EC605: Computer Engineering Fundamentals – Fall 2024

Lab 1: Multiplexer

Combinational Logic via Block Design

Goals

- Introduction to gate-level design and simulation.
- Designing simple combinational circuits.
- Utilizing hierarchical design to construct larger circuits.

Overview

In this lab you will design an 8:1 multiplexer from smaller multiplexers, which are built from basic logic gates, via hierarchical design.

Tasks

Task 1: Logisim Intro

1. In this lab we will use the Logisim logic simulator, which allows you to design and simulate digital circuits using a graphical user interface. To run Logisim on the lab computers through the terminal, use the following commands from the home directory:

    > cd /ad/eng/opt/Logisim/
    > ./logisim.sh

    Alternatively, Logisim may also be installed on your personal computer from here: https://sourceforge.net/projects/circuit/.

    (Note: some security problems might arise if downloading logisim for mac, in that case this additional guide is helpful for debugging: https://www.techinfoin.com/install-logisim-on-mac/).

2. Logisim is a simple tool to use, most of the features you will need are well documented in the reference document. You can obtain the guide from the Logisim Documentation page: http://www.cburch.com/logisim/docs.html. Start with the Beginner's tutorial under 2.7.x documentation. It will show you around the graphical interface, as well as guide you through a simple XOR circuit.

Task 2: 2:1 Multiplexer

(For tasks 2 and 3 it is easiest to implement all circuits in the same project as **subcircuits,** as they build on each other).

1. In a new project, click Project -> Add Circuit to create a new circuit file for your 2:1 multiplexer. Following the process that was described in the lecture notes, build a 2:1 multiplexer from AND, OR, and INV(NOT) gates using block design. For an extra challenge, build a 2:1 multiplexer from NAND gates only.

2. Test your design via simulation. Ensure that your mux works properly by testing all input combinations.

Task 3: 8:1 Multiplexer

1. Build a 4:1 mux from 3 instances of your 2:1 mux, as shown in the lecture notes. The 2:1 mux should be used as a **subcircuit**, as described in the Logisim Documentation page.

2. Build an 8:1 mux from instances of smaller muxes. The 4:1 mux should be made into a hierarchy block first. Test your design as in the previous step.

Deliverables

1. Submit a PDF with a short description and screen capture of tasks 2 and 3 on Blackboard.

2. Sign-up to demo your design to a TA. Come prepared to show your work and answer questions on your design.