = 128 + 56 + 0.5 = 184.5_{10}$

b. Convert the decimal number $(45.0625)_{10}$ to binary, octal and hexadecimal. (15 pts.)

45	
22	1
11	0
5	1
2	1
1	0
0	1

45 = 101101

0.0625	x	2	=	0.125	0
0.125	x	2	=	0.25	0
0.25	x	2	=	0.5	0
0.5	x	2		1	1

0.0625=0.0001

45.0625=**101101.0001**
101101.000100 = **55.04_8**
00101101.0001=**$2D.1_{16}$**

Question 2 (20 points):

a) Find the (*r*-1)'s and *r*'s complements of the following numbers in the indicated bases. (10 pts.)

i. $(4190)_{10}$
9's complement of 4190 = **5809**
10's complement of 4190 = **5810**

ii. $(11011000)_2$

1' complement of 11011000 = 00100111
2' complement of 11011000 = 00101000

b) Perform the following subtractions in the indicated bases by using the *r*'s complement of the subtrahend. Express the results in decimal. (10 pts.)

i. $(2300 - 2305)_{10}$

2300+7695 =9995 ⇒ - (0005)

ii. $(11010 - 1101)_2$ = 11010 – 01101 26 – 13 = 13

11010 +10011 = ~~1~~01101

Question 3 (20 points):

a) Construct truth table for the following function (5 pts.)

$F(a,b,c)=(ab+a'c)'+bc$

a	b	c	a'	ab	$a'c$	$ab+a'c$	$(ab+a'c)'$	bc	$(ab+a'c)'+bc$
0	0	0	1	0	0	0	1	0	1
0	0	1	1	0	1	1	0	0	0
0	1	0	1	0	0	0	1	0	1
0	1	1	1	0	1	1	0	1	1
1	0	0	0	0	0	0	1	0	1
1	0	1	0	0	0	0	1	0	1
1	1	0	0	1	0	1	0	0	0
1	1	1	0	1	0	1	0	1	1

b) Use the truth table of (a) to write the function F in sum of minterms form (2.5 pts.)

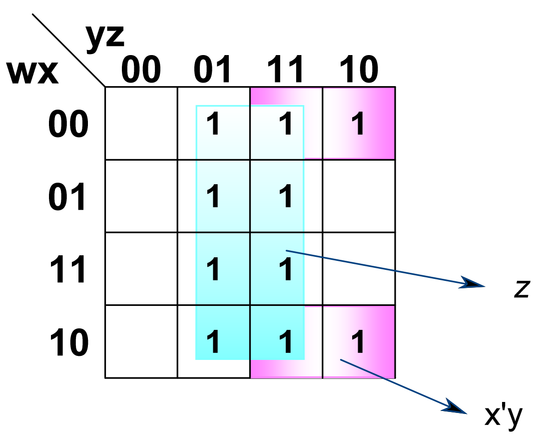
$$F(a,b,c)=\sum(0,2,3,4,5,7)$$

c) Expand the function $F(x,y,z)= y + x'z$ to product of Maxterms form. (2.5 pts.)

$$F(x,y,z)=y+x'z=(x'+y)(y+z)=(x'+y+zz')(xx'+y+z)$$
$$F(x,y,z)=(x'+y+z)(x'+y+z')(x+y+z)(x'+y+z)$$
$$F(x,y,z)=\prod(0,4,5)$$

d) Simplify the following function using Karnaugh map. (10 pts.)

$F(w, x, y, z) = w'z + xz + x'y + wx'z$



$$F(w,x,y,z)=z+x'y$$

Question 4 (20 points):

Simplify the following function and implement it using

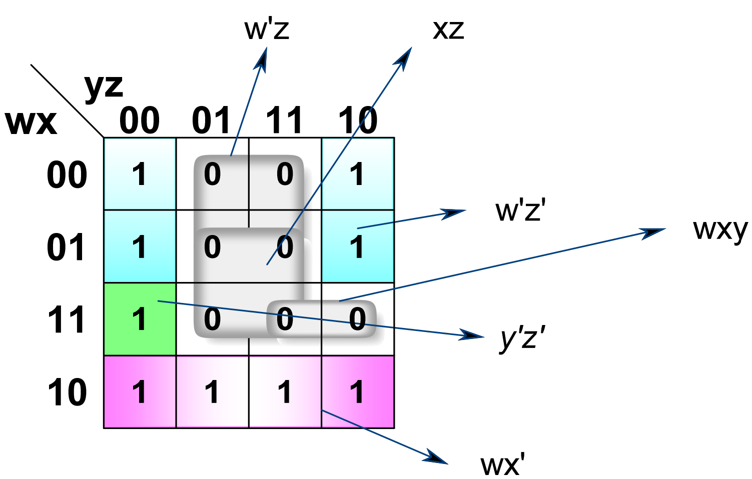
(i) NOR gates only

(ii) NAND gates only

(iii) OR-NAND

(iv) AND-NOR

$$F(w, x, y, z) = wx' + y'z' + w'yz'$$



$F(w,x,y,z) = wx' + y'z' + w'z'$ Sum of products (NAND implementation)

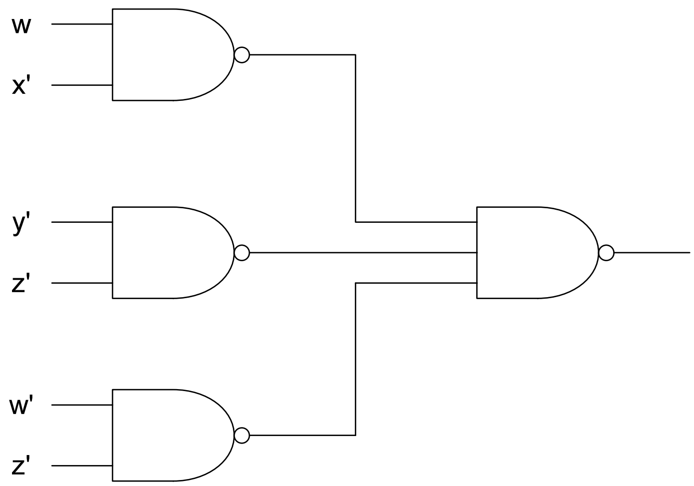
$F'(w,x,y,z) = (w'+x)(y+z)(w+z)$

$F(w,x,y,z) = (F'(w,x,y,z))' = ((w'+x)(y+z)(w+z))'$ OR-AND-invert (OR -NAND implementation)

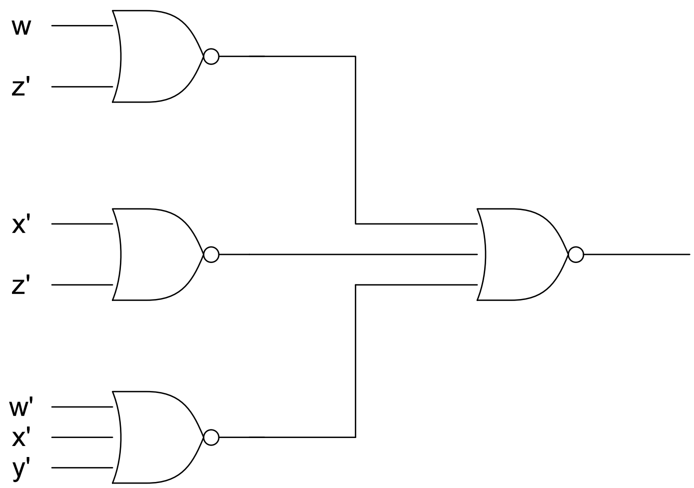
$F'(w,x,y,z) = w'z + xz + wxy$ Product of sums

$F(w,x,y,z) = (F'(w,x,y,z))' = (w+z')(x'+z')(w'+x'+y')$ NOR implementation

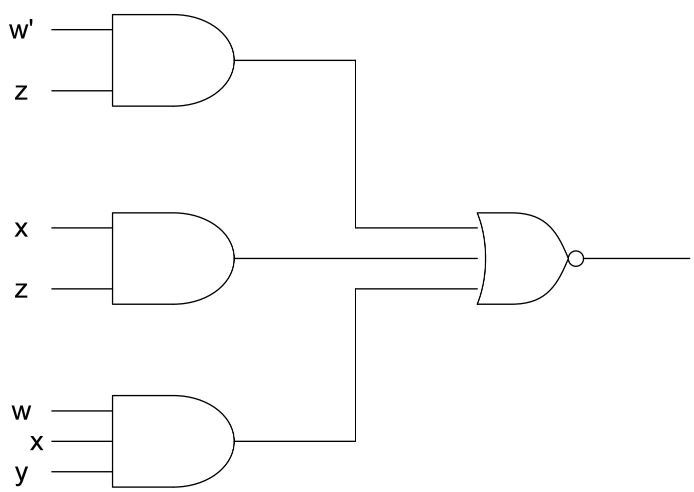
$F(w,x,y,z) = (F'(w,x,y,z))' = (w'z + xz + wxy)'$ AND-OR-invert (AND-NOR)



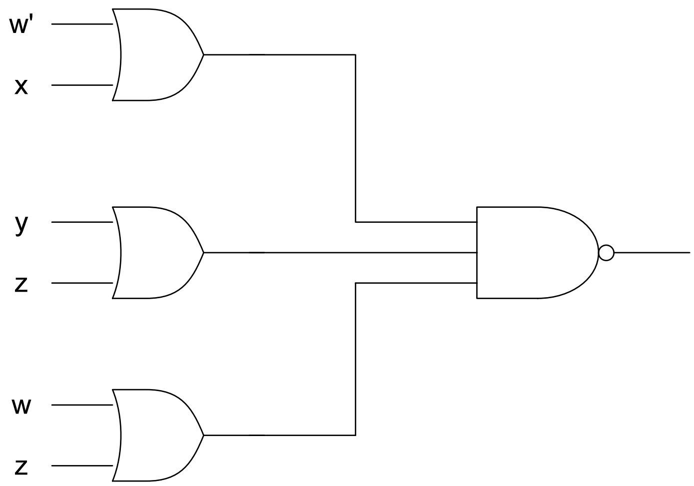
NAND Implementation



NOR Implementation



AND – NOR Implementation

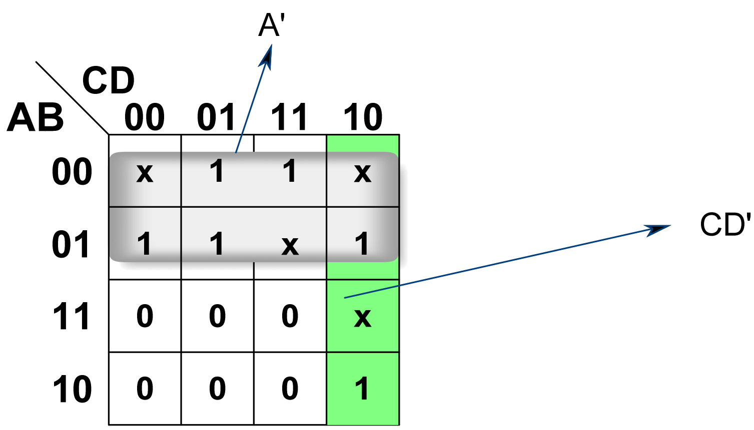


OR- NAND Implementation

Question 5 (20 points):

Implement the following Boolean function *F*, together with the don't-care conditions *d*. Use minimum number of NAND gates for your implementation.

$$F(A,B,C,D) = \Pi\,(8,9,11,12,13,15)$$
$$d(A,B,C,D) = \sum(0,2,7,14)$$



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