CSCI 2400: Computer Systems
Recitation Exercise 1 Solutions
(Dated: September 10, 2014)

1. (a) A = A XOR B = 01101101
   B = A XOR B = 11110101
   A = A XOR B = 10011000

   (b)

Function	x	y
	A	B
$A = A \oplus B$	$A \oplus B$	B
$B = A \oplus B$	$A \oplus B$	$(A \oplus B) \oplus B$
$Simplify$	$A \oplus B$	$A \oplus (B \oplus B)$
$Simplify$	$A \oplus B$	$A \oplus (0)$
$Simplify$	$A \oplus B$	A
$A = A \oplus B$	$(A \oplus B) \oplus A$	A
$Simplify$	$A \oplus (A \oplus B)$	A
$Simplify$	$(A \oplus A) \oplus B$	A
$Simplify$	$(0) \oplus B$	A
$Simplify$	B	A

2. (a) 43 = 0010 1011 , -27 = 1110 0101
   0010 1011 + 1110 0101 = 001 0000 = 16 (no overflow)
   43 - 27 = 16. This is correct

   (b) -102 = 1001 1001, -70 = 1011 1010
   1001 1001 + 1011 1010 = 0101 0011 = 83 (with overflow of 1)
   -102 - 70 = -172. This is not correct.

   (c) 127 =0111 1111, 1 = 0000 0001
   0111 1111 + 0000 0001 = 1000 000 = -128 (with overflow of 1)
   127 + 1 = 128. This is not correct

   (d) -21 = 1110 1011, -8 = 1111 1000
   1110 1011 + 1111 1000 = 1110 0011 = -29 (no overflow)
   -21 - 8 = -29. This is correct

3. (a) Range: -127 to $+127$ since its -2^{w-1} to $+2^{w-1}$

   (b) Flipping all the bits for 0 or (0000 0000) gets us (1111 1111). The latter binary representation also gets us the numerical value of 0. Thus we have two separate binary patterns for the same numerical value of 0. This is the inherent issue.

   (c) For negative values, we can write: $Two's\ Complement = Ones'\ complement + 1$.
   This allows us to have a unique representation for 0. Consider $w = 8$,
   $+0$ is represented as 00000000 is both the schemes. $-0$is represented as 11111111 in Ones' complement.
   With Two's complement, -0 is represented as:
   Ones' complement of $0 + 1 = 11111111 + 1 = 00000000$
   We would discard the carry generated here due to finite $w = 8$.
   Thus Two's complement has solved the issue and we have a unique representation for both $+0$ and -0.

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

Numeric Value	Ones' Complement	Two's Complement
127	0111 1111	0111 1111
-127	1000 0000	1000 0001
-1	1111 1110	1111 1111
-10	1111 0101	1111 0110