Computer Organization and Structure

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. Suppose that all of the conditional branch instructions except `beq` and `bne` were removed from the MIPS instruction set along with `slt` and all of its variants (`slti`, `sltu`, `sltui`). Show how to perform

    ```
    slt   $t0, $s0, $s1
    ```

    using the modified instruction set in which `slt` is not available. (Hint: It requires more than two instructions.)

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.
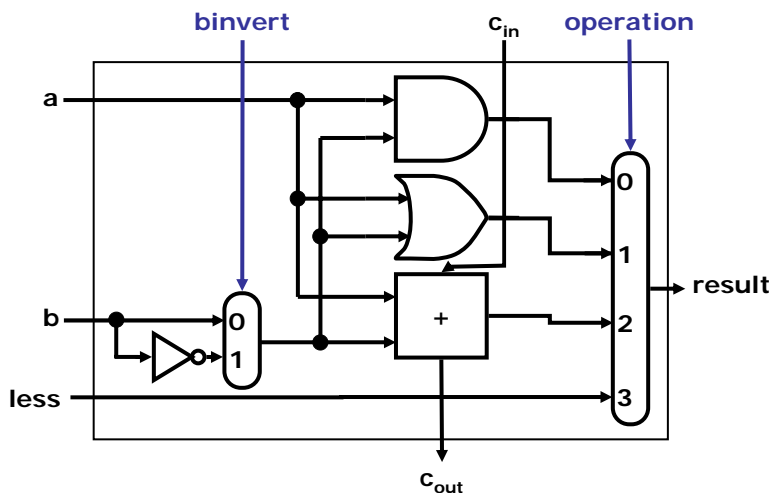

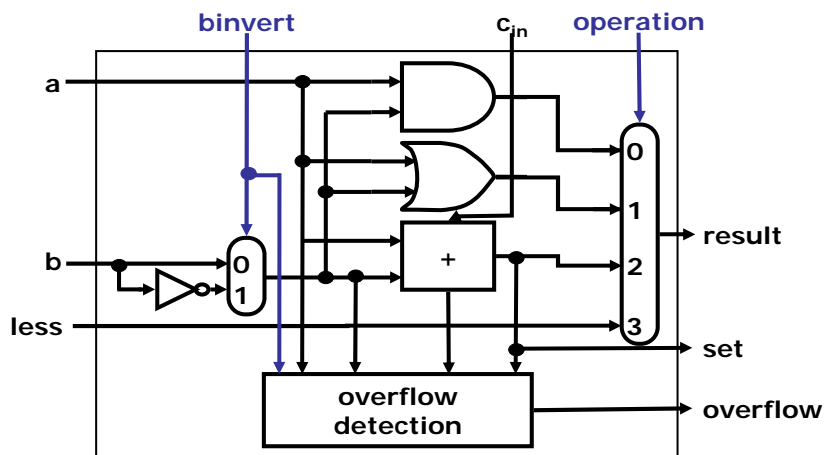Figure 1: A 1-bit ALU that performs AND, OR, and addition on a and b or b'.

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

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

5. Show the IEEE 754 binary representation for the floating-point numbers 20_{ten}, 20.5_{ten}, 0.1_{ten}, and -5/6, respectively.