CS 4341 Fall 2021
Project, Part 1
Assigned Week of January 24th
Due February 11th, 11:59 pm

1 Objective

For this semester, you are to form a team, and build a simple processor, such as an ALU, in a hardware design language. For the first part of the project, you must form a team and select your software.

2 Tasks

The following tasks to complete for this project will be:

- Forming a Cohort (15 points)
- Program the given problem with the given requirements. (70 points)
- Work Log (15 points)
- Think about the Bonus

2.1 Forming a Cohort (15 points)

Form a team, called a cohort, of students. Each cohort will be working together over the course of the semester on the project.

2.1.1 How big should a team be?

Ideally, the team should be between 4 to 5 people. Given a class of 75 students, 15 cohorts of 5 students each would be ideal.

2.1.2 How will the team function?

With the pandemic still impacting campus, I want your team to choose an online archive for your work and some means of asynchronous communication. The most popular archive is GitHub, but other servers exist. I have seen communication kept track off with GitHub, Facebook, Discord, GroupMe, Slack and other collaboration software.

2.2 Naming the Cohort and Writing the Description

Each Cohort should have a good, clear name and an explanation of the name.

2.2.1 The Cohort Name

I want a name for your Cohort that will be suitable to be put into the Blackboard Gradebook. That is quite the handicap, since Blackboard is going require an identifier of about 16 characters at most. Such a name can be silly or serious, but it needs to be appropriate, recognizable, and understandable.

2.2.2 The Cohort Description

Why is the cohort the name it is? Yes, I have students turn in “Cohort 1” or “Cohort A” or similar, for no other reason that they couldn’t be bothered to think of a good name. That reason is actually acceptable, so long as it is included in your submission. The description has to be correct, appropriate, and have good spelling and grammar.

2.3 Choice of a Project Topic and Why

Right, onto the project topic. Your project this semester is to build a circuit in a hardware design language that incorporates an ALU in its design.

2.3.1 The Arithmetic Logic Unit

The Arithmetic Logic Unit is a controlled data path…which will not mean much here on part 1. The ALU has the ability to do the basic math functions: add, subtract, multiply, divide, and modulus. The ALU also has the ability to do logic functions: AND, OR, NOT, NAND, NOR, XOR, XNOR. The ALU also has the ability to shift a binary number left or right, either as a circular form or by doing concatenation. Also, the components of an ALU should report (but not handle) basic errors such as divide-by-zero or overflow.

From there, the ALU can be used to create multiple types of tools.

The simplest is just a calculator…you give it an input command, input data, and receive back either the output data or an error statement. Not particularly impressive, but it covers the most basic ALU functions.

A more complex project would be a robot, like the Starship delivery robots. For example, the simulation would take commands for motion, and the ALU would be used to calculate the current values of the robot. Addition and subtraction can handle the drain on the robot's battery. Clock functions can be used to work out the time elapsed for a delivery. Logic functions could be used to determine if the delivery was made on time, and memory registers could keep track of the robot's location in memory registers.

Past projects include a lightsaber control system, using the ALU to change the length of the blade, track the energy drain on the light saber, setting the color of the light saber, adjusting the power of the blade (stun vs. vorpal), and having single or multi-blade.

Other past projects included making a video game using a Verilog ALU (Pacman, Tetris level of complexity), the controls for Spiderman's web shooter, a super-vault with a complex combination lock, and the coordinates for a time machine using the ALU to calculate and display coordinates, and Rik & Morty's gun. All of these would be fine, or you might think of one of your own, but the project has to include calculations in math and logic.

For this portion of your project, your Cohort needs to define their project, and give an English description of what it does.

2.4 Implement Gate-based Code

Being the first phase of the project, what is required includes turning a truth table into a set of equations in a simulation in Verilog using a structured programming style. Structured programming is not the same as knocking out equations in C++ or Java and dumping the output.

The program must meet the following requirements.

2.4.1 Requirement 1:

The main of the program must be called testbench. This contains a portion called the ***stimulus***. The testbench will invoke a module called breadboard passing the inputs and receiving the outputs.

2.4.2 Requirement 2:

The breadboard module will be the workspace where circuits will be assembled in the code. For this first phase, the program will concentrate on gate logic.

2.4.3 Requirement 3:

Solve for the ***min-term*** form of the 10 equations for the following truth table, turn those equations into circuits in the program. The 10 individual circuits for these equations should be in the breadboard module, but the output should be displayed in the testbench.

#	w	x	y	z	f_0	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9
0	0	0	0	0	0	0	1	0	1	0	0	1	1	0
1	0	0	0	1	1	0	0	1	0	0	1	0	0	0
2	0	0	1	0	0	0	0	1	1	0	0	0	1	1
3	0	0	1	1	0	1	1	1	1	1	0	1	1	0
4	0	1	0	0	0	1	1	1	0	1	1	1	1	0
5	0	1	0	1	1	0	1	0	1	1	0	0	1	1
6	0	1	1	0	1	1	0	0	1	1	0	0	1	0
7	0	1	1	1	0	1	1	0	1	1	0	1	1	1
8	1	0	0	0	1	0	0	1	0	1	1	1	0	0
9	1	0	0	1	1	0	1	1	0	0	0	1	1	1
A	1	0	1	0	1	0	1	0	0	0	0	0	0	1
B	1	0	1	1	1	1	1	1	0	0	1	1	0	0
C	1	1	0	0	0	1	1	0	1	1	1	0	1	1
D	1	1	0	1	1	1	0	1	1	0	1	0	1	1
E	1	1	1	0	1	1	0	0	0	1	1	1	0	0
F	1	1	1	1	0	1	1	0	0	1	1	0	0	1

2.5 Work Log (15 points)

Over the course of this first part of the project, your cohort is expected to meet either online or in person. Discussion, editing, software research, solving the truth table and writing the program are key to getting full points on this part of the project.

Every member of the cohort must have a working copy of the Verilog program and have run the Verilog. If they have not done so, they are not correctly participating. Yes, Dr. Becker is fully aware that past cohorts have assigned all the programming to one person, and then everyone else just discuss and do the writeup.

Since each student will turn in their own copy of the project, each student will also turn in their own copy of the work log. In the work log, if you feel a member of the cohort has not fully participated, you are free to name them in your copy of the work log.

What should be in the work log:

2.5.1 The Journal

A calendar of events, meeting, discussion, choice of software, writing code, that has the date, a description of the work done, and who was doing the work.

Date	Task	Who
September 1	Working on Group Name	Fred, Daphne, Velma, Norville
September 2	Software Research	Velma, Fred
September 3	Editing Writeup	Daphne, Norville
September 8	Solving equations	Velma, Fred
September 10	Started Verilog	Fred, Daphne, Velma, Norville
September 12	Debug session (with pizza)	Norville
September 13	Running Program	Norville, Daphne
September 14	All running code	Fred, Daphne, Velma, Norville

2.5.2 Affirmation

A list of cohort members who got the program running on their own equipment. Everyone can help each other, share code, debug…but can everyone get the program running.

Norville had it running on September 12, Daphne on the 13th, everyone got it on GroupMe on the 14th. Everyone in our cohort succeeded in running the code.

2.5.3 Peer Grade

A separate assignment is available on blackboard, a Peer Participation Report. This document is required for every member of the cohort individually. See blackboard for details.

2.6 Think about the Bonus

The semester project as a bonus worth a +5% to the semester score. Not to just the project, the semester score. To do so, a Cohort has to do the following.

1. Finish all four parts of the project
2. Create a visually impressive addition based on the main project
3. Examples
    a. Plugging Verilog into Jscript and Unity
    b. Using an interface with physical hardware
    c. Rebuilding the circuit in a visual system, such as Minecraft Redstone
4. Anyone wanting the points must present to the class
5. The presenters must answer questions from their peers.
6. And it cannot be boring. If the presentation is boring, and the student peers reject it, no points will be given.

3 Turn In:

- A PDF called <CohortName>.Part1:
    - Pick a Cohort Name
    - Cohort Description
    - List of your cohort members
    - If you are using a source repository (like GITHUB), identify the service
    - Your main form of digital communication (Facebook, Trello, Slack, GroupMe, Discord, etc.)
    - Description of the Project you chose.
- A text file of your Verilog code.
- A text file of your Verilog Output
- A PDF called "<netid>.WorkLog" that contains your Cohort's journal and the affirmation.

4 Common Questions, Comments, and Problems

Q. Can I turn in the work late?
A. No.

Q. But really, it's all finished! My cohort will vouch for me! They have their copies in on time!
A. Okay, if your cohort is on time, and will vouch for you, then I am cool with it.

Q. Can we have this string of random characters be the name of our cohort?
A. The name has got to be about 16 characters, file-compatible with Blackboard, and appropriate.

Q. Can we change our minds about our project topic and design during the semester?
A. You can change your mind up to the final part of the project.

Q. I hate working in a cohort! I want to leave! I want to do the project on my own!
A. Then you forfeit the entire Peer Grade portion of the semester score.

Q. Our cohort does nothing but fight! We want to split up!
A. Fine…I will break your cohort into individuals, and everyone loses the peer points.

Q. I'm bullied by the other members of my Cohort, can I leave?
A. Yes, but I'll have to dock the peer points unless you find another cohort.

Q. We have a bully in our cohort! Can we eject him?
A. Yes.

Q. We have one person who never participates, and we don't want them to get access to any of our material!
A. Then your cohort must log it as such, and that person will be moved to individual, and lose all peer points unless they find another cohort.

Q. We're three or four people who lost our cohort, can we make a new one?
A. Yes.

Q. Can I join a different cohort during the semester?
A. If the new Cohort will have you, its fine.

Q. Only one person wants to do the Bonus Presentation!
A. Then that one person is the only one who gets the points.

Q. How dare you make rules! We will band together to beat Dr. Becker at his own game! We'll make the best project ever! We will protect every member of our team against your evil shenanigans!
A. Suits me fine.

Q. Curse you, Dr. Becker! You tricked me into learning something!
A. … I really need to get that on a t-shirt or coffee mug.