EEE 120

Lab 3 Answer Sheet (Online Class)

Registers, Counters and the “Brainless CPU”

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Semester/Year/Session (A/B): Summer/2023/C Date: 6/11/2023

**Task 3-1: Build and Test a 4-Bit D Register with Enable**

Include a picture of your Digital circuit here:

A screenshot of a computer

Description automatically generated

Please comment on the single biggest issue you were facing when designing the circuit.

The biggest issue was connecting all the wires in the circuit.

Include a picture of your GTKWave waveforms (timing diagram) here:

A screenshot of a computer

Description automatically generated

Did the circuit behave as expected? If no, what was wrong?

Yes, It did behave as expected.

Please comment on the single biggest issue you were facing when simulating the circuit.

Understanding the stimulus file and editing it was the biggest issue I faced.

**Task 3-2: Build and Test a 4-Bit UP Counter**

Include a picture of your Digital circuit here:

A screenshot of a computer

Description automatically generated

Please comment on the single biggest issue you were facing when designing the circuit.

There were no issues with building the circuit.

Did the circuit behave as expected? If no, what was wrong?

Yes, It behaves as expected and counts from 0 to F.

Please comment on the single biggest issue you were facing when simulating the circuit.

I had to manually toggle the clock to count up.

**Task 3-3: Create a 4-Bit RAM with 16 4-Bit Words**

Include a picture of your Digital circuit here:

A screenshot of a computer

Description automatically generated

Please comment on the single biggest issue you were facing when designing the circuit.

There were not any issues designing the circuit.

Did the circuit behave as expected? If no, what was wrong?

Yes, when I put an address of 1 it gave me 5. I added some more values and tested.

Please comment on the single biggest issue you were facing when simulating the circuit.

There were no issues with simulating the circuit.

**Task 3-4: Build and Test the Brainless Central Processing Unit**

Include a picture of your Digital circuit here:

A screenshot of a computer

Description automatically generated

Please comment on the single biggest issue you were facing when designing the circuit.

Making sure I get all the connections right.

Did the circuit behave as expected? If no, what was wrong?

It is working as expected.

Please comment on the single biggest issue you were facing when simulating the circuit.

Figuring out the order in loading the values from the RAM and adding them.

**Task 3-5: Simulate the Brainless Central Processing Unit**

Include a picture of your GTKWave waveforms (timing diagram) here:

A screenshot of a computer

Description automatically generated

Did the circuit behave as expected? If no, what was wrong?

Yes, the circuit did behave as expected and I checked the waveform to make sure all outputs and inputs were correct.

Please comment on the single biggest issue you were facing when simulating the circuit.

Looking at the stimulus file and all the bits to understand the sequential operation of the circuit was difficult.

**Task 3-6: Create Additional Tests**

In order to stay organized, you may use the table here to map out the different values for each test. Repeat this table for each of the additional ALU operations.

|  |  |
| --- | --- |
| **Table 1** | |
| **Operation [ Add operand to Accumulator (ACC) ]** | |
| Control Line | Value |
| data\_in | 0 |
| addr\_bus | Address of operand |
| write | 0 |
| read | 1 |
| acc\_to\_db | 0 |
| load\_acc | 1 |
| pass | 0 |
| invert | 0 |
| arith | 1 |

Include a picture of your Digital circuit here:

A screenshot of a computer

Description automatically generated

Include a picture of your GTKWave waveforms here (one per required test):

Brainless\_ext\_write: This is writing A into address 2 and then reading to check if A is written properly.

A picture containing text, screenshot, font, line

Description automatically generated

A screenshot of a computer

Description automatically generated

Brainless\_int\_write: Load a 3 from address 0, then do a 2s complement of 3 to get D and load into data\_bus, then do an internal write into address 3, and read back to check if the write was good.

A picture containing text, font, screenshot, algebra

Description automatically generated

A screenshot of a computer

Description automatically generated

Brainless\_alu: Load a 3 from address 0 and 5 from address 1. Then I did a subtraction of 3 – 5 to get E. Then in line 5 I performed a second alu function which was A’ AND B to get 2.

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Description automatically generated

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Please comment on the single biggest issue you were facing when designing the circuit.

Keeping track of the sequential operations and the order to perform them to get the right output was hard.

Did the circuit behave as expected? If no, what was wrong?

Yes, it did behave as expected.

Please comment on the single biggest issue you were facing when simulating the circuit.

Loading all the waveforms and checking all the inputs and outputs to ensure and verify the functions.

**Task 3-7: Create a video and submit your report (Optional)**

[This task is useful to get partial credit if your schematic is not working. Take advantage of it to explain to the grader your understanding of the circuit. More importantly, explain where you think the mistake is in and what you would do if you were given more time to fix it.]

Record a short video showing your schematic in Digital and your waveforms in GTKWave. Be sure to show yourself in the video and show your screen. **Upload the video to your Google Drive (personal one or ASU one). Copy and paste the sharing link to that video here. Make sure the link is working and pointing to the correct video. Do NOT upload your video to YouTube.** If your circuit is not working as expected, explain in the video how it is not working and where you expect the mistake to be from.

**Video Link:**

**At the beginning of your recording, say your name, the task number and circuit name. Be brief in your recording. Submit the completed template to Canvas.**

**Make sure all your files are in the Lab3 directory. Create a zip file of the Lab3 directory. Remember to turn in the zip file and your completed template on Canvas! Make sure you upload the template before the zip file.**

Lab 3: Lab Report Grade Sheet

|  |  |
| --- | --- |
| **Name:** |  |

## Instructor Assessment

|  |  |  |
| --- | --- | --- |
| **Grading Criteria** | **Max Points** | **Points Lost** |
| **Description of Assigned Tasks, Work Performed & Outcomes Met** |  |  |
| Task 3-1: Build and Test a 4-Bit D Register with Enable | 10 |  |
| Task 3-2: Build and Test a 4-Bit UP Counter | 10 |  |
| Task 3-3: Create a 4-Bit RAM with 16 4-Bit Words | 10 |  |
| Task 3-4: Build and Test the Brainless Central Processing Unit | 10 |  |
| Task 3-5: Simulate the Brainless Central Processing Unit | 10 |  |
| Task 3-6: Create Additional Tests | 30 |  |
| Task 3-7: Create a video and submit your report (Optional) |  |  |
|  | **Points Lost** |  |
| **Lab Score (80 points total)** | **Late Lab** |  |
|  | **Lab Score** |  |