CS 382
Fall 2024

Computer Architecture
and Organization

Lab 8

1 Task 1: Mini Register File

1.1 Configuration

In this lab, we are going to use Logisim-Evolution to build a mini register file. The configuration is as follows:

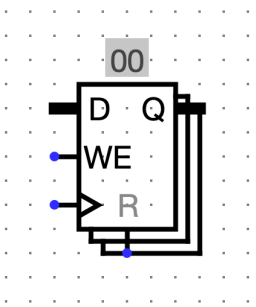
- The register file contains **four** registers, one write port, and two read ports;
- Each register can store one **byte**;
- All registers are synchronized by a clock.

Based on Figure 3.14 from the textbook, we need the following data signals:

- Input:
  - `WriteReg` : the register ID for writing data;
  - `RegWrite` : the switch to control if we need to write to a register;
  - `RegDataW` : the data we want to write to the register;
  - `ReadReg1` : the register ID for reading (register 1);
  - `ReadReg2` : the register ID for reading (register 2);
- Output:
  - `RegData1` : data read from register 1;
  - `RegData2` : data read from register 2.

1.2 Write-Enabled Registers

In Logisim-Evolution, we can use write-enabled registers (left panel ► Memory ► Register), shown on the right.



The grey box with number shows the data stored in the register (hexadecimal); `D` is the input for data (write), and `Q` is the output for data (read). We can leave `R` unattached. The port with a small triangle is used to connect a clock. For this part you'd need to go to left panel ► Wiring ► Clock, choose the clock, and connect it with the register triangle.

The `WE` port means write-enabled, which is the `E` signal we used Figure 3.14 in the textbook, and should connect to an AND gate with input `RegWrite` and the output from a decoder. In this lab, you can certainly use the decoder provided by Logisim-Evolution: left panel ► Plexers ► Decoder.

1.3 Simulation and Timing Diagram

Before we start exploring timing diagram, make sure you have labeled all the input and output signals, as well as register numbers (such as `X1` , `X2` , etc).

Once you have built the timing diagram, we can start simulating our register file. To set up a comfortable environment for simulation, do the following:

(1) Change the cursor to the finger (not arrow) to get ready for simulation;
(2) Go to the top menu, choose Simulate, and make sure the item "Auto-Tick Enabled" is chosen;
(3) Under same menu, choose "Auto-Tick Frequency", and choose 0.5Hz so it's not running too fast;
(4) Under same menu, choose "Timing Diagram" to open a new window, and click on Timing Diagram tab;
(5) Click the play button.

Then you'll see the clock starts ticking!

2 Task 2: Report

After task 1 has been completed, you will write a report to show that your register file works properly. The report includes two parts: reading and writing register file. Please follow the steps in the report template provided, and add screenshots (four in total) in each box.

3 Grading

The lab will be graded based on a total of 10 points, 5 for task 1 and 5 for task 2.

- Task 1:
  - **-5:** if the circuits cannot be simulated at all;
  - **-4:** if the configuration does not match the description in Section 1.1 Configuration;
  - **-2:** if any of the components is not labeled correctly (see Section 1.1);
  - **-1:** no pledge and/or name.
- Task 2:
  - **-3:** if any of the screenshots misses timing diagram and/or the circuit;
  - **-3:** if any of the screenshots show the register file is not working properly under certain condition;
  - **-1:** no pledge and/or name.

Earlybird Extra Credit: 2% of extra credit will be given if the lab is finished by Wednesday 11:59PM EST (1 day before the lab deadline). For specific policy, see syllabus.

Attendance: check off at the end of the lab to get attendance credit.

Deliverable

One `.circ` file, and one PDF report, no need to zip.