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Computer Architecture

Laboratory work 2 : Exercises in Logisim

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Introduction

Logisim is "An educational tool for designing and simulating digital logic circuits, featuring a simple-to-learn interface, hierarchical circuits, wire bundles, and a large component library. As a Java application, it can run on many platforms." When learning computer architecture and logic circuits, you will need a real-world, graphical example of what you are studying. Text and diagrams only go so far. A helpful tool for designing and simulating logic circuits is Logisim.

Because the tool lets you create large circuits from smaller circuits, you can design entire CPUs using Logisim. Further, the tool will run on any computer!

The interface itself is very intuitive and the use of color-coding of wires and elements allows for easy analysis and testing of circuits. You can also save the completed file as an image, or as a .circ file (core to Logisim).

The main window consists of the following items:

- **Toolbar:** contains short cuts to several commonly used items
 - The simulation tool: shaped like a hand, is used in simulation mode to alter input pins.
 - The design tool: is used while designing the circuit.
 - The input pin: green circle surrounded by a square box, is used to send a signal through a wire. When placing the input on the canvas it initializes the input to logic 1 or 0. The number of bits can be increased in the Attribute Table.
 - The output pin: green circle surrounded by a circular shape, is used to observe the output from a gate or a block. The output pin toggles in real time as long as the simulation is enabled from the menu bar: Simulate ↺ Simulation Enabled
- **Explorer Pane:** This pane contains the list of wiring, gates, multiplexers and other components that are available for digital design in Logisim.
- **Attribute Table:** Gives detailed attributes of digital design components (e.g., AND, OR, XOR gates). The attribute table allows you to alter the number of inputs/outputs that a digital component may have.
- **Canvas:** The canvas is the area for you to create your digital circuits. In this area you may simulate your circuits while designing in real time.

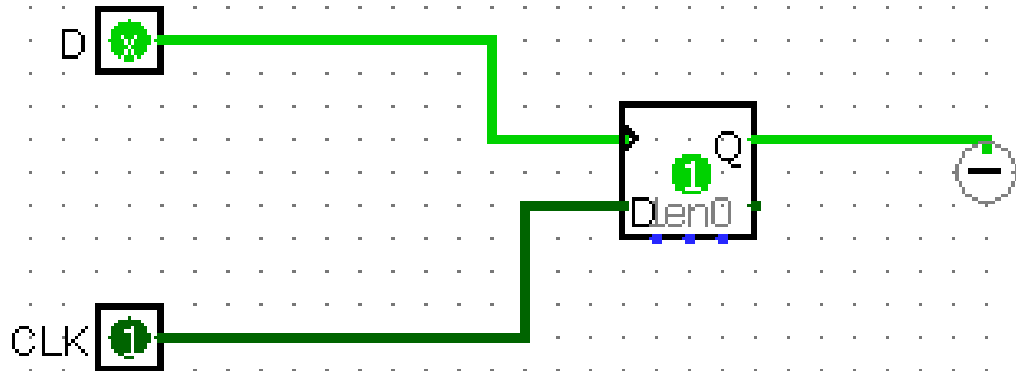
Objectives

1. Familiarize yourself with the basic components of digital circuits such as logic gates, flip-flops, and multiplexers.
2. Develop skills in designing and testing simple and complex digital circuits using Logisim.
3. Learn how to use Logisim's simulation tools to analyze circuit behavior and identify potential problems or errors.
4. Gain proficiency in creating custom components in Logisim to support the design and simulation of more advanced digital circuits.
5. Build experience in using Logisim to design and simulate real-world digital systems such as computer CPUs, memory units, and control units.
6. Practice using Logisim in a team setting to collaborate on digital circuit design projects and ensure that designs meet performance, timing, and other requirements.
7. Develop an understanding of how digital circuits are used in different applications such as telecommunications, automation, and control systems, and use Logisim to design circuits that meet specific requirements in these fields.
8. Experiment with advanced Logisim features such as hierarchical design, subcircuits, and Verilog import/export to improve your digital circuit design skills.
9. Participate in online communities or forums related to Logisim to learn from other users, share knowledge, and collaborate on digital circuit design projects.
10. Continuously evaluate and improve your Logisim skills by experimenting with new design techniques, exploring new features, and taking on increasingly challenging digital circuit design projects.

Implementation

Exercise 10

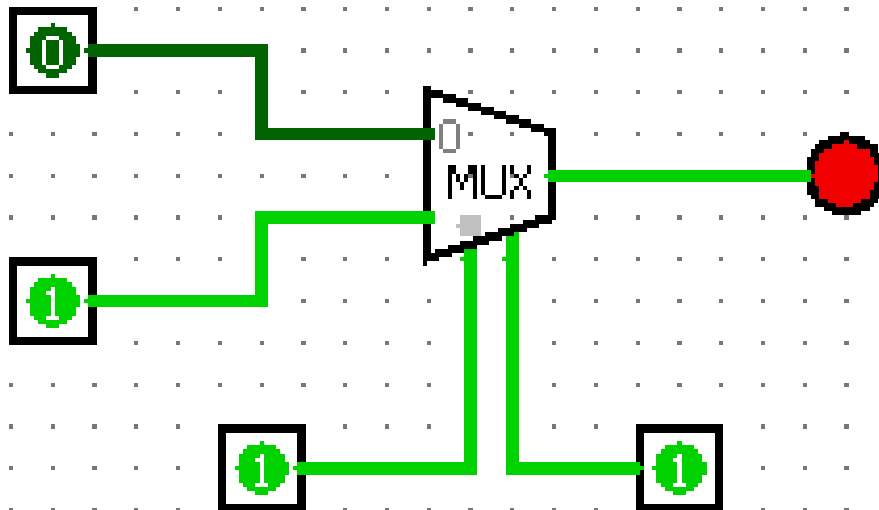
D Flip-Flop: Build a D flip-flop to hold the input state when enabled the clock.



D flip-flop that holds its input state when enabled requires careful consideration of the flip-flop's clock and enable inputs, as well as the logic used to implement the flip-flop's internal latching mechanism.

Exercise 15

2-Input Multiplexer: Build a 2-input multiplexer and a select input

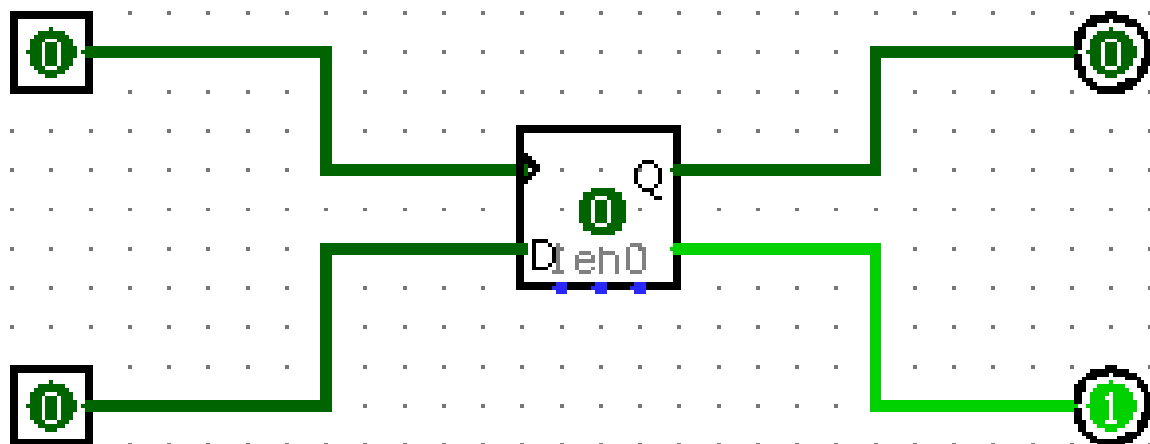


You can set the values of the input pins and the select pin in the "Simulate" mode. The output pin will then display the value of the selected input pin based on the value of the select pin. For example, if the select input is set to 0, then the output will display the value of the first input pin. If the select input is set to 1, then the output will display the value of the second input pin.

Exercise 20

D Flip-Flop: Build a D flip-flop.

You can set the values of the D input in the "Simulate" mode. The Q output will then display the value of the D input. If the Reset input is pressed, the Q output will be set to 0 regardless of the state of the D input.



Exercise 25

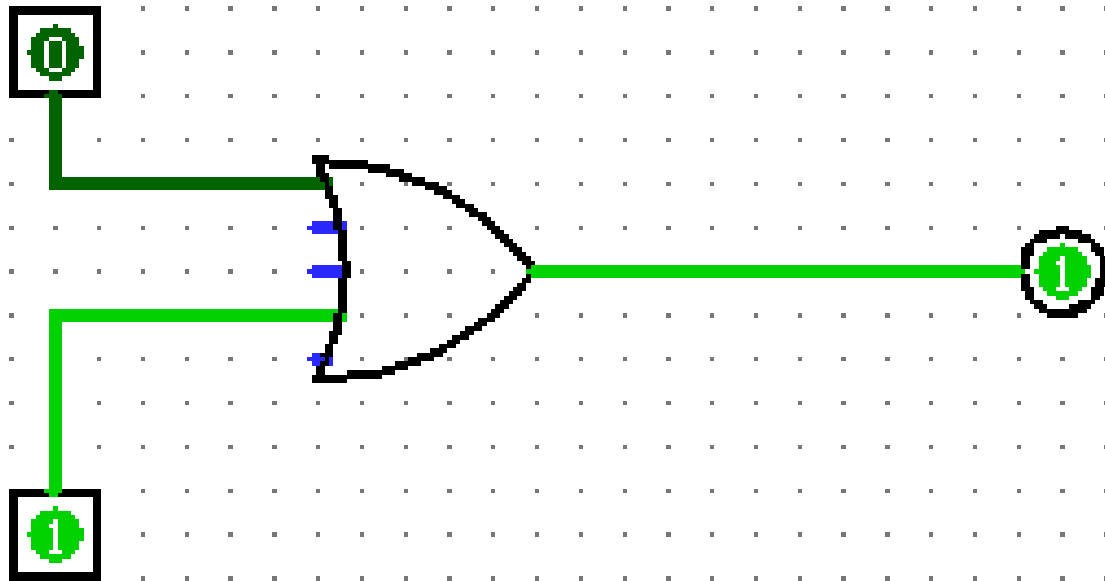
Circuit for Switching Two LEDs: Build a circuit that allows two LEDs to be switched using a button.



We have the first led directly connected to button, and the second one connected through a NOT gate, in that way the second led is on when the button is not pressed. When we press the button the first led is lighting up, and the second one is turning off

Exercise 3

OR Gates: Build an OR gate that has two inputs and provides a "1" output signal when at least one of the inputs is "1".



We have a connection through OR gate with two inputs and one output, in that way when at least one of the input is "1", the output flow will be "1"

Conclusions

Logisim is a software tool that makes designing and simulating digital circuits easy and efficient for users. Its user-friendly interface and broad component library enable designers to quickly select and place components and connect them with ease using its versatile wiring tool. The library includes a wide range of components like logic gates, adders, multiplexers, registers, and memory, making it easy for designers to create complex circuits.

Moreover, Logisim boasts advanced simulation capabilities that allow designers to detect errors, optimize circuit performance, and evaluate circuit behavior by simulating clock cycles, setting input signals, and monitoring output signals. The software also offers debugging tools that enable designers to isolate and fix errors in the circuit.

Additionally, Logisim promotes teamwork and collaboration by allowing designers to share circuits with their colleagues and peers, making it easier for them to work together on the same project simultaneously. The software enables users to export and import circuits in various formats such as VHDL, Verilog, and circuit diagrams.

Overall, Logisim is a versatile digital circuit design and simulation tool that provides designers with an efficient and powerful means to create, edit, and simulate complex digital circuits. Whether you're a student or a professional in the field of digital circuit design, Logisim offers the necessary tools and resources to help you succeed.