CS 3410 Homework 1
Due Monday, February 6th, 2012, 11:59pm

NetID__________ Date:______________
Name:______________________________

Problem 1

a) Fill in the missing numbers below by performing the necessary conversions. Negative numbers should be in 16-bit two's complement.

hex	octal	Binary	Decimal
0x08C1			
	Leave blank		-18
		0000 0001 0000 1000	

b) Convert these two numbers to two's complement binary, add them, and convert back to a decimal answer.

 26397
-31421

c) True or false: When performing addition or subtraction in two's complement, overflow has occurred if and only if the carry-out bit is 1. Explain your answer.

Problem 2.

Consider the truth table below:

A	B	C	D	Out
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	1	0	0	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	1	0	1	0
1	1	1	1	0

a) Write the formula for this truth table in sum-of-products form.

b) Fill in the Karnaugh map of this truth table. Draw X's for the don't-cares. Shade in the smallest number of groups that express this formula. Use a different color shade for each group.

			AB		
CD		00	01	11	10
	00				
	01				
	11				
	10				

c) Write the minimal formula based on these groupings.

d) Write a minimal formula for the inverse of the above truth table.

e) Shade in exactly four groups to express the minimum formula in the Karnaugh map below. Use different colors for each group.

					ABC				
DE		000	001	011	010	110	111	101	100
	00	1	0	1	1	1	0	0	X
	01	1	0	1	0	0	1	X	1
	11	0	X	1	0	0	X	0	0
	10	1	0	1	1	X	0	0	1

Problem 3.

The NAND gate is universal in that any circuit can be created using only NAND gates.

a) Implement the AND logical circuit using only NAND gates.

b) Implement the OR logical circuit using only NAND gates.

c) Implement the NOT logical circuit using only NAND gates.

Problem 4.

1. Cornell wants to substitute McGraw Tower's clock with an LED clock showing only the hour instead of the complete time information. For example, when it is 1:15AM, the LED output will show 1; when it is 2:15PM, the LED output will show 14 (Assume one day is from 0:00 to 23:59). Due to budget concerns, Cornell does not want an actual clock to be built inside in this new output system. Rather, every time the chime rings, someone will manually change the output. The button input panel consists of thirteen buttons: twelve to indicate the hour, and one to indicate AM or PM. Below are the diagrams for the button input panel and LED output panel. Note that only one button from 1-12 can be pressed at a time. Using encoders and decoders, help Cornell to build this new clock system!

Input – 13 buttons total

<Hour>

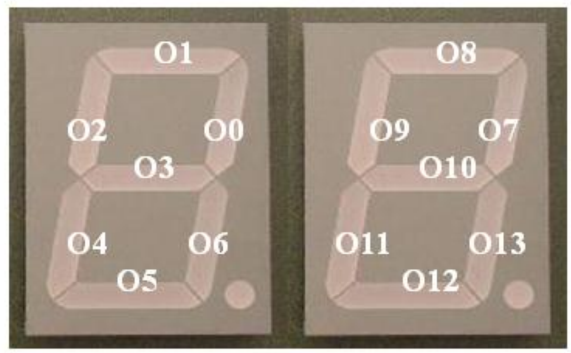
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*

<AM/PM>

Not Pressed : AM, Pressed : PM

Note **: 0:00AM ~ 0:59AM – Press 12 only**
– Output '0'

Output



O0~O6 are used when two digits necessary.

(a) Encoder Design : Fill in the truth table on the next page. The output should encode what the clock should display. Explain why we need 5 output bits.

Input												
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**A/P**
1	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*
1	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*

Output				
B4	**B3**	**B2**	**B1**	**B0**

(b) Decoder Design

(1) The 5 outputs from the encoder will be 5 inputs for the decoder. Below is an excerpt from the truth table for the decoder. Output bit O*i* is a 1 if LED segment O*i* is lit. Fill in the blanks.

Input						**Output**													
B4	**B3**	**B2**	**B1**	**B0**		**O0**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O8**	**O9**	**O10**	**O11**	**O12**	**O13**
0	**0**	**0**	**1**	**1**															
0	**1**	**0**	**0**	**0**															
0	**1**	**1**	**0**	**1**															
1	**0**	**0**	**0**	**0**															
1	**0**	**1**	**1**	**1**															

(2) Using input B4, B3, B2, B1, B0, write down the *simplified* logical function that expresses the output of LED O6.

Survey

How long did this homework take you (x hrs)?

How hard did you find this homework (easy/medium/hard)?

Other comments on this homework?