King Fahd University of Petroleum and Minerals
College of Computer Science and Engineering
Computer Engineering Department

COE 202: Digital Logic Design (3-0-3)
Term 092 (Spring 2010)
Major Exam 1
Thursday March 25, 2010

Time: 120 minutes, Total Pages: 9

Name:_____ ID:_____ Section: _____

Notes:

- Do not open the exam book until instructed
- Calculators are not allowed (basic, advanced, cell phones, etc.)
- Answer all questions
- All steps must be shown
- Any assumptions made must be clearly stated

Question	Maximum Points	Your Points
1	10	
2	20	
3	38	
4	15	
5	12	
Total	95	

Question 1. **(10 points)**

Fill in the Spaces:

a. To assign unique codes to 214 items we need a minimum of _____ (how many) bits. This leaves us with _____ (how many) additional spare codes.

b. Using 5 bits to represent fractions, the smallest non-zero value that can be represented has the decimal value of _____.

c. One factor that may limit gate fan out is _____.

d. In signed-1's complement arithmetic, the most negative decimal result that can be accommodated using 7-bit registers before an overflow occurs is _____.

e. Adding two signed numbers of different signs may cause overflow _____ (True/False).

f. Eight Tri-state gates have their outputs connected together. For normal circuit operation, at least _____ (how many) gates should be in the Hi-Z state at any point in time.

g. The transmitted bit sequence 10110110 has the last (right-most) bit as a parity bit. The scheme uses _____ parity (select from "even" or "odd")

h. The consensus theorem states that $X\,Y + \overline{X}\,Z + Y\,Z = X\,Y + \overline{X}\,Z$. Accordingly, $C\,D + (A + B)\,C + (\overline{A}\,\overline{B})\,D$ can be simplified to _____

i. The expressions $A\,B + A\,C + \overline{B\,C}$ and _____ are duals

Question 2. **(20 Points)**

Convert the following numbers to the specified base:

$(9D.7E)_{16} = (\quad)_8$ **Hint**: Use binary as an intermediate step	$(00101001)_{\text{BCD Code}} = (\quad)_2$
$(45.3)_{10} = (\quad)_2$ **Note**: Express fractions up to 3 bits only	$(1101011.01)_2 = (\quad)_{10}$
$(A7.4)_{16} = (\quad)_{10}$	$(123)_{10} = (\quad)_8$

Question 3. **(38 Points)**

a. Perform the following unsigned arithmetic operations in the specified number system. Show any corrective steps that may be required to obtain the final result. **(10 Points)**

Octal Subtraction	**Hexadecimal Addition**	**Binary Subtraction**	**Binary Multiplication**
563 - 276	3DC + 58E	1010 - 0111	1011 x 1001

b. For the binary numbers shown below, compute their equivalent decimal values if the numbers are: unsigned, in signed magnitude representation, in 1's complement representation, or in 2's complement representation. **(16 Points)**

Binary Number	**Unsigned**	**Signed Magnitude Representation**	**1's Complement Representation**	**2's Complement Representation**
111111				
010110				
110110				
100000				

c. If **7-bit** registers are used, show the binary representation of the following numbers in the 2's complement system: **(5 Points)**

	2's Complement Representation
+29	
-29	
+58	
-58	

Perform the following operations in signed 2's complement indicating cases (if any) where overflow occurred. **(7 Points)**

i. Z = (+29) - (+58)

ii. Z = (-29) - (+58)

iii. Z = (-29) - (-58)

Question 4. **(15 Points)**

a. Consider the Boolean function: $F(A,B,C) = \overline{A}\,\overline{B} + \overline{A}BC + AC$ **(10 Points)**

i. Using Algebraic manipulation, show that F can be simplified as follows:

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

ii. Obtain the truth table of F

iii. Draw a circuit of the simplified F

b. Without any simplification, find the complement of the following expression and express the result in **SOP** form:

$$F(A,B,C) = (A + \overline{B} + C)(\overline{A}\,\overline{B} + C)(A + B\overline{C})$$ **(5 Points)**

Question 5. **(12 Points)**

Consider the Boolean function E and F which are given by the following truth table:

X	Y	Z	E	F
0	0	0	1	0
0	0	1	1	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	0
1	0	1	0	0
1	1	0	0	1
1	1	1	0	1

a. Using a ***numerical form*** (i.e. $\sum$m, $\prod$M), list the following:
   i. The minterms of F.
   ii. The maxterms of F**'**.
   iii. The minterms E + F.

b. Using an ***algebraic form***, express the following
   i. E as a sum of minterms
   ii. F as a product of maxterms