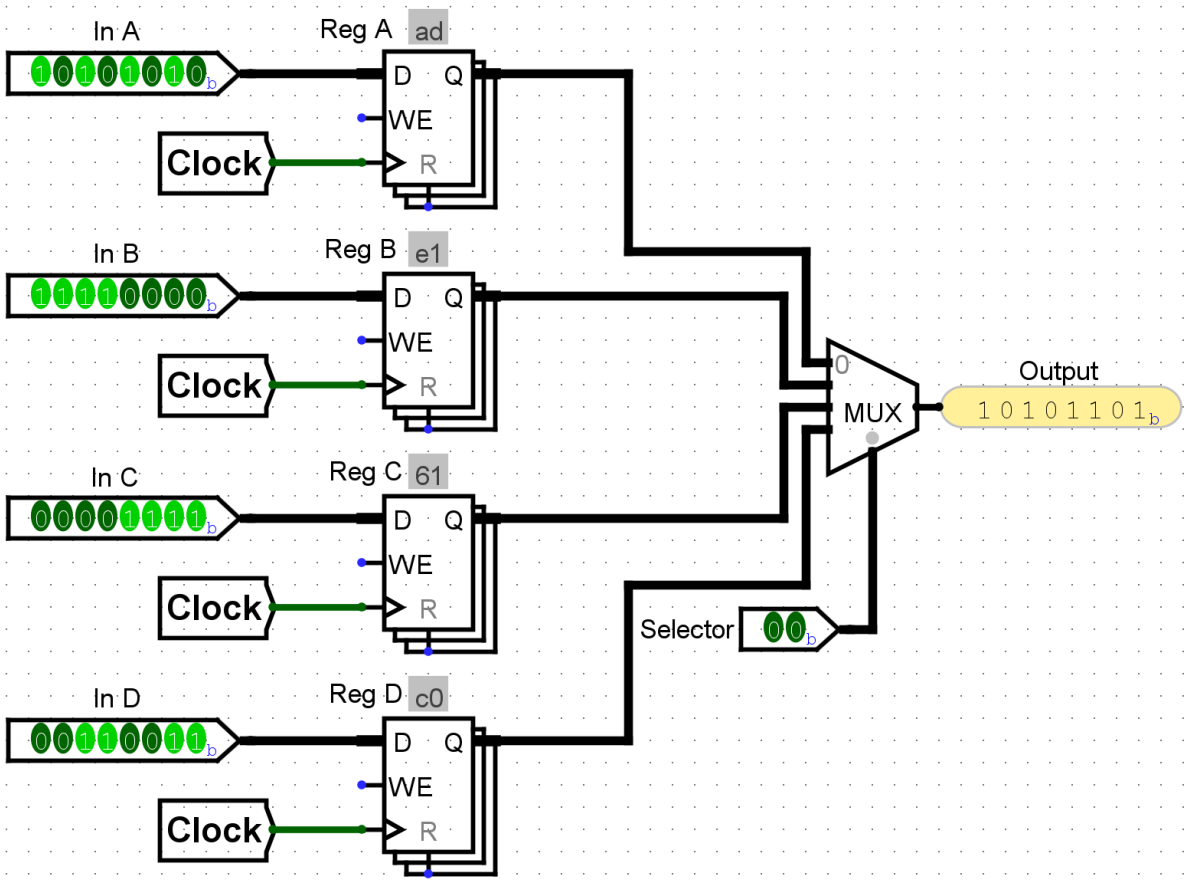
HW6.1. Register file implementation

A register file is a collection of X Y-bit registers. In RISC-V, for example, we have 32 different registers that we can access and each register is 32-bits each, giving us a 32 32-bit register file. To read a specific register, we can utilize a multiplexer to select the corresponding register that will show up at the output. A sample implementation of a 4 8-bit register file is shown:



This current register file setup allows us to read specific registers selected by the "Selector" input. Currently, we have 2 bit selector since we are just selecting from 4 registers. In RISC-V, 32 registers will correspond to a 5-bit selector.

The current register values are shown above each register (written in hex). Reg A, for example, has a current output of 0xAD or `10101101`. "Selector" = `00` corresponds to Reg A, "Selector" = `01` corresponds to Reg B, and so on.

For the following questions, **write the corresponding 8-bit output assuming everything else is held constant in the given figure, except for those indicated in the question.** Write your answer in binary without the 0b prefix.

Note that each question is independent of each other. Changes done in the previous questions will not reflect on the current question.

Hint: Recall that registers only update their outputs on the positive edge of the clock.

Q1.1: "Selector" = `01`

Q1.2: "In A" = `00001111`

Q1.3: "In D" = `00001111`, "Selector" = `11`

Q1.4: "In C" = `01101001`. *Positive edge of the clock occurs.* "Selector" = `10`

Q1.5: "In B" = `00001111`. *Positive edge of the clock occurs.* "Selector" = `10`

The main problem with this setup is that we need dedicated input ports *per register*. A true register file should allow us to write to a specific register on a single write port using a selector as well. One way to do this is to make all registers share the same input, and then control the "WE" ports of the registers so that only a specific register is updated depending on another selector input. If the "WE" of the corresponding register is 1, the register updates its value on the positive edge of the clock, else, the register will just hold its current value.

Homework 6

Assessment overview

Total points: 0/100

Score: 0%

Question

Value: 10

History:

Awarded points: 0/10

Report an error in this question

Previous question

Next question

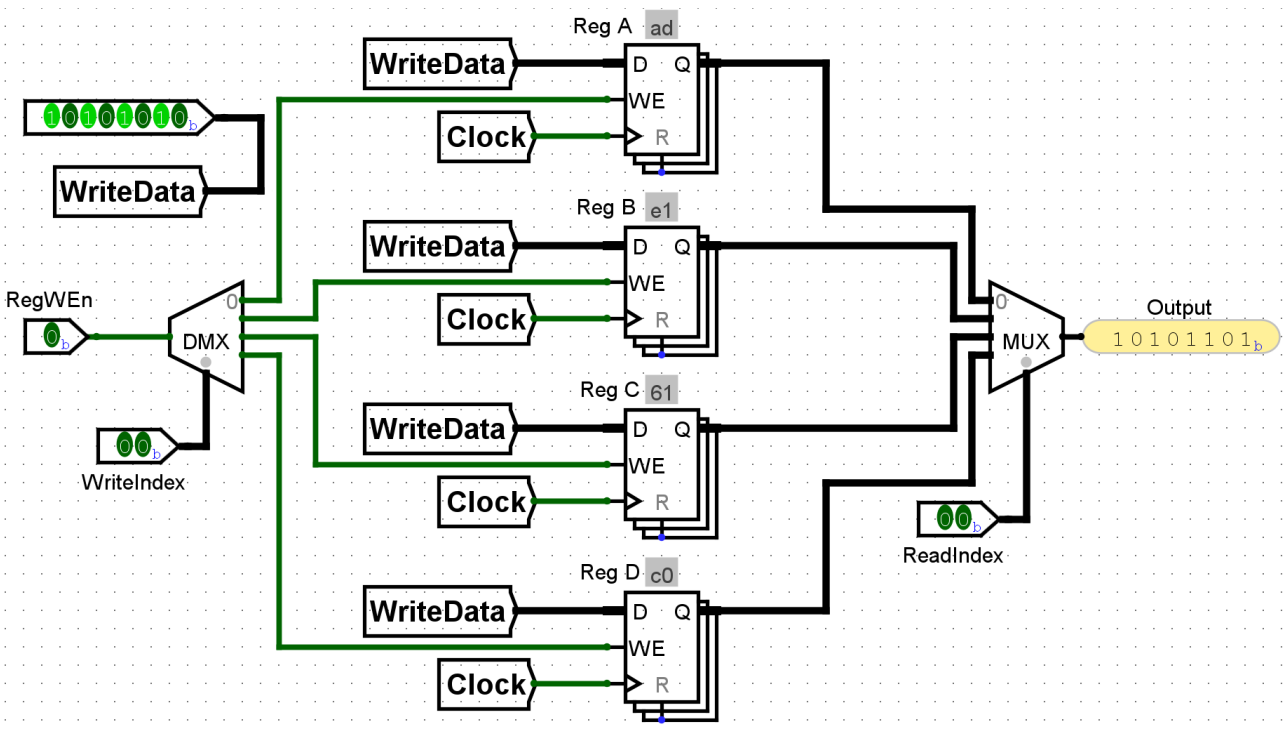
Attached files

No attached files

Attach a file

Attach text

Now, I introduce another combinational logic block called demultiplexer (or demux, for short) that will allow us to do that functionality. A demux is like the inverse of the multiplexer in terms of functionality. Depending on the selector bits, the input will be transferred to the corresponding output. The rest of the output bits that are not selected will be 0. A demux can be used to control the "WE" ports of each register in the register file as shown below:



For the following questions, **write the corresponding 8-bit output assuming everything else is held constant in the given figure, except for those indicated in the question.** Write your answer in binary without the 0b prefix.

Note that each question is independent of each other. Changes done in the previous questions will not reflect on the current question.

Hint: Recall that registers only update their outputs on the positive edge of the clock and if "WE" = `1`.

Q2.1: "ReadIndex" = `01`

Q2.2: Positive edge of the clock occurs.

Q2.3: "WriteIndex" = `01`, "ReadIndex" = `01`

Q2.4: "WriteIndex" = `10`. *Positive edge of the clock occurs.* "ReadIndex" = `10`

Q2.5: "WriteIndex" = `11`. "RegWEn" = `1`. *Positive edge of the clock occurs.* "ReadIndex" = `11`

Which of the following statements are true about register files?

Also, once you have correctly answered the following questions, spend some time reading the provided explanations.

- [ ] (a) Let's say *after* the positive edge of the clock, "RegWEn" becomes `1`. Since "WriteIndex" = `00`, we will see an updated value of RegA right away.
- [ ] (b) If we want to read two register values at once, we need another multiplexer with a different "ReadIndex" selector.
- [ ] (c) Since all registers share the same input "WriteData", all registers will change their values on the positive edge of the clock.
- [ ] (d) Due to the presence of the demux, writing/updating the register values is purely combinational (i.e. no need to wait for the positive edge of the clock to update the register value).
- [ ] (e) If "RegWEn" = `1`, then on the next positive edge of the clock, the corresponding register selected by "WriteIndex" will update its value.
- [ ] (f) In RISC-V, if an instruction does not need to write to the register file (e.g. store instructions), then we don't care what "RegWEn" should be.

- [ ] (g) Reading a specific register value is purely combinational (i.e. no need to wait for the positive edge of the clock), since we only need to change the "ReadIndex".
- [ ] (h) If "RegWEn" = `0`, we don't care what "WriteIndex" is since the registers will not change their current values anyway.

Select all possible options that apply.

Save & Grade *20 attempts left* | Save only

Additional attempts available with new variants