CS200 - Computer Organization

Logic Design 02

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Types of Circuits

- Combinational Circuits: The output of the circuit is based on the current inputs.
- Sequential Circuits: The output of the circuit is based on the current inputs and past outputs. A memory unit is needed.

Adders

- At the digital logic level, addition is performed in binary.
- Addition operations are carried out by special circuits called adders.
- There are two types of adders:
  - Half adder
  - Full adder

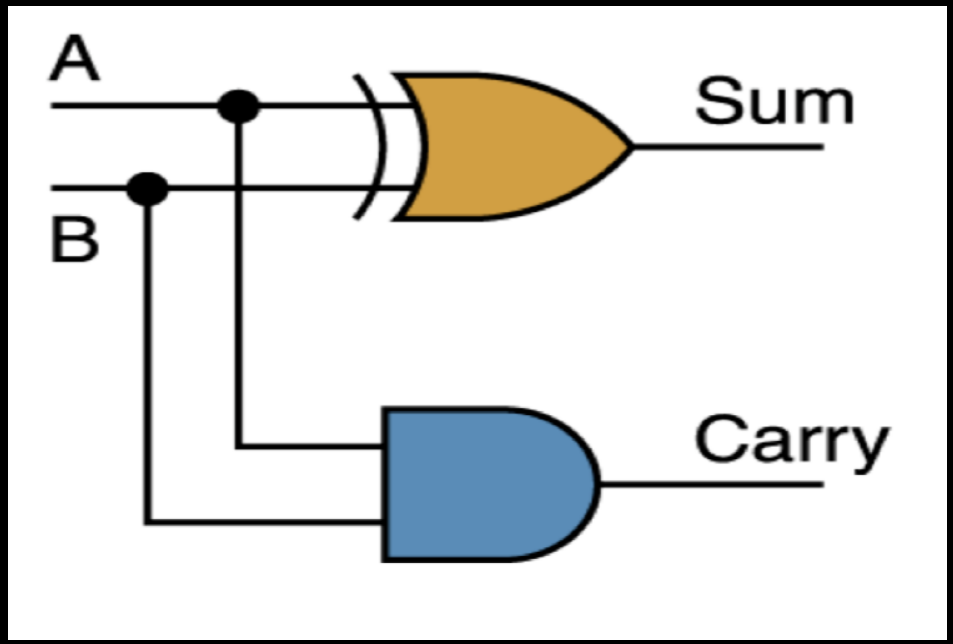
Half Adder

- Recall that 1 PLUS 1 = 10 in base two.
- In other words: 0 with a carry of 1

Inputs		Outputs	
A	B	Carry	Sum
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

So how to design a Half Adder?

- We need One Exclusive Or and One And Gate.
- Two Inputs and Two Outputs



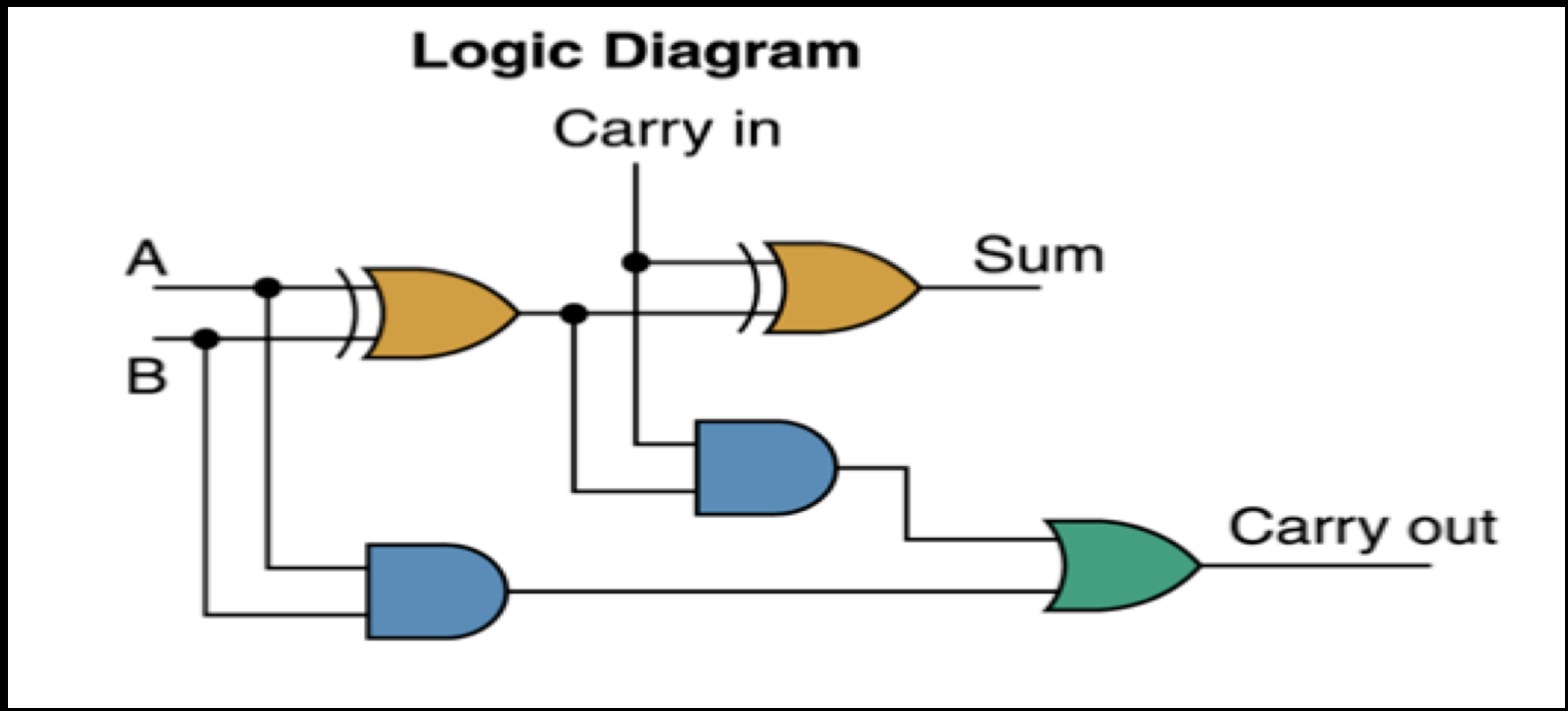
Full Adder

- A circuit is called a full adder if it takes the carry-in value into account.

Inputs			Outputs	
A	B	Carry In	Carry-Out	Sum
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

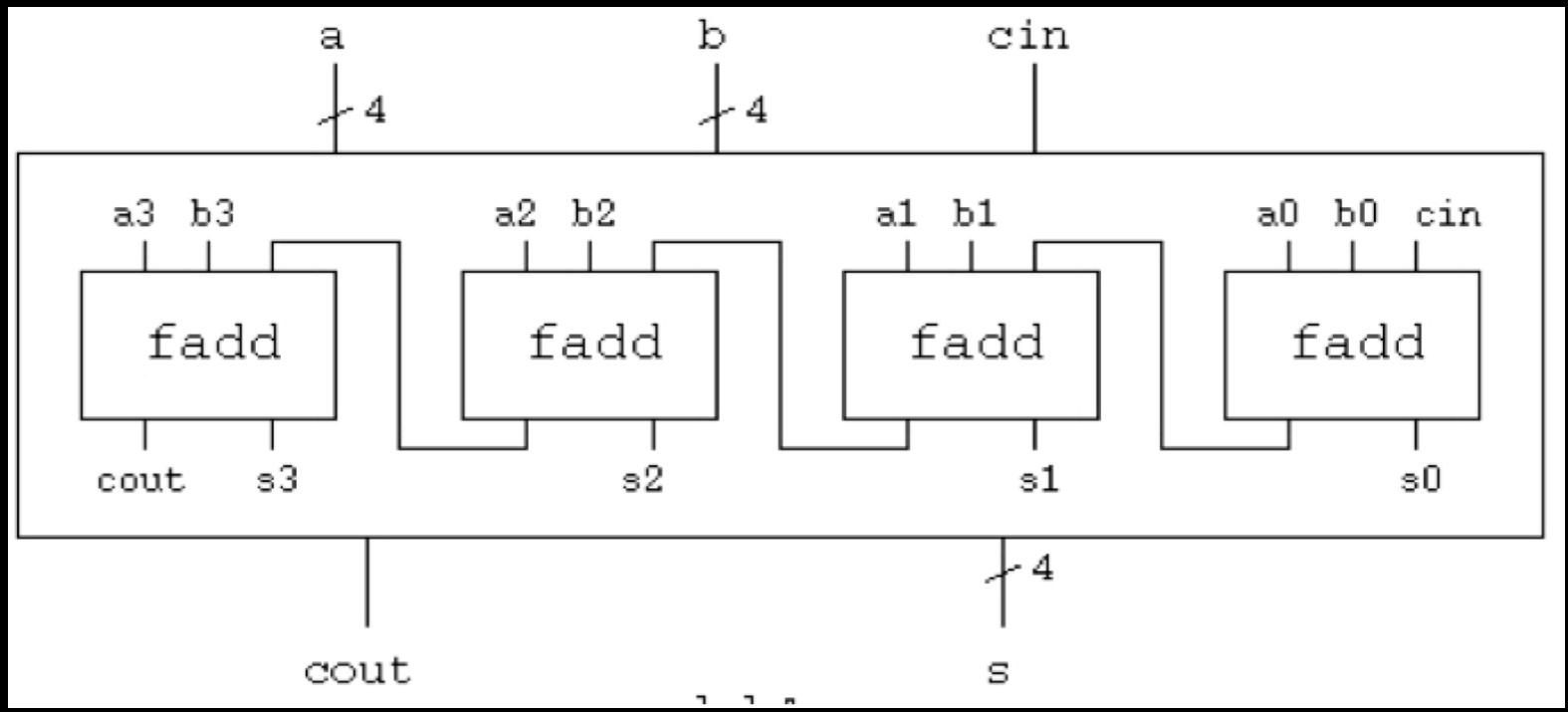
So how to design a Full Adder?

- We need Two Exclusive Or and Two And, and One Or Gate.
- Three Inputs and Two Outputs



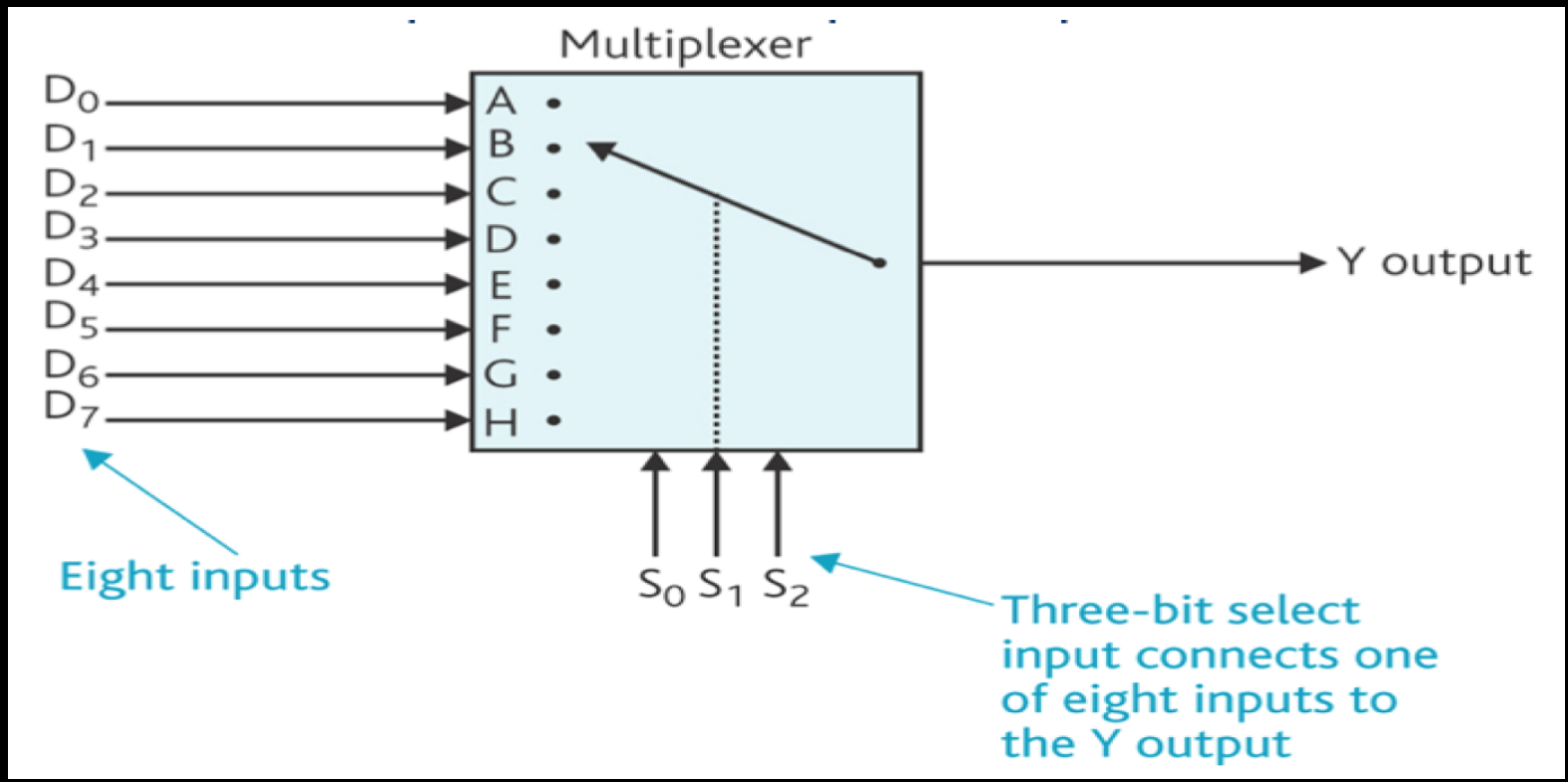
4 bit Adder

- Can we combine 4 full adders to make a Four-bit Adder Circuit?



MUX - Multiplexer

- It is a device that selects one out of the several input lines and forward it to a single output line.



Application of MUX

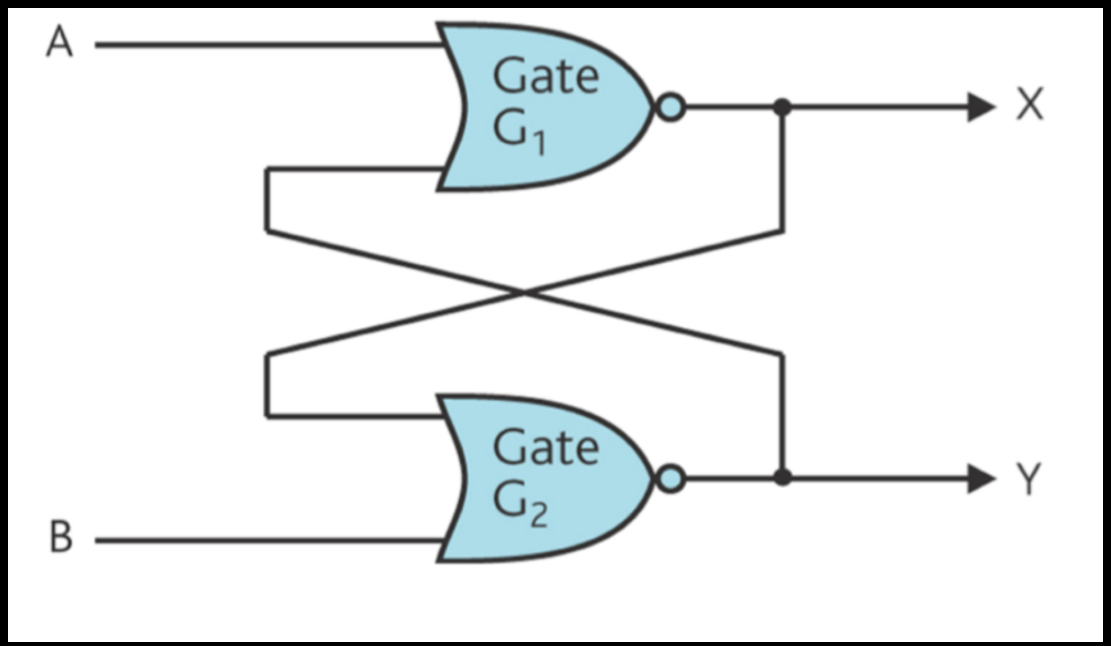
- Telephone Network: Integrating multiple audio signals to a single line.
- Computer Memory: Reduce the cables connecting Memory to other parts of computer.

Sequential Circuit

- The output of a sequential circuit depends both on the current input and the past output.
- Latch - A 1-bit memory element. Saves one bit that can be used later.
- Register - A set of m latches that can be used to store a m-bit word.
- Flip Flop - A controlled latch, changes state when the control signal goes high to low or low to high.

Latch Design using Gates

- So can we do the same using NAND Gates?



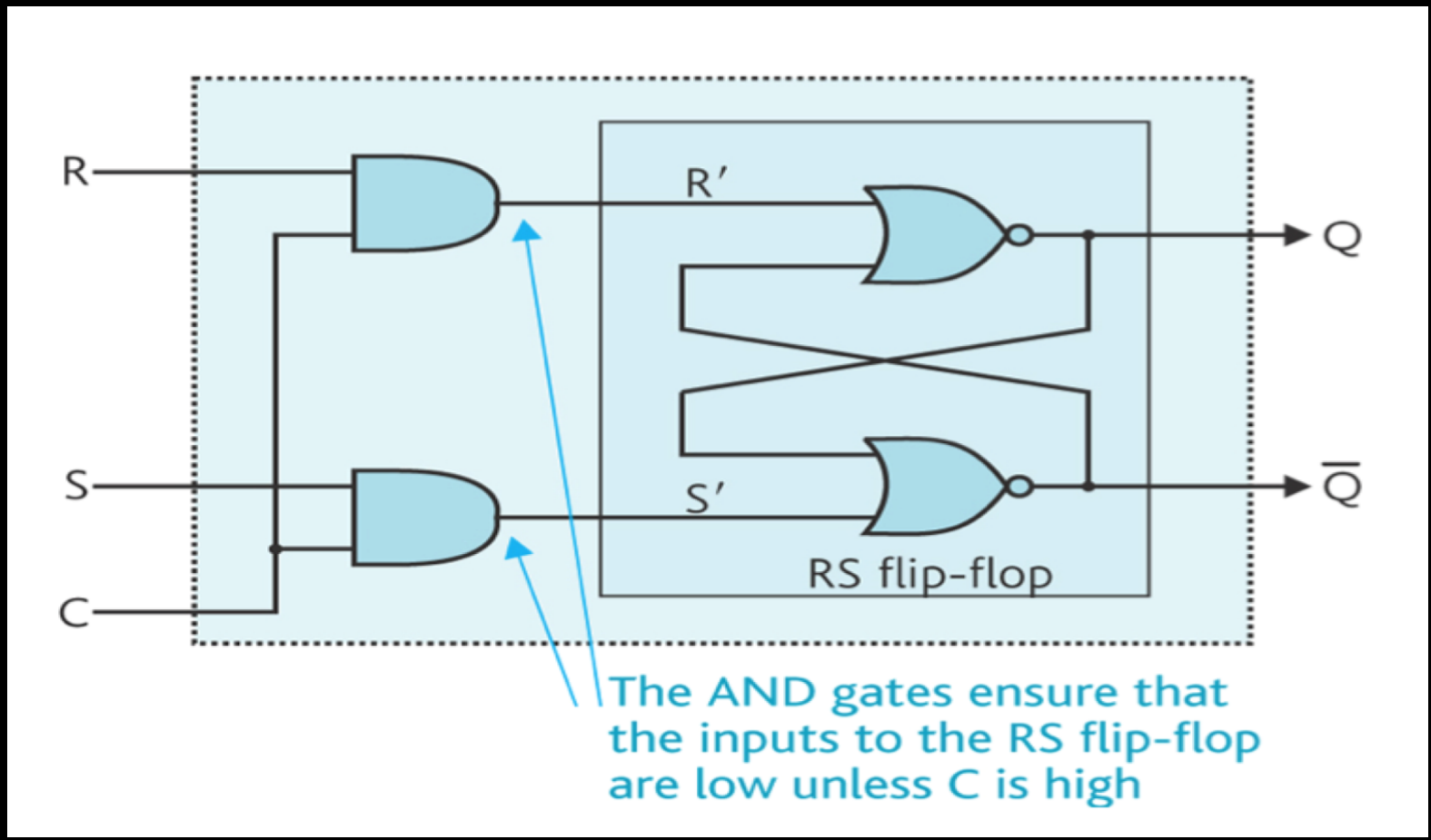
Latch Characteristics Table

- What is the difference between Characteristics Table and Truth Table?

Inputs		Output	Description
R	S	Q^+	
0	0	Q	No Change
0	1	1	Set Output to 1
1	0	0	Reset Output to 0
1	1	X	Invalid Input

Flip Flop

- Clock is the control signal that goes high to low or low to high.



Let us apply these to an Application

- Counter

Reading Assignment

- Principles of computer hardware by Alan Clements - Chapter 02 - 2.6;
- Computer Organization and Design by Patterson and Hennesssy - Appendices Section B - B.3;

Questions

Do you have any questions from this class discussion?