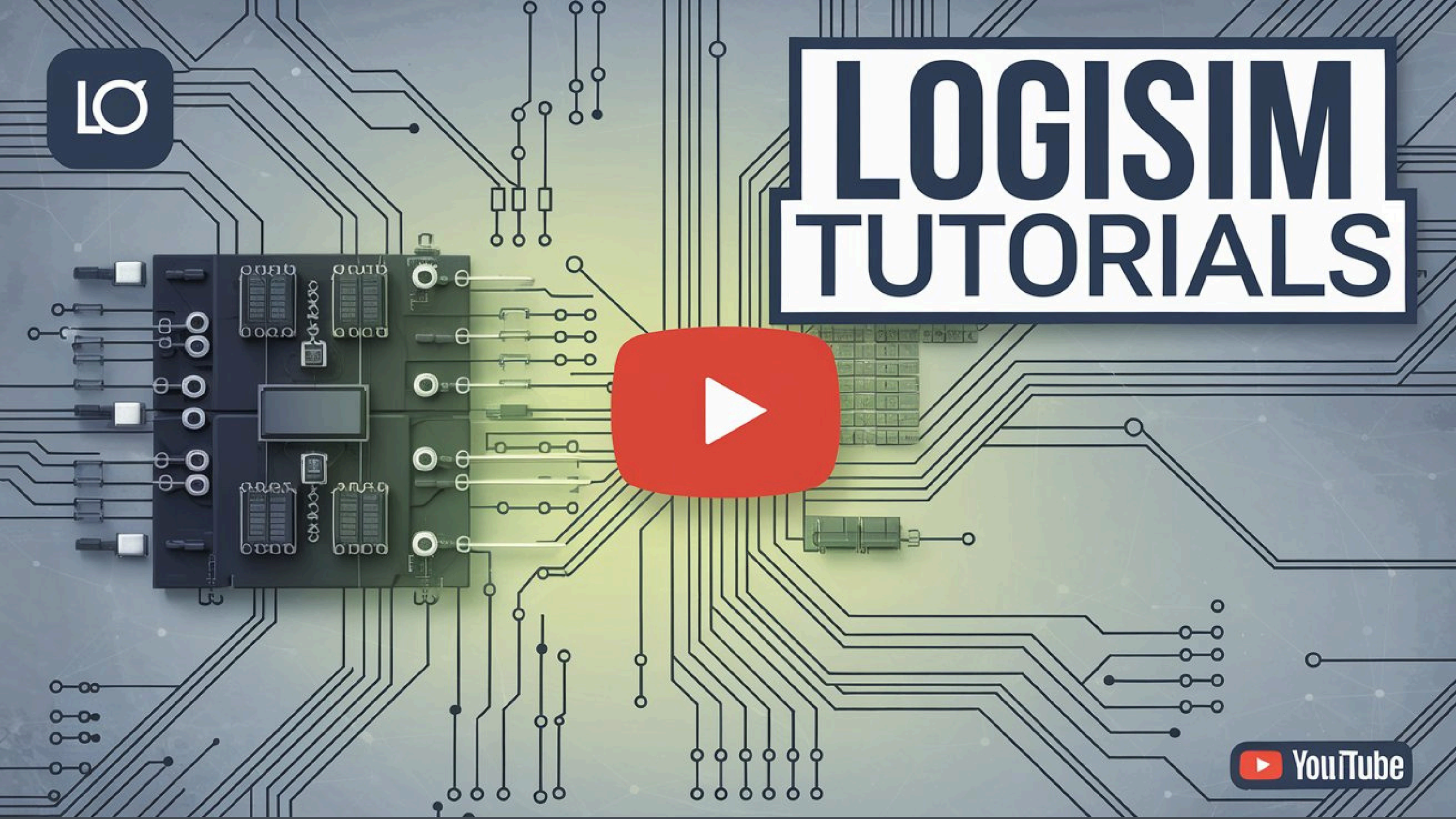
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What is an ALU?

- The Arithmetic Logic Unit (ALU) is a core component of the CPU responsible for performing arithmetic and logical operations.
- It handles all basic mathematical and decision-making tasks in the processor.

ALU Operations in RISC-V

Arithmetic Operations:

- ADD – Adds two values.
- SUB – Subtracts one value from another.

Logical Operations:

- AND – Performs bitwise AND.
- OR – Performs bitwise OR.
- XOR – Performs bitwise exclusive OR.

How the ALU Works

- The ALU receives commands via the instruction's opcode.
- The opcode determines which operation the ALU performs.
- Operations include basic math, logic, and comparison tasks.

Designing the ALU in Logisim

A and B Inputs:

- Both A and B are 4-bit numbers representing the operands for arithmetic and logic operations.
- These inputs will be used for addition, subtraction, and logic operations like AND, OR, and XOR.

Operation Control Input:

- A 3-bit wide control signal will be added to select the operation the ALU performs.
- The 3 bits allow us to choose between different operations such as addition, subtraction, AND, OR, and XOR, corresponding to the RISC-V ISA opcodes.

ALUControl [2:0]	Function
000	Add
001	Subtract
010	AND
011	OR
100	XOR

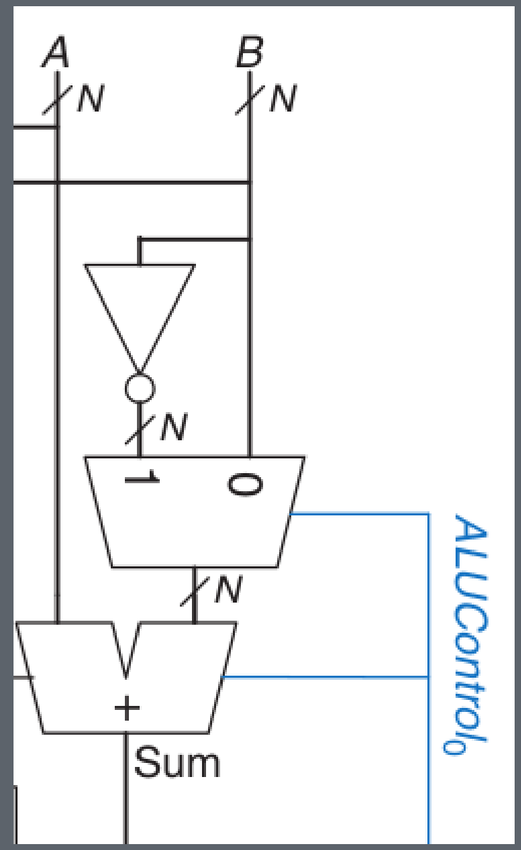
Adder and Subtractor Logic in ALU

Overview:

- A 4-bit adder can be adapted for both addition and subtraction using simple logic.
- The difference between addition and subtraction is controlled by a single control bit.

Subtraction Logic:

Subtraction is performed by inverting the B input and adding a carry-in of 1 to implement two’s complement subtraction.



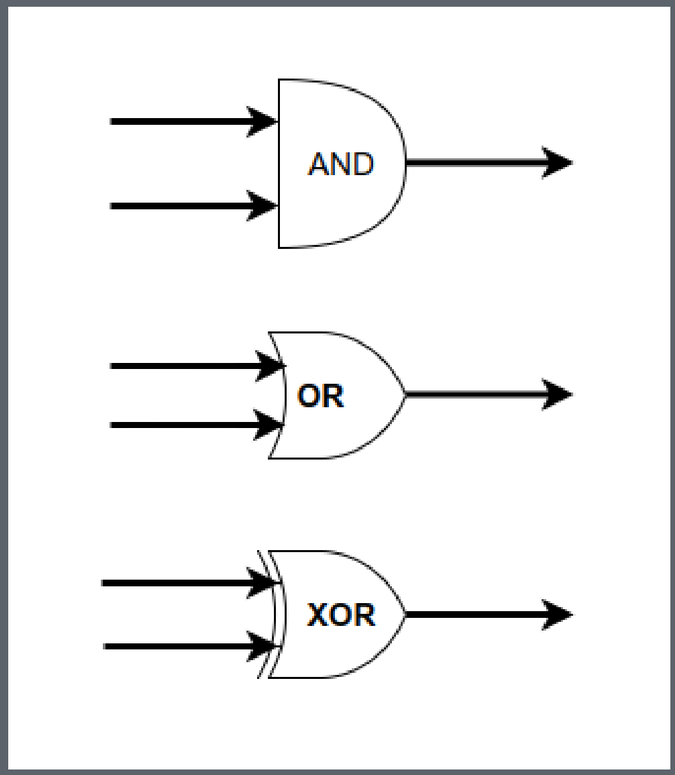
Logic Operations in ALU

Logic Operations Overview

- The ALU performs logical operations like AND, OR, and XOR on the input data.
- These operations are essential for bitwise manipulations in the processor.

Logic Gates for AND, OR, XOR

- AND Gate: Outputs 1 only if both inputs are 1.
- OR Gate: Outputs 1 if either input is 1.
- XOR Gate: Outputs 1 if the inputs are different (exclusive OR).



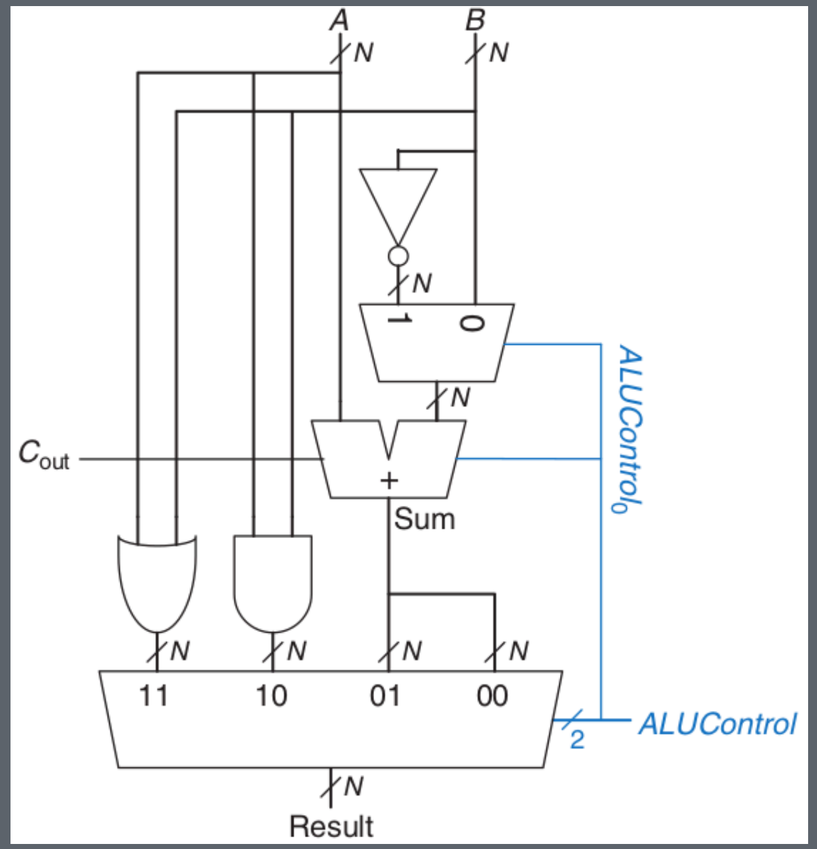
Operation Control in the ALU

- The ALU uses a 3-bit control signal to select between different operations.
- This control signal is derived from the RISC-V opcode, determining whether the ALU performs addition, subtraction, AND, OR, or XOR.

Multiplexer Logic

- A multiplexer (MUX) is used to switch between the outputs of various operations:
  - Outputs from the adder (addition/subtraction)
  - Outputs from the AND, OR, XOR gates (logic operations)
- The MUX selects the correct operation based on the 3-bit control signal.

Operation Control with Multiplexers in ALU



Thank You