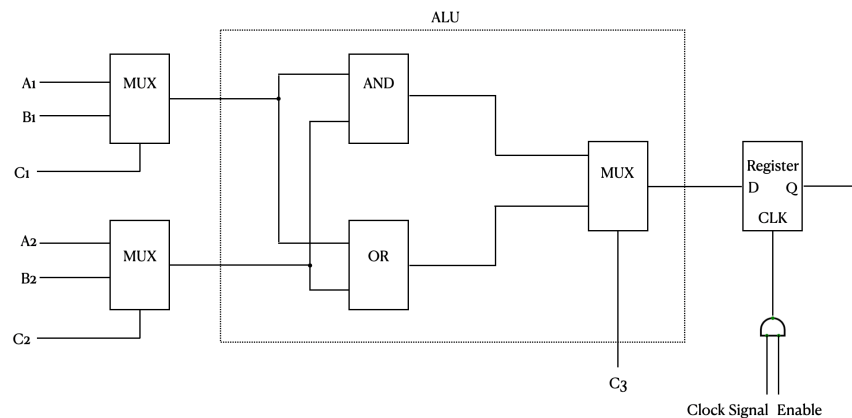


Sequential Circuits (IV)

ALU

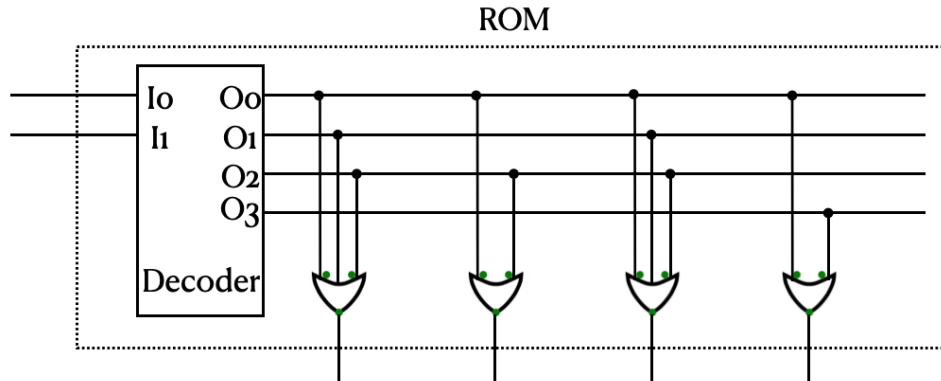
- CPU is composed of two parts: ALU (arithmetic logic unit) and PCU (program control unit). ALU is in charge of arithmetic and logic operations.



- Here is an ALU example.
- This ALU has **two operations: AND and OR**. The output of AND and OR connect to a MUX as inputs. The **control bit** of the MUX, C3, can **decide the output of the ALU**. In other words, the control bit decides the **operation we want the ALU to execute**.
- The ALU has **two inputs**, which are **connected to two multiplexers**. So, we can use **control bits C1 and C2 to decide the sources** of the ALU inputs.
- The output of the ALU is written in a register.

ROM (Read-only Memory)

- Now, we know two important components of making a computer compute: registers and ALU. However, to make a computer be able to run programs, we need some **way to store the programs**.
- In a computer, we can use RAM (random access memory) to help store the programs you want a computer run. But, for some **applications**, such as toys, appliances, and cars, **whose programs are preset and don't need to be changed**, ROM is widely used.
- Programs and some of the data **remain stored even when the power is turned off**.
- The **data and program** in ROM are **inserted during its manufacture**, and **ever changed**. To change the program in a ROM is to replace the entire chip.
- ROMs are **much cheaper** than RAMs.
- It's essentially **a lookup table**. Given an address, produces the value stored at that address.
- A simple ROM example.



I_1	I_0	Output (Left to Right)	
0	0	1	1111
0	1	1	1010
1	0	1	1110
1	1	0	0001

In this example, I_1I_0 provides the address, and the output is the value stored at that address.

- Based on I_1I_0 , the ROM can generate an output, which can then be used to control ALU operations.

PC and IR

- ROM stores the entire program, but the program is executed line by line. So, we need some way to track the program execution and tell the current line that is executed.
- So, we need PC (program counter) and IR (instruction register) on the circuit. PC and IR are two important hidden registers.
 - PC contains the address of the next instruction, incorporating increment logic.
 - IR contains the instruction being executed.