

Group 20 :

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## Arithmetic Logic Unit (ALU) Design Report

### Introduction:

The Arithmetic Logic Unit (ALU) is a fundamental component of a central processing unit (CPU) responsible for performing arithmetic and logical operations on binary data. This report outlines the design of a 32-bit ALU that can execute eight different operations based on opcode inputs.

### ALU Operations and Opcodes:

The ALU supports the following operations with their corresponding opcodes:

- Opcode 0000: ADD (Addition)
- Opcode 0001: SUB (Subtraction)
- Opcode 0010: AND (Bitwise AND)
- Opcode 0011: OR (Bitwise OR)
- Opcode 0100: XOR (Bitwise XOR)
- Opcode 0101: NOT (Bitwise NOT)
- Opcode 0110: SLA (Shift Left Arithmetic)
- Opcode 0111: SRA (Shift Right Arithmetic)
- Opcode 1000: SRL (Shift Right Logical)

### Inputs:

The ALU accepts two 32-bit binary numbers, A and B, as input. These numbers represent operands on which the specified operation will be performed.

### Outputs:

The output of the ALU is a 32-bit binary number that represents the result of the operation specified by the opcode. The output is produced based on the selected operation and the values of operands A and B.

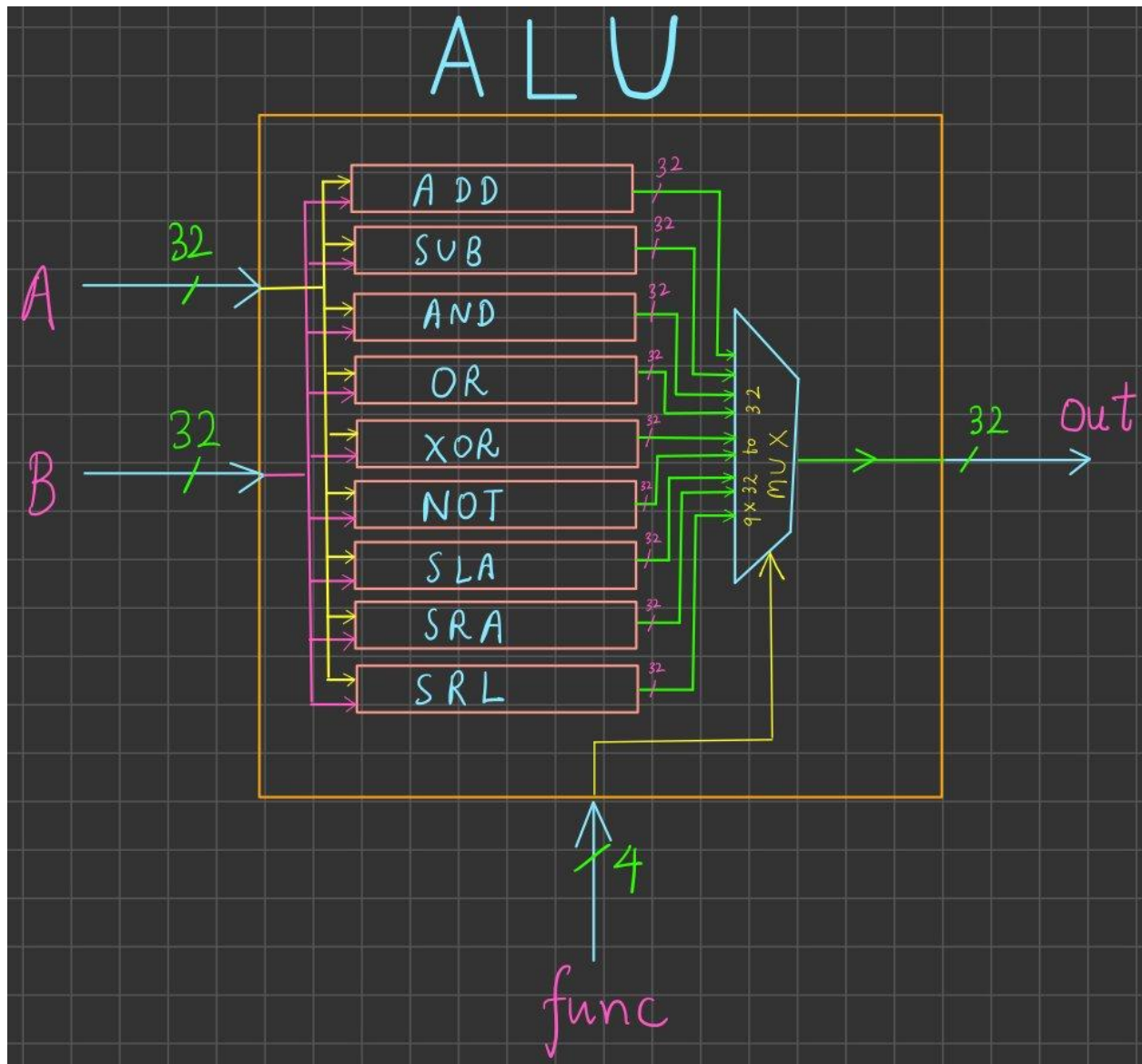
### ALU Operation Execution:

- ADD (Opcode 0000): Performs binary addition of A and B.
- SUB (Opcode 0001): Performs binary subtraction of B from A.
- AND (Opcode 0010): Performs bitwise AND operation between A and B.
- OR (Opcode 0011): Performs bitwise OR operation between A and B.
- XOR (Opcode 0100): Performs bitwise XOR operation between A and B.
- NOT (Opcode 0101): Performs bitwise NOT operation on A.
- SLA (Opcode 0110): Performs arithmetic left shift of A.
- SRA (Opcode 0111): Performs arithmetic right shift of A.
- SRL (Opcode 1000): Performs logical right shift of A.

### Design Considerations:

- The ALU is designed to handle 32-bit binary numbers.
- Appropriate hardware components, such as adders, logical gates, and shifters, are used to implement each operation.
- The control unit decodes the opcode to select the correct operation and control the data flow within the ALU.
- Sign extension is applied when necessary for signed arithmetic operations (SUB, SLA, SRA).

### Circuit Diagram:



### Conclusion:

This ALU design provides the capability to execute a variety of arithmetic and logical operations on 32-bit binary numbers based on specified opcodes. It serves as a crucial component within a CPU, enabling the CPU to perform a wide range of computations.