Institute of Statistical Studies and Research
Department of Computer and Information Sciences
Digital Logic –CS504
January 2013
Time permitted: Three Hours

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Question 1: (8 points)

a) Using the version of Hamming code shown, Code the data "*1011*"

a1= a3 ⊕ a5 ⊕ a7
a2= a3 ⊕ a6 ⊕ a7
a4= a5 ⊕ a6 ⊕ a7

b) If the word "*1010101*", was received after being coded with Hamming code, what word was sent (assuming single error).

c) We have a computer that can store three decimal digits (12 bits). How are the following numbers stored, using the specified code/form?:

(i) BCD Exsess3 (157) (ii) BCD 8421 (91) (iii) BCD 5421 (238)
(iv) 2's Complement (-98) (v) Signed integer (-124)

Question 2: (10 points)

a) Show the Truth Table for a system that has four inputs, *a, b, c* and *d*, and one output, *f*. The first two inputs (*a, b*) represent one binary number (in the range 0 to 3) and the last two (*c, d*) represent another number in the range 1 to 3. The output, *f*, is to be one, iff, the second number is larger than the first.

b) Reduce the following expression to a minimum Sum of products and a minimum Product of sums, **show** each step.

$$F(w, x, y, z)= x'y'z + w'xz + wxyz' + wxz + w'xyz$$

c) Manipulate the following to sum of product expression

$$F(a, b, c, d)=(a+b+c+d')(b+c+d')(b'+c')$$

Question 3: (9 points)

Given the function, [assume all variables are available, both complemented and uncomplemented]

$$F= b'c'd' + bd + acd + abc$$

a) Show a block diagram for a two level implementation of *F* using *And* and *OR* gates
b) Show a block diagram for an implementation of *F* using, Only, two-input NAND gates.
c) Expand *F* to sum of minterms, write it in numeric form and eliminate any duplications

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Question 4: (9 points)

Find the minimum Sum of products, and the minimum Product of sums for the following functions (use K-Map):

a) $F= Bc'd' + cd + bc'd + abc + bd$

b) $G= \Sigma m(3, 4, 9,13, 14, 15) + \Sigma d(2, 5, 10, 12)$

***Question 5*: (12 points)**

A 1-bit full subtractor that has three inputs, a borrow B_{in}, x and y, and produces Two outputs, the difference D ($D = x-y-B_{in}$) and the new borrow B_{out} .

a) Show the truth table for the full subtractor
b) Use the truth table to find the expressions for D and B_{out}
c) Minimize and implement the subtractor using Programmable Logic Array with five *AND* gates, **show the shared terms**.
d) Implement the subtractor using 3-8 active low decoder with one active low enable; and two *OR* gates.

***Question 6*: (12 points)**

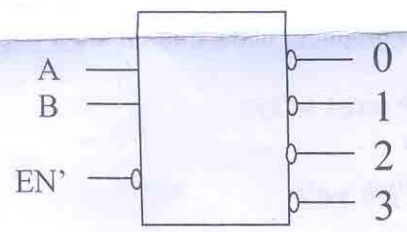
Consider the following two function:

$$F(a, b, c, d) = \Sigma m(1, 2, 3, 5, 6, 7, 11, 15)$$

$$G(a, b, c, d) = \Sigma m(1, 2, 3, 6, 11, 13, 15)$$

a) Implement them using PLA gate arrays with 7 terms, show the shared terms and be sure to label the inputs and the outputs, full credit if you use **6** or less terms.

b) Given the shown decoder, with active low outputs, active low enable, implement the given functions. Use two 8-input *NAND* gates and **at most four** of the shown decoder.



EN'	A	B	0	1	2	3
1	X	X	1	1	1	1
0	0	0	0	1	1	1
0	0	1	1	0	1	1
0	1	0	1	1	0	1
0	1	1	1	1	1	0

***Question 7*: (10 points)**

A system has two inputs ($x, y \in \{a, b\}$) and one output ($z \in \{0, 1\}$). The output z is one when x has been different from y for at least two consecutive clock cycles, and is zero, otherwise.

a- Describe the system
b- State the system Model
c- Show the transition and the output functions in a state table
d- Draw the state diagram

☺ GOOD LUCK