Homework 2 - Due at Lecture on Wed, Feb 2nd

Primary contact for this homework: Newsha Ardalani [newsha at cs dot wisc dot edu]

You must do this homework **alone**. Please staple multiple pages together.

Question 1. (4 points)

Find the 2's complement of the following binary numbers:

a. 0110 0011 ----> 1001 1101
b. 0011 1010 ----> 1100 0110
c. 1001 1100 ----> 0110 0100
d. 0010 1101 ----> 1101 0011

Question 2. (4 points)

Convert the following 2's complement binary numbers to decimal numbers.

a. 0111 = +7
b. 1101 = - (0011) = -3
c. 011110 = +30
d. 111010 = - (000110) = -6

Question 3. (8 points)

Using 1 byte (8 bits) to represent each number, write the binary representations of 30 and -30 in unsigned, sign-magnitude, 1's complement, and 2's complement.

Number	unsigned	sign-magnitude	1's complement	2's complement
30	0 0 0 1 1 1 1 0	0 0 0 1 1 1 1 0	0 0 0 1 1 1 1 0	0 0 0 1 1 1 1 0
-30	NA	1 0 0 1 1 1 1 0	1 1 1 0 0 0 0 1	1 1 1 0 0 0 1 0

Question 4. (4 points)

a. Assume that there are exactly 1020 entries in a table. If every entry is to be assigned a unique bit pattern, what is the minimum number of bits required to do this?

2^9 (512) < 1020 < 2^{10} (1024)

so we need at least 10 bits.

b. How many more entries can be added to the table without requiring additional bits for each entry’s unique pattern?

1024-1020=4

Question 5. (4 points)

a. What is the largest positive number one can represent in a 10-bit 2's complement code? Write your result in binary and decimal.

0111111111 =2^9 -1 = 511

b. What is the greatest magnitude negative number one can represent in a 10-bit 2's complement code? Write your result in binary and decimal.

1000000000 = -(2^9) = -512

c. What is the largest positive number one can represent in a 10-bit 1's complement code? Write your result in binary and decimal.

0111111111 = 2^9 - 1 = 511

d. What is the greatest magnitude negative number one can represent in a 10-bit 1's complement code? Write your result in binary and decimal.

1000000000 = - (2^9 - 1) = -511

Question 6. (2 points)

Write the decimal equivalents for these IEEE floating point numbers.

a. 0 01111111 11000000000000000000000 = + $(1.11)_2$ * 2^(127-127) = +$(1.11)_2$ = 1+1/2+1/4 = 7/4
b. 1 01111101 10000000000000000000000 = - $(1.1)_2$ * 2 ^ (125-127) = - $(1.1)_2$ * 2 ^ (-2) = - $(0.011)_2$ = - (1/4+1/8) = - 3/8

Question 7. (2 points)

Compute the following:

1. NOT(1101) OR NOT(1100) = (0010) OR (0011) = 0011
2. NOT(1000 AND (1100 OR 0101)) = NOT(1000 AND (1101)) = NOT (1000) = 0111

Question 8. (2 point)

Using ASCII 8-bit, null-terminated string patterns, represent each of the characters in the string "Last question, yes!" using the hexadecimal value. (Only represent the characters between the quotation marks.)

4C 61 73 74 20 71 75 65 73 74 69 6F 6E 2C 20 79 65 73 21 00

(XC) Question 9. (2 points)

Given a black box which takes n bits as input and produces one bit for output, how many unique functions such a black box could implement? (Hint: Try to visualize a truth table for a single function of n bits. Determine how many rows such a truth table has. Then determine how many combinations are possible with the number of rows that you just found)

> Consider a single function that this black box implements. If there are n binary inputs, the truth table contains 2^n rows.
> Now, the output of each of these rows in the truth table can be filled with 0 or 1. The number of ways in which we can fill in the output column (using 0 and 1) gives us the number of unique functions. Since each of the rows can be filled in using 2 possible values and since the number of rows is 2^n, the number of ways = 2 power (2^n)