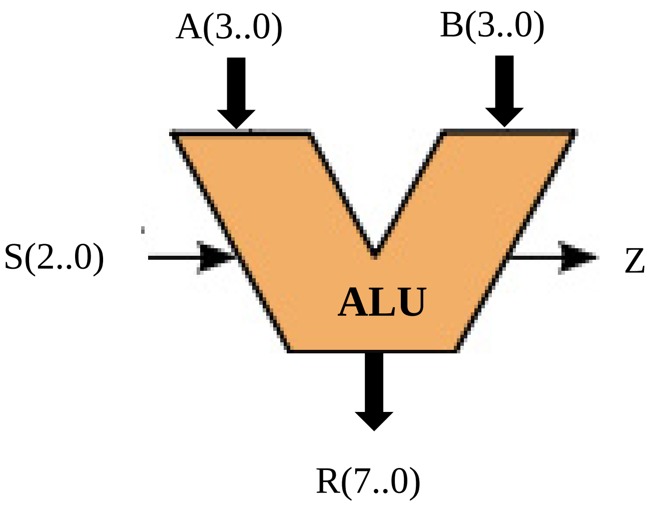
Technical Objective:

The Arithmetic and Logic Unit (ALU) in a microprocessor is the hardware in which arithmetic and logic operations are executed. In this lab the design of an ALU in VHDL will be investigated. New concepts that will be introduced in this lab are VHDL arithmetic operations and Modelsim simulation using a VHDL testbench.

Pre-Laboratory: (30%)

The block diagram shown below represents an *ALU Circuit*. The **ALU** design has eleven inputs and nine outputs. A and B are each 4 bit numbers that will be operated on according to the table below. S is a 3 bit input that determines which operation is to be performed on A and B. R is the 8 bit result of the operation. Z is a flag to indicate that the result of the operation is zero.



S	Operation
000	AND
001	OR
010	XOR
011	INVERT A
100	ADDITION
101	SUBTRACTION
110	MULTIPLICATIO
111	NEGATE A

1. Write the VHDL module (entity and architecture) for the ALU. Use a case statement.
2. Compile the VHDL
3. Submit to the dropbox prior to lab:
    - Your VHDL code

Procedure: (70%)

1. Download the ALU_tb.VHD file from MyCourses. Open the file and edit such that the component in the testbench matches exactly with your entity. If your port names are different than the ones on the component in the testbench, you will have to edit the port map as well.
2. Using the Modelsim tutorial from MyCourses, simulate your ALU using the testbench provided.
3. Verify the operation of your ALU by inspecting the output waveform. To make verification easier, you can change the radix for A, B and R. Use signed integers for arithmetic operations and binary for logic operations.
4. Print and annotate comments onto the Modelsim waveform printouts. You will need 8 printouts; one for each operation. Make sure that it is sufficiently zoomed in so that a reader can determine the values of the signals. You will only be able to capture a few examples of each operation.
5. Obtain a signoff when you are sure your simulation is correct.
6. In Quartus, assign pins for the DE2 board. The inputs should be on switches and the ouputs on LEDs. Put R on the green LEDs and Z on a red one.
7. Recompile the project with the pin assignments. Program the board.
8. Verify that your board is working and get a signoff.

Documentation:

There is no documentation due for this lab. Save the signoff sheets and annotated waveforms for lab 6.

Name Cliff Chapman

ALU (VHDL)

Signoff

1. **Simulation results** 9/25/13
2. **Working Board** 10/9/13