CDA 4205 Computer Architecture

Project: Single Cycle Processor Implementation

1. **Objectives**

Using the Logisim Simulator to design and test a single-cycle 32-bit processor.

1. **Tasks** 
   * Model the designed 32x32-bit register file as one single module in Logisim and test the register file for correct operation by writing to and reading from different register combinations.
   * Design a 32-bit ALU to perform all the arithmetic, logic and shift operations required by your data path, and model the your designed 32-bit ALU in Logisim, then test the correct functionality of all operations implemented by the ALU.
   * Design the datapath for a single-cycle CPU and model it using logisim.
   * Apply the needed values of for the control signals needed for the execution of each instruction to ensure correct functionality of the datapath.
   * Design the control unit for the designed datapath and model it using logisim.
   * Test the correct functionality of the control unit by ensuring that it generates the correct control signal values for each instruction.
   * Model the single cycle CPU design in logisim by combining the datapath and control units.
   * Test the correct functionality of the designed CPU by storing all the implemented instructions in the instruction memory and verifying the correct execution of each instruction.
2. **Testing**

* Test all components and sub-circuits independently to ensure their correctness. For example, test the correctness of the ALU, the register file, the control logic separately, before putting your components together.
* Test each instruction independently to ensure its correct execution.
* Document all your test programs and files and include them in the report document.

1. **Project Report**

The report document must contain sections listed in the following:

1. **Design and Implementation**

* Specify clearly the design giving detailed description of the datapath, its components, control, and the implementation details.
* Provide drawings of the component circuits and the overall datapath.
* Provide a description of the control logic and the control signals. Provide a table giving the control signal values for each instruction. Provide the logic equations for each control signal.

1. **Simulation and Testing**

* Carry out the simulation of the processor developed using Logisim.
* Describe the test programs that you used to test your design with enough comments describing the program, its inputs, and its expected output. List all the instructions that were tested and work correctly. List all the instructions that do not run properly.
* Provide snapshots of the Simulator window with your test program loaded and showing the simulation output results.

1. **Team work**
   * 3 or at most 4 students can form a group. Make sure to write the names of all the group members on the project report title page.
   * Group members are required to coordinate the work equally among themselves so that everyone is involved in all the following activities:
     + Design and Implementation
     + Simulation and Testing
   * Clearly show the work done by each group member. You can also mention how many meetings were conducted between the group members to discuss the design, implementation, and testing.
2. **Submission Guidelines**

* All submissions will be done through canvas.
* Attach one zip file containing all the design circuits and sub-circuits, the test programs, their source code and binary instruction files that you have used to test your design, their test data, as well as the report document.

1. **Grading Policy**

The grade will be divided according to the following components:

* Correctness: whether your implementation is working
* Completeness and testing: whether all instructions have been implemented and tested properly.
* Participation and contribution to the project
* Report document

1. **Late Policy**
   * The project should be submitted on the due date by midnight.
   * Late projects are accepted for a maximum of 1 day.
   * Projects submitted after 1 late day will not be accepted.
   * The maximum late penalty is 10%.
2. **Bonus points (10 pts)**

Provide a video demo for the design, simulation and testing of your processor.