

Binary Integers

CS 350, Lab 1, Due Fri Jan 27 (2400 hrs)*

version 3 of Jan 25

Submit your *.c file to the Lab 1 assignment folder on Blackboard. Include the answers to the written questions and your program output as separate files or as comments in your *.c file.

* Read the [course syllabus](#) to see how to get an automatic extension to Mon Jan 30.

A. Why?

- Binary integers are one of the basic ways to store information in a modern computer.

B. Outcomes

At the end of this lab you should:

- Know the three ways to represent signed binary integers.
- Know how to take the negative of a binary number in each system.
- Know the representations of the most positive and negative numbers and zero, in each system.
- Know how to do subtraction in two's complement.
- Know what overflow looks like and when it occurs.

C. Questions [100 points total]

Part 1: For each of the three systems sign-magnitude, one's complement, and two's complement,

1. [8 = 2+3*2 pts] What does 011010 represent, and what bitstring is its negative?
2. [9 = 3*3 pts] What does 110111 represent, and what bitstring is its negative?
3. [6 = 3*2 pts] For 6-bit bistrings, what bitstrings are the representation(s) of zero?
4. [1 pt] For 6-bit bistrings, what bitstring is the most positive and what is its decimal equivalent? (It's the same in all 3 systems.)
5. [6 = 3*2 pts] What bitstring is the most negative and what is its decimal equivalent?
6. [1 pt] In any system, does taking the negative of the most positive number cause overflow?
7. [6 = 3*2 pts] Does taking the negative of the most negative number cause overflow?
8. [8 = 2+3*2 pts] In two's complement, what bitstring results from 111011 + 101110? What are the decimal values of the 3 bitstrings?

Part 2: Rewrite the following additions and subtractions in 6-bit binary, using two's complement. E.g., $3 - 5 = -2$ would be $000011 - 000101 = 000011 + (-000101) = 000011 + 111011 = 111110 = -(000010) = -2$

9. [5 pts] $12 + 18 = 30$
10. [5 pts] $13 - 30 = -17$
11. [5 pts] $-25 - 7 = -32$
12. [5 pts] $24 + 10 = ???$ (Show the decimal result; you should get overflow.)

New Part 3: [replaces previous Part 3]

13. [6 = 3*2 pts] Convert 428 from decimal to binary, octal, and hexadecimal.
14. [6 = 3*2 pts] Convert 123 from hexadecimal to binary, octal, and decimal.
15. [3 pts] What is the octal representation of hex A63CB59 ?
16. [6 = 3*2 pts] As an 8-bit sign-magnitude number, hex FF represents $-7F_{16} = -127_{10}$. What does it represent in (a) unsigned binary, (b) 2's complement, and (c) 1's complement?
17. [5 pts] What is the hex representation of the (2's complement) negative of 16-bit 2's complement hex F556 ? Show the translation two ways: Once with hex \rightarrow -hex using 16's complement and once with hex \rightarrow bitstring \rightarrow -bitstring \rightarrow -hex.
18. [5 pts] What is the hex representation of the (2's complement) negative of **15-bit** 2's complement hex 7A6 ?
19. [4 pts] What is the octal representation of the (2's complement) negative of 8-bit 2's complement octal 127 ?