Faculty of Engineering

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EENG115/INFE115 Introduction to Logic Design
EENG211/INFE211 Digital Logic Design I

Fall 2012-13

Instructors:
M. K. Uyguroğlu
H. Abou Rajab

Midterm EXAMINATION

Nov. 12, 2012

Duration: 100 minutes

Number of Problems: 5

Good Luck

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO	

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

Question 1 (20 points)

Convert decimal 53 and 34 to binary, using the signed 2's complement representation and enough digits to accommodate the numbers. Then perform the binary equivalent of
(+53) + (-34), (-53) + (+34), and (-53) + (-34).

	R		R		
53/2	1	34/2	0	53	110101
26/2	0	17/2	1	34	100010
13/2	1	8/2	0	87	1010111
6/2	0	4/2	0		
3/2	1	2/2	0		
1/2	1	1/2	1		
0		0			

Therefore for sign 2's complement representation of
+53=00110101 -53=11001011
+34=00100010 -34=11011110

(+53) + (-34)=00110101+11011110=100010011 most significant bit is discarded. (19)
(-53) + (+34)=11001011+00100010=11101101 (signed 2's complement of -19)
(-53) + (-34)=11001011+11011110=110101001 most significant bit is discarded. The rest signed 2's complement of -87

Question 2 (20 points):

a) How many bit errors can be corrected by an odd parity code?

None

b) Express $(527)_{10}$ in (i) BCD, (ii) Excess-3 and (iii) 2421 codes

	5	2	7
BCD	0101	0010	0111
	5	2	7
Excess-3	1000	0101	1010
	5	2	7
2421	1011	0010	1101

c) Without simplification, write the expressions for F^D (dual) and F' (complement) corresponding to the Boolean function

$\mathrm{F} = A + 0.B'(C' + 1.D)$.

F^D=A.(1+B'+(C'(0+D)))

F'=A'.(1+B+(C(0+D')))

d) Minimize $F(A,B,C) = A' + ABC + A(B \oplus C) + AB'C'$ by algebraic manipulations

$$A' + ABC + A(B \oplus C) + AB'C' = A' + ABC + AB'C + ABC' + AB'C' = A' + AB(C + C') + AB'(C + C')$$

$$= A' + A(B + B') = A' + A = 1$$

e) Given

$F_1(w,x,y,z) = \sum(0,\ 1,\ 3,\ 5,\ 9,\ 13)$ and

$F_2(w,x,y,z) = \sum(0,3,6,14)$

i. Express $G(w,\ x,\ y,\ z) = F_1.F_2$ in sum of minterms $= \sum(0,\ 3)$

ii. Express $H(w,\ x,\ y,\ z) = F_1 + F_2$ in product of maxterms$= \Pi(2,4,7,8,10,11,12,15)$

Question 3 (20 points):

Given the Boolean function

$$F(A, B, C, D) = \sum(1, 3, 8, 11, 12, 14)$$
$$d(A, B, C, D) = \sum(0, 2, 6, 9, 10, 13, 15) \text{ don't care conditions}$$

a) Simplify F in sum of products (SOP)

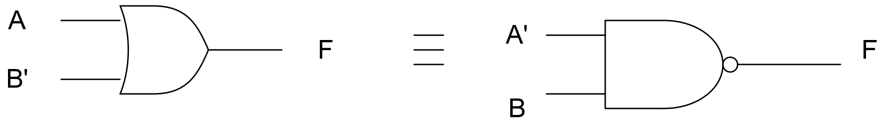
b) Implement F with the minimum number of NAND gates

c) Simplify F in product of sums (POS)

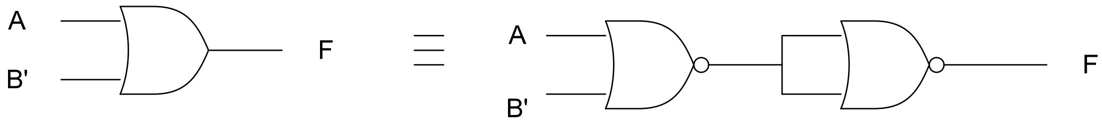
d) Implement F with the minimum number of NOR gates

AB\CD	00	01	11	10
00	x	1	1	x
01				x
11	1	x	x	1
10	1	x	1	x

F=A+B'



F'=A'B
F=A+B'



Question 4 (20 points):

Simplify and then implement the following Boolean function F using two-level forms of logic by using

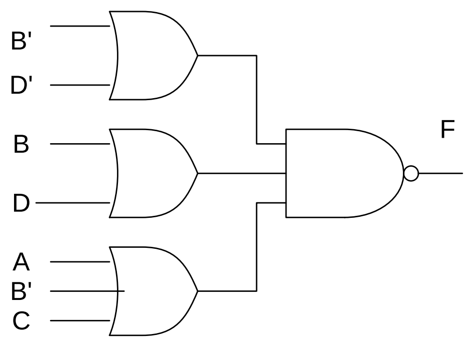
(a) OR-NAND,

(b) AND-NOR.

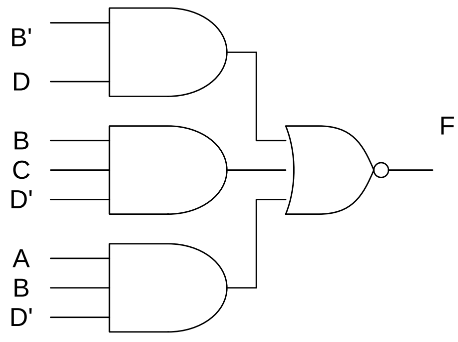
$$F(A,B,C,D)=\prod(1,3,6,9,11,12,14)=\sum(0,2,4,5,7,8,10,13,15)$$

AB\CD	00	01	11	10
00	1	0	0	1
01	1	1	1	0
11	0	1	1	0
10	1	0	0	1

F=BD+B'D'+A'BC' or BD+B'D'+A'C'D'
F'=(B'+D')(B+D)(A+B'+C) or (B'+D')(B+D)(A+C+D)
F=F''=((B'+D')(B+D)(A+B'+C))' or ((B'+D')(B+D)(A+C+D))'

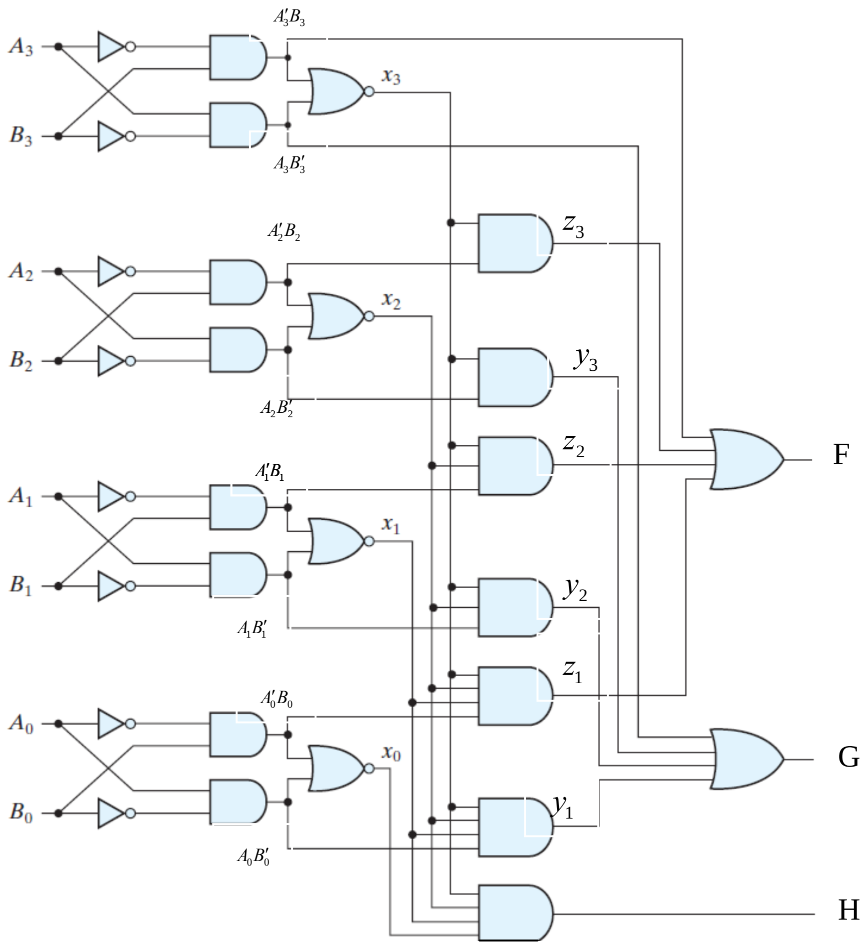


F'=B'D+BCD'+ABD'
F=F''=(B'D+BCD'+ABD')'



Question 5 (20 points):

Obtain the simplified Boolean expressions for output variables F, G, and H in terms of input variables in the circuit shown below:



$$x_0 = \left(A_0'B_0 + A_0B_0'\right)' = A_0'B_0' + A_0B_0$$
$$x_1 = \left(A_1'B_1 + A_1B_1'\right)' = A_1'B_1' + A_1B_1$$
$$x_2 = \left(A_2'B_2 + A_2B_2'\right)' = A_2'B_2' + A_2B_2$$
$$x_3 = \left(A_3'B_3 + A_3B_3'\right)' = A_3'B_3' + A_3B_3$$

$$z_3 = x_3A_2'B_2$$
$$y_3 = x_3A_2B_2'$$
$$z_2 = x_3x_2A_1'B_1$$
$$y_2 = x_3x_2A_1B_1'$$
$$z_1 = x_3x_2x_1A_0'B_0$$
$$y_1 = x_3x_2x_1A_0B_0'$$

$$F = A_3'B_3 + z_3 + z_2 + z_1 = A_3'B_3 + x_3A_2'B_2 + x_3x_2A_1'B_1 + x_3x_2x_1A_0'B_0$$
$$G = A_3B_3' + y_3 + y_2 + y_1 = A_3B_3' + x_3A_2B_2' + x_3x_2A_1B_1' + x_3x_2x_1A_0B_0'$$
$$H = x_3x_2x_1x_0$$