Lab 1: A Calculator ISA

Lab 1 is due Monday March 5. Your lab report and source code must be submitted by **10:10AM before the class**. The late policy applies to this lab project.

This lab is a team project. Two students are expected to work together on ALL parts of the lab. Get started early! The required format for lab reports can be found on the resource page.

Objective: The objective of this laboratory is to design an 8-bit calculator ISA, implement a simulator, and test your ISA and simulator.

Equipment and software: The C programming language is recommended for this project. All lab computers are installed with C compilers. You can also use other programming languages for implementing the simulator.

Specification of the calculator: The calculator ISA must support the following operations. You may encode other functions in the ISA as you wish.

- Address four 8-bit registers.
- All registers should have value "0" before their first write.
- Load a 4-bit immediate number into a register. The immediate number should be sign-extended.
- Add/subtract between two registers and store the result in a third register.
- Display a register's content to console.
- Compare two registers. If they are not equal, execute the next instruction. If equal, the instruction should support the choice of skipping either the next 1 or the next 2 instructions

Task 1: Design the ISA. Submit a design document that specifies the format of instructions and the semantics of each instruction.

Task 2: Implement the ISA in a simulator written in C (or in another programming language of choice). The simulator must accept a file that encodes instructions of your ISA in binary (you can use a textual representation of the binary code, e.g., "00110010" in the file, or use the true binary file format), and print out the result. The simulator shouldn't accept any other input.

Task 3: Design benchmarks, i.e., a series of programs written ONLY in your ISA, to verify the functionality and correctness of your own simulator as a BLACKBOX. The benchmark suite should be designed to test every instruction, including each instruction's major variations. You should document all problems that you have experienced, how the problems are fed back to your teammate, and how they are fixed.

What to Turn In

For this lab project, turn in your design documents, source code of your simulator and benchmarks. You should submit all documents to Canvas.

Each submission should include (1) an ISA design document for task 1; (2) your simulator implementation and usage documentation; and (3) the benchmarks you design, and the documentation of all problems that you have experienced running your benchmarks on your simulator, how the problems are fed back to help debugging, and how they are fixed.

Peer evaluation: Please submit your peer evaluation (guideline is on Canvas) of your teammates, including scores and justification, directly to the TA.