CSCI 2400: Computer Systems
Recitation Exercise 1
(Dated: September 1, 2014)

1. It is common to swap two variables by using a third temporary variable. For example, to swap A and B, let the temporary variable be T, then set T=A, followed by A=B, then finally B=T – this will swap A and B.

   (a) However, let us now try to swap without using a temporary variable and instead use only boolean logic. Suppose we have two variables, A=11110101 and B=10011000. Come up with a technique to swap these two specific values using only the XOR operation.

   (b) Will this approach work with any A and B? Show why or why not.

2. Add the following pair of integers by converting them into two's complement binary number. Indicate if overflow has occurred. Explain if the results obtained are correct or not. Assume the addition is performed on an 8 bit computer.

   (a) 43, -27

   (b) -102, -70

   (c) 127,1

   (d) -21,-8

3. Assume we have an integer data type of w bits. We denote the bit vector :

$$\vec{x} = [x_{w-1}, x_{w-2}, \ldots, x_0] \tag{1}$$

   The Ones' complement representation of $\vec{x}$ is defined as:

$$\text{B2O}\,(\vec{x}) = -x_{w-1}\left(2^{w-1} - 1\right) + \sum_{i=0}^{w-2} x_i 2^i \tag{2}$$

   (a) For $w = 8$, give the range of values that could be represented using this system.

   (b) In this scheme, given a number a we can easily get $-a$ by simply flipping (or complementing) all the bits. As an example see the comparison of 2 and -2 in the Ones' complement representation and the corresponding bit patterns in Table I.

TABLE I: Comparison of the Unsigned and the One' Complement representations

Bit Pattern	Unsigned	Ones' Complement
0111 1111	127	127
0000 0010	2	2
1111 1101	253	-2
1000 0000	128	-127

   For Ones' complement, try flipping all the bits for the numeric value '0'. Which numeric value is represented once we flip all the bits? What is the inherent problem with this scheme?

   (c) For the given numeric values, give the bit patterns for the Ones' complement and the Two's complement representation:

TABLE II: Comparison of the One' Complement and the Two's Complement representations

Numeric Value	Ones' Complement	Two's Complement
127		0111 1111
-127	1000 0000	
-1		
-10		