

Binary Integers

CS 350: Computer Organization & Assembler Language Programming

*Lab 1, due Fri Sep 9 (2400 hrs) **

A. Why?

- A basic way to store information in a computer is to use binary integers.
- There are multiple ways to represent negative integers.

B. Outcomes

After this lab, you should be able to

- Represent binary integers in sign-magnitude, 1's complement, or 2's complement; to list the pros and cons of each of these three systems and to explain why hardware commonly uses 2's complement to represent negative integers.
- List the representations of the most positive and negative values in each system; know when overflow occurs and how to recognize it.

C. Problems [50 points total]

1. [1 pt] Read as an unsigned binary number, 110111 represents what decimal value?
2. [3 pts] Let V be the decimal value from Problem 1; what is the 7-bit representation of $-V$ in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement? (Add a sign bit and possibly modify the 6 bits inherited from problem 1.)
3. [3 pts] Reading 110111 as a signed 6-bit value, what are the bitstring and decimal representations of $-(110111)$ in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?
4. [6 = 3*2 pts] What is the bitstring and decimal value for the most negative 6-bit number in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?

* Have you read the syllabus to find out how to get an automatic one-day extension?

5. [6 = 3*2 pts] What is the bitstring and decimal value for the most negative n -bit number in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?
6. [4 pts] Which of the three systems have two forms of zero ("positive" and "negative" zero), and how do you write them in each of those systems?
7. [2 pts] In which (if any) of the three systems does taking the negative of the most negative number cause overflow? What about the negative of the most positive number?
8. [2 pts] What is $111011 + 001110$, using unsigned addition? Does overflow occur?
9. [2 pts] What is $111000 - 001101$, using unsigned subtraction?

For Problems 10 – 12, rewrite the following additions and subtractions in 6-bit 2's complement. E.g., $-3 - 5 = -000011 - 000101 = 111101 - 000101 = 111101 + 111011 = 111000 = -001000 = -8$

10. [7 pts] $13 - 30 = -17$
11. [7 pts] $-25 - 7 = -32$
12. [7 pts] $24 + 10 = ???$ (Be sure to show the decimal result; you should get overflow.)

D. How to Submit Labs

See <http://cs.iit.edu/~cs350> → Syllabus > Labs > Submitting Work for your options.