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

Question 1: (9 points)

a) Using the version of Hamming code shown,

$a1 = a3 \oplus a5 \oplus a7$
$a2 = a3 \oplus a6 \oplus a7$
$a4 = a5 \oplus a6 \oplus a7$

If the word "***1110101***", was received after being coded with Hamming code, what word was sent (assuming single error).

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b) We have a computer that stores binary signed numbers in two's complement form. All numbers are 8 bits long.
(i) What decimal numbers are represented by ***01110011*** and ***10111010***, respectively?
(ii) How are the following numbers stored? -122 158

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c) Show the **Truth Table and the output function** 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 two numbers do not differ by more than 1.

Question 2: (12 points)

a) Convert each of the following expressions to product of sums form:
(i) $F = wxy' + xy'z + wx'z'$ ***(ii)*** $G = a'c'd + a'cd' + bc$

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b) Reduce the following expression to a minimum Sum of products and a minimum Product of sums, show each step, and show how the steps appear on Karnaugh maps.

$$F(w, x, y, z) = wxz + xy'z + wz' + xyz + wxy'z + w'y'z'$$

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c) Implement the following logical expression using only 2-input NAND gates

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

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d) Expand *F* to sum of minterms, write it in numeric form and eliminate any duplications

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

Question 3: (10 points)

For the following five-variable problem, find both minimum Sum of products expressions, five terms and 15 literals. (use K-Map):

$$F(a,b,c,d,e) = \sum m(0,2,7,8,9,10,11,15,16,17,18,19,20,22,23,25,27,28,30,31)$$

***Question 4*: (10 points)**

Show a block diagram for a decoder, the truth table for which is shown below. The available components are one-, two- and three-input NAND gates.

E1	E2	A	B	1	2	3
0	X	X	X	1	1	1
X	0	X	X	1	1	1
1	1	0	0	1	1	1
1	1	0	1	0	1	1
1	1	1	0	1	0	1
1	1	1	1	1	1	0

***Question 5*: (18 points)**

Consider the following two functions:

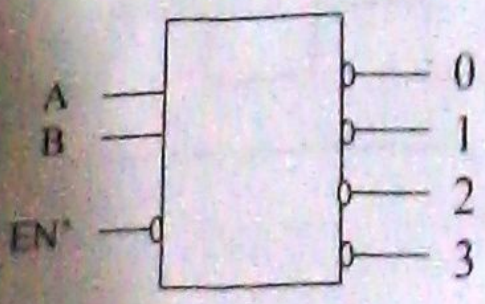
$$F(a, b, c, d) = \Sigma m(2, 4, 5, 8, 9, 10, 12, 13, 14, 15)$$

$$G(a, b, c, d) = \Sigma m(1, 2, 4, 5, 9, 12, 13, 15)$$

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.

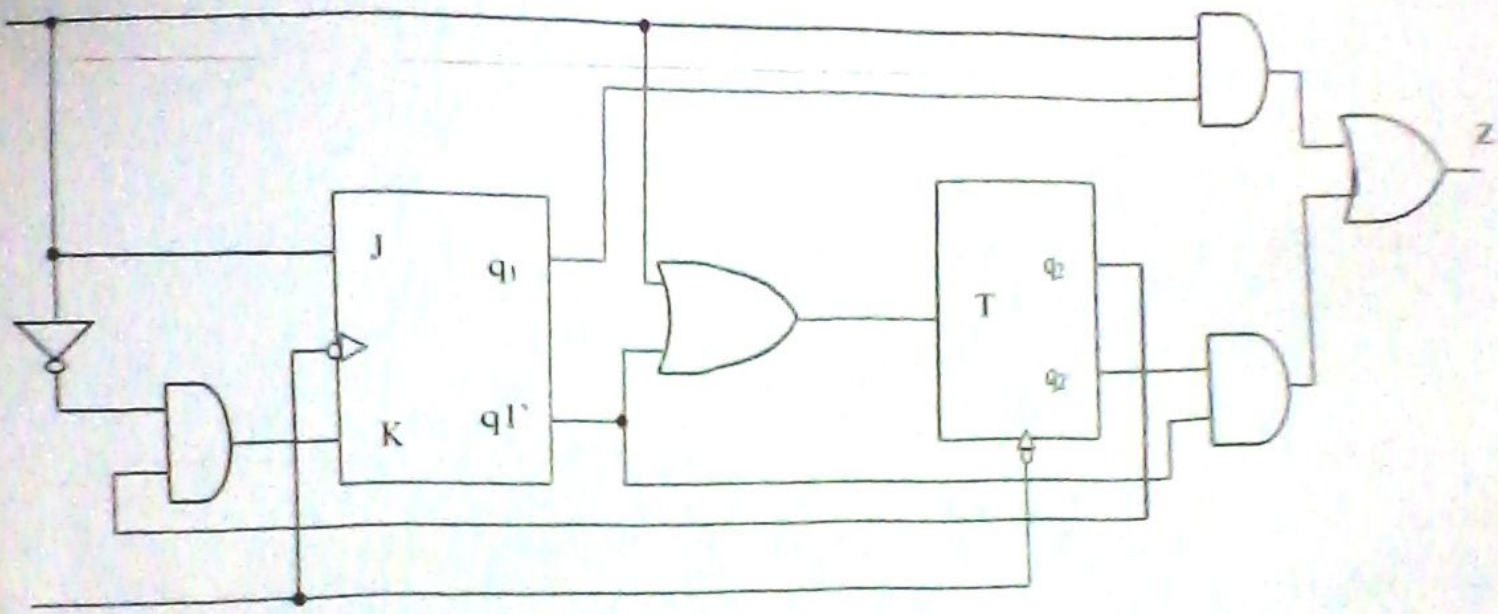
b) Given the shown decoder, with active low outputs, active low enable, implement the given functions. The available component are two *NAND* gates (as many inputs as you need) and as many as needed of the shown decoder.

Five points extra bonus: show a diagram that uses only 2 eight-input NAND GATES and four of these decoders



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 6: (12 points)
For the following system



a) State the system model

b) Find the state diagram and state table

c) Assume that the flip flop are each initially in state 0, complete the timing trace for the states of the flip flops as far as possible

x 1 0 1 1 1 0

d) For the input shown bellow, complete the timing diagram for the state of each flip flop.

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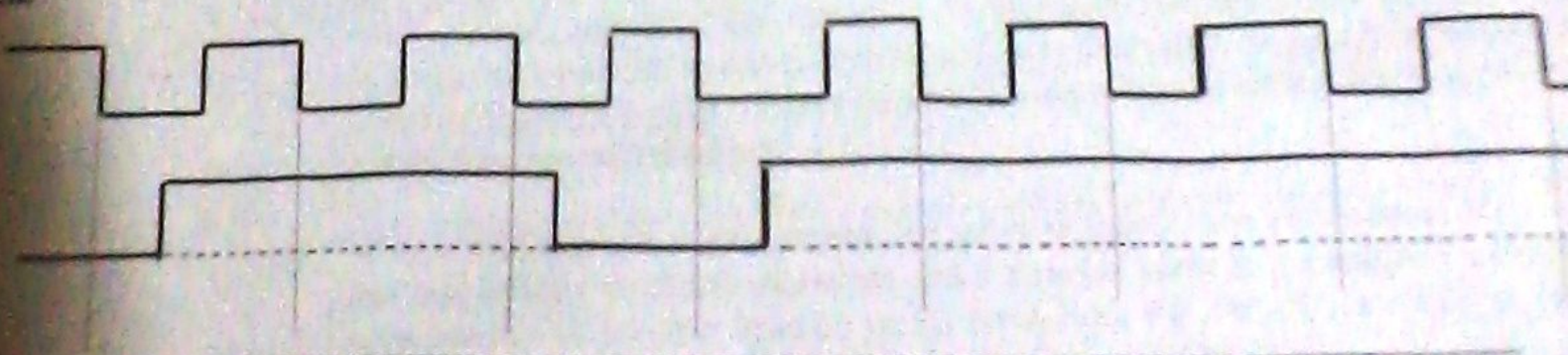

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