Computer Organization and Structure

Homework #3
Due: 2006/11/14

1. Convert 4096_{ten}, $-2{,}047_{ten}$, and $-2{,}000{,}000_{ten}$ into 32-bit two's complement binary numbers, respectively, and convert the following two's complement binary numbers to be decimal numbers:

   a. 1111 1111 1111 1111 1111 1111 0000 0110_{two};
   b. 1111 1111 1111 1111 1111 1111 1110 1111_{two};
   c. 0111 1111 1111 1111 1111 1111 1110 1111_{two}.

2. The following MIPS instruction sequence could be used to implement a new instruction that has two register operands. Give the instruction a name and describe what it does. Note that register $t0 is being used as a temporary.

```
srl   $s1, $s1, 1      #
sll   $t0, $s0, 31     # These 4 instructions accomplish "new $s0 $s1"
srl   $s0, $s0, 1      #
or    $s1, $s1, $t0    #
```

3. The ALU supported set on less than (`slt`) using just the sign bit of the adder. Let's try a set on less than operation using the values -7_{ten} and 6_{ten}. To make it simpler to follow the example, let's limit the binary representations to 4 bits: 1001_{two} and 0110_{two}.

   $1001_{two} - 0110_{two} = 1001_{two} + 1010_{two} = 0011_{two}$

   This result would suggest that $-7_{ten} > 6_{ten}$, which is clearly wrong. Hence we must factor in overflow in the decision. Modify the 1-bit ALU in the following figures to handle `slt` correctly.

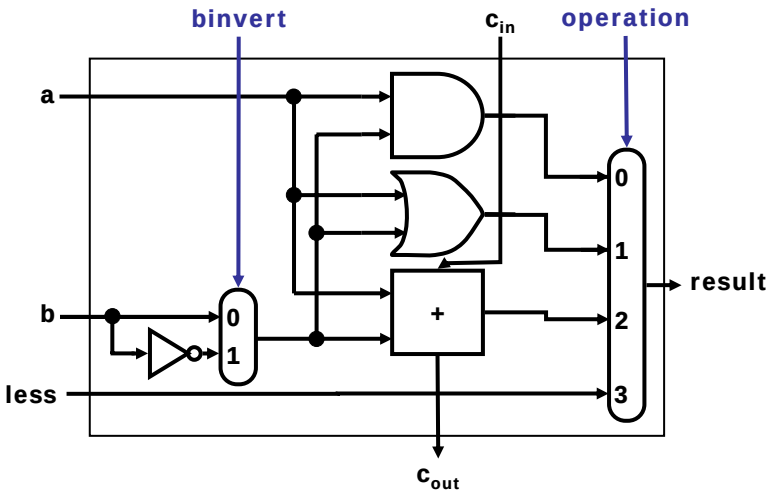

Figure 1: A 1-bit ALU that performs AND, OR, and addition on a and b or b'.

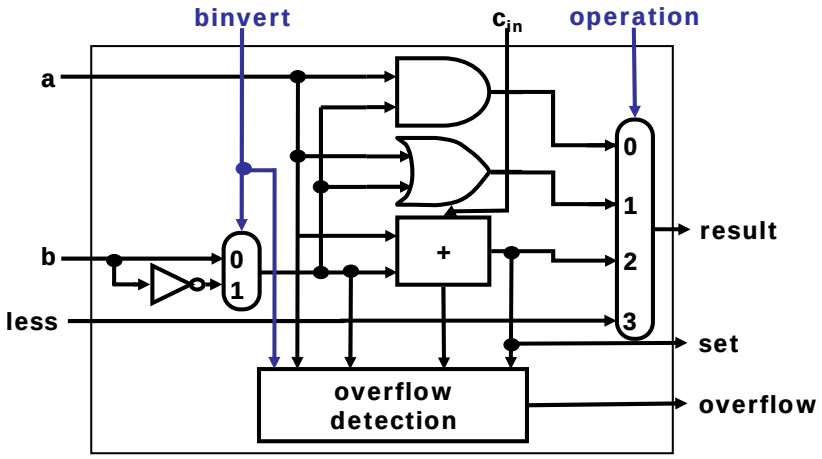

Figure 2: A 1-bit ALU for the most significant bit.

4. Add 2.85_{ten} x 10^3 to 9.84_{ten} x 10^4 and add 3.63_{ten} x 10^4 to 6.87_{ten} x 10^3, respectively, assuming that you have only three significant digits, first with guard and round digits and then without them.

5. Given the bit pattern:

   1010 1101 0001 0000 0000 0000 0000 0010

   what does it represent, assuming that it is

   a. a two's complement integer?
   b. an unsigned integer?
   c. a single precision floating-point number?
   d. a MIPS instruction?