

Homework 2 CS/ECE 252: Sec 1 & 2 [Due at lecture on Wed, Feb 05]

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Instructions: You must do this homework alone. Please hand in ONE copy of the homework listing your section number, full name (as appear in Learn@UW) and UW ID. You must staple all pages of your homework together to receive full credit.

Problem 1 (2 points)

Assume that UW-Madison is hosting an Athletic Meet this Spring, and 300 athletes have registered for the event. Since you are a volunteer for the event, you've been assigned the task of designing T-Shirts **for all the registered athletes** with unique numbers printed on each of them. Assume that you came up with a design similar to that shown in Fig 1. But instead of printing numbers in decimal (like 20 shown in figure), assume that you decided to print numbers in binary !!



Fig. 1 Sample T-shirt

a) What is the minimum number of bits that you need to print on each side of the T-shirt, so that the number is unique for each registered candidate?

Ans:

$$2^8 < 300 < 2^9$$

=> Minimum number of bits = 9

b) How many more athletes can you accommodate in the event, without increasing the number of bits printed on the t-shirt?

Ans: $2^9 - 300 = 212$

Problem 2 (1 point)

Convert the following bit sequence to hexadecimal:

0010 0011 1100 1010

Ans: 0x23CA

Problem 3 (4 points)

The binary number 1100 1001 is a string of 0s and 1s that can be interpreted differently depending on its data type. Please find the decimal value of this binary number if its data type is:

i. An unsigned integer :

$$= 2^7 + 2^6 + 2^3 + 2^0 = 201$$

ii. A signed-magnitude integer:

$$= -(2^6 + 2^3 + 2^0) = -73$$

iii. A 1's complement integer :

$$= -(2^5 + 2^4 + 2^2 + 2^1) = -54$$

iv. A 2's complement integer :

$$= -(00110111) = -(2^5 + 2^4 + 2^2 + 2^1 + 2^0) = -55$$

Problem 4 (5 points)

Convert the following decimal numbers to 6-bit 2's complement binary numbers. If the number cannot be converted to 6-bit 2's complement binary number, specify that it is not possible and also indicate what is the minimum number of bits required for representing this number in 2's complement notation.

a) 31 : 011111

b) -31 : 100001

c) 32 : Cannot be represented (requires atleast 7 bits)

d) -32 : 100000

e) -33 : Cannot be represented (requires atleast 7 bits)

Problem 5 (8 points)

The table below shows two sets of values for inputs A, B and various operations performed on them. Complete the rest of the table with the results of these operations. Assume that the values of A, B are in 4-bit 2's complement form (Show your calculations for partial credit)

A	B	A + B	A - B	A AND B	A OR (NOT (B))
0100	0001	0101	0011	0000	1110
1100	1111	1011	1101	1100	1100

Problem 6 (1 point)

What conditions indicate overflow has occurred when two 2's complement numbers are added?

- a) Adding two positive numbers generate a negative result
- b) Adding two negative numbers generate a positive result

Problem 7 (4 points)

Write the decimal equivalents for the following IEEE single-precision floating-point numbers.

1. 0 01111110 10000000000000000000000000000000
 $= (1 + 2^{-1}) \times 2^{(126-127)} = 1.5 / 2 = 0.75$
2. 1 10000000 01000000000000000000000000000000
 $= -((1+2^{-2}) \times 2^{(129-128)}) = -(1.25 \times 2) = -2.5$

Problem 8 (4 points)

Represent the decimal 5.25 in

- a) Fixed point notation

$$5 = 101$$

$$.25 = \frac{1}{4} = 2^{-2} = 0.01$$

$$\Rightarrow \text{Ans: } 101.01$$

- b) IEEE single-precision floating point notation

$$101.01 = 1.0101 \times 2^2$$

$$\text{Exponent} - 127 = 2 \Rightarrow \text{Exponent} = 129 = 10000001$$

$$\text{Mantissa} = 0101$$

$$\text{Sign} = 0$$

$$\Rightarrow \text{Ans: } 0\ 10000001\ 010100000000000000000000$$

Problem 9 (1 point)

Convert the ASCII string "Hw_2" to its hexadecimal representation. Only represent the characters within the quotation marks and assume it is null terminated.

0x48 77 5f 32 00