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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.

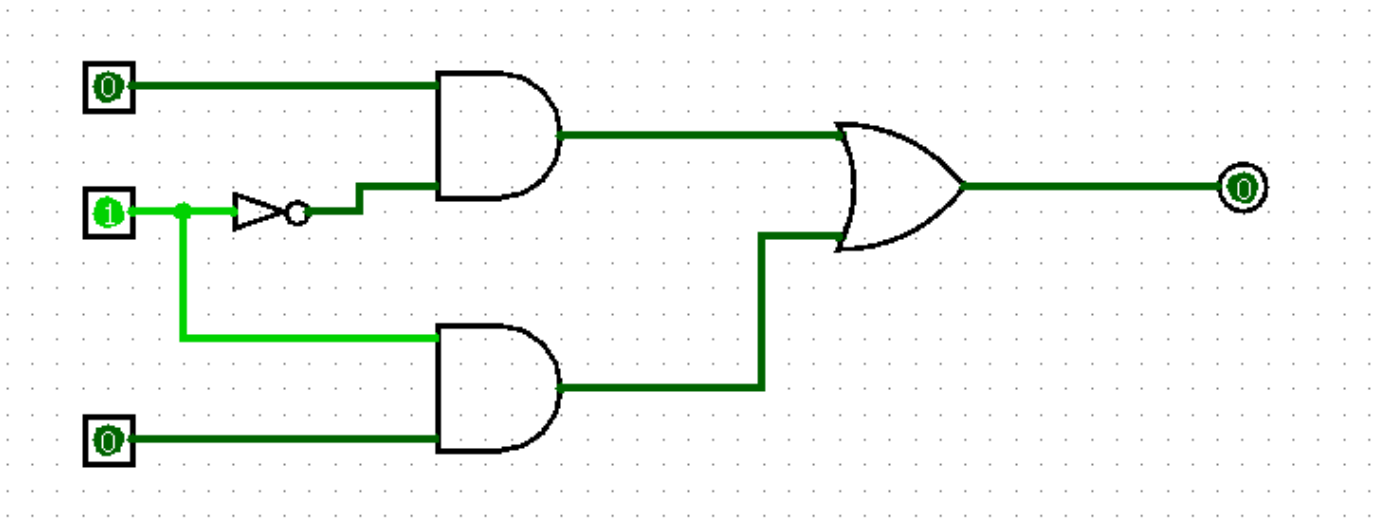
Objectives

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 15

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

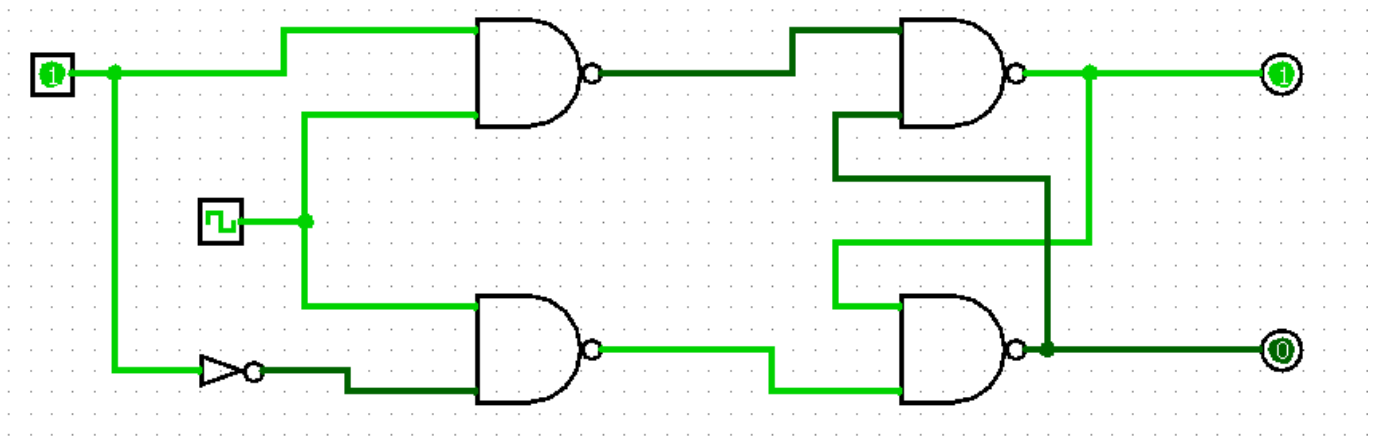


You can set the values of the input pins and the select pin in the "Simulate" mode. The output pin will then display the value of the selected input pin based on the value of the select pin. For example, if the select input is set to 0, then the output will display the value of the first input pin. If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

Exercise 20

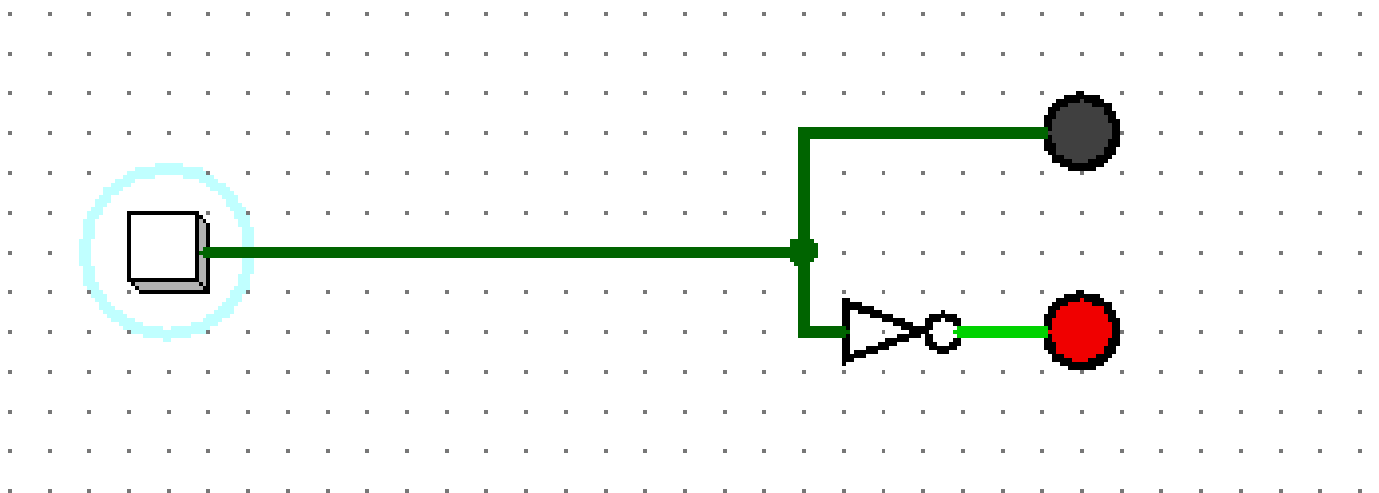
D Flip-Flop: Build a D flip-flop.

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

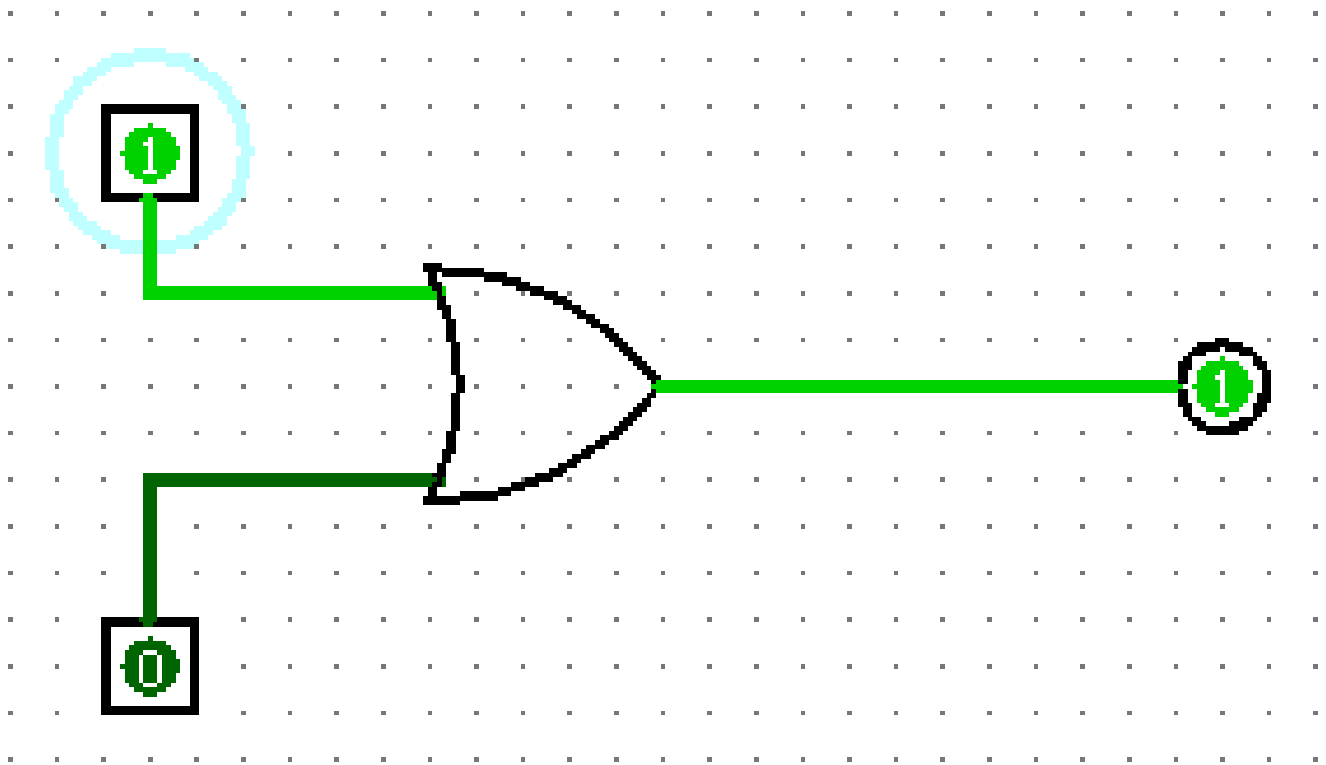
Circuit for Switching Two LEDs: Build a circuit that allows two LEDs to be switched using a button.



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

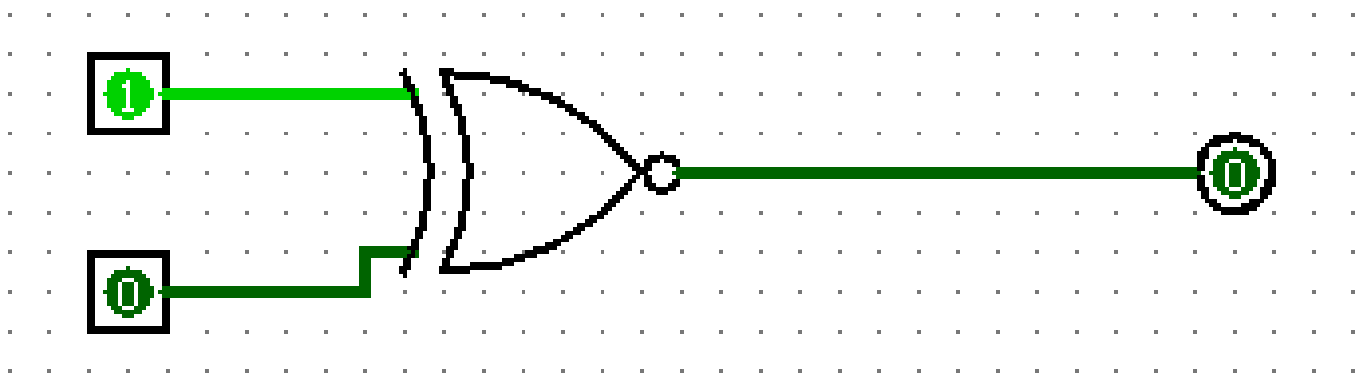
OR Gates: Build an OR gate that has two inputs and provides a "1" output signal when at least one of the inputs is "1".



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"

Exercise 8

XNOR Gates: Build an XNOR gate that has two inputs and provides a "0" output signal when only one input is "1"



We have a connection through XNOR gate with two inputs and one output, in that way when at least one of the input is "1", the output flow will be "0"

Conclusions

Logisim's intuitive interface and comprehensive component library make it easy for users to design and simulate digital circuits. The software's drag-and-drop functionality and customizable toolbars allow designers to quickly select and place components, while its versatile wiring tool makes it easy to connect components and define signal paths. Logisim's library includes various components such as logic gates, adders, multiplexers, registers, and memory, enabling designers to create complex digital circuits with ease.

Another strength of Logisim is its advanced simulation capabilities. The software provides a range of simulation tools that enable designers to verify circuit behavior, detect errors, and optimize circuit performance. For example, the software allows designers to simulate clock cycles, set input signals, and monitor output signals to evaluate circuit performance. Logisim also provides debugging tools that allow designers to isolate and fix errors in the circuit.

Furthermore, Logisim supports collaboration and teamwork by allowing designers to share circuits with colleagues and peers. The software enables users to export and import circuits in various formats, including VHDL, Verilog, and circuits diagrams. This feature is particularly useful for teams working on a shared project, as it allows them to work on different aspects of the circuit simultaneously and merge their changes seamlessly.

In conclusion, Logisim is a powerful and versatile digital circuit design and simulation tool that empowers users to create, edit, and simulate complex digital circuits. The software's intuitive interface, comprehensive component library, advanced simulation capabilities, and collaboration features make it an indispensable tool for designers in various fields. Whether you're a student learning digital circuit design or a professional working on complex digital systems, Logisim provides the tools and resources you need to succeed.