CS1101: Lecture 22

The Digital Logic Level: Basic Logic Circuits

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Lecture Outline

- Basic Digital Logic Circuits
- Integrated Circuits
- Combinational Circuits
- Multiplexer
- Decoder
- Comparator
- **Reading**: Tanenbaum, Chapter 3, Section 2

Basic Digital Logic Circuits

- We have seen how to implement truth tables and other simple circuits using individual gates.
- Few circuits are built like this in the realworld
- Instead modules containg many gates are used
- We will briefly look consider:
  - Integrated Circuits
  - Combinational Circuits
  - Arithmetic Circuits
  - Clocks

Integrated Circuits

- Gates are manufactured and sold in units called **Integrated Circuits**, often called **ICs** or **chips**.
- These are usually either square or rectangular packages of either plastic or ceramic, and have pins to connect them to the outside world.
- **Dual Inline Packages** or **DIPs** have two rows of parallel pins
- ICs can be classified according to the number of gates they contains:
  - SSI (Small Scale Integrated) circuit: 1-10 gates
  - MSI (Medium Scale Integrated) circuit: 10-100 gates
  - LSI (Large Scale Integrated) circuit: 100-100,000 gates
  - VLSI (Very Large Scale Integrated) circuit: $>$100,000 gates

Integrated Circuits

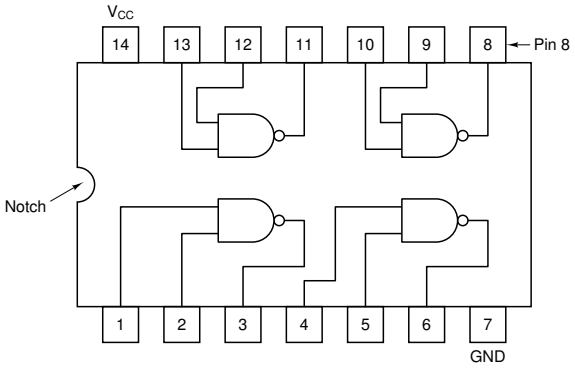

Figure 3-10. An SSI chip containing four gates.

Combinational Circuits

- Many applications of digital logic require a circuit with multiple inputs and multiple outputs in which the outputs are uniquely determined by the current inputs.
- This is a **combinational circuit**
- Some frequently used combinational circuits are:
  - Multiplexers
  - Decoders
  - Comparators
  - Programmable Logic Arrays

Multiplexers

- A multiplexer is a circuit with 2^n data inputs, one data output and n control inputs that select one of the outputs.
- The selected data input is selected "gated" (routed) to the output.
- The n inputs encode an n-bit number that specifies which input is selected as the output.

Example: A Multiplexer

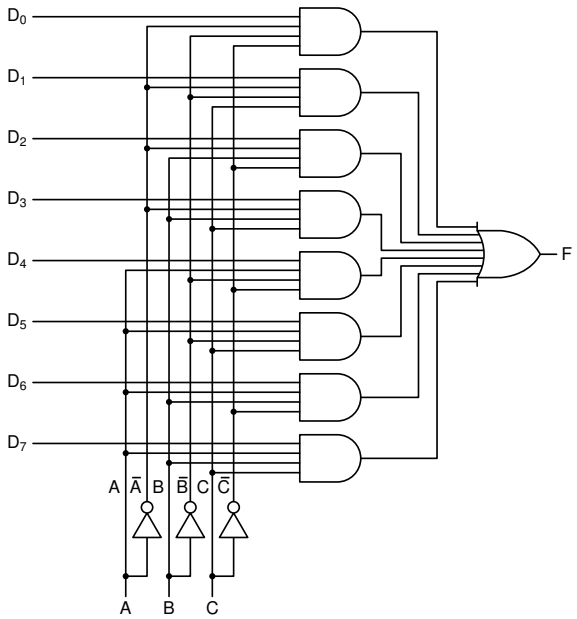

Figure 3-11. An eight-input multiplexer circuit.

A Multiplexer Application

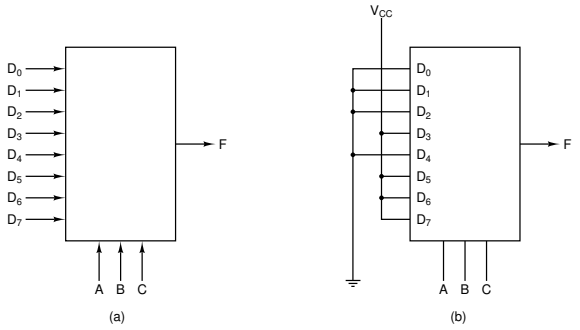

Figure 3-12. (a) An MSI multiplexer. (b) The same multiplexer wired to compute the majority function.

Decoders

- A decoder is a circuit which takes an n-bit number as input and uses it to select (set to 1) exactly one of its 2^n outputs

Example: A Decoder

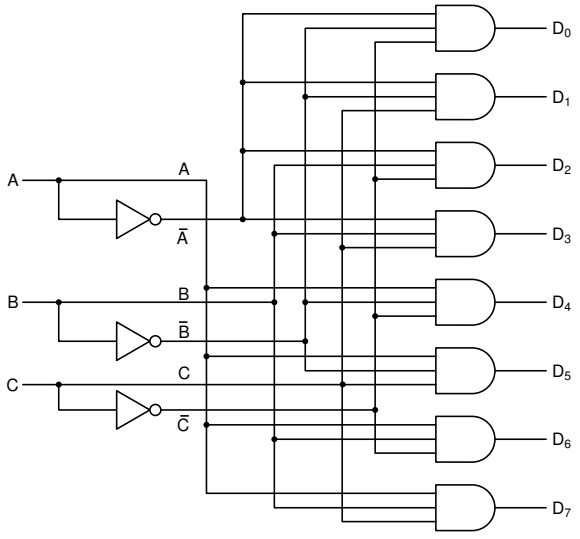

Figure 3-13. A 3-8 decoder circuit.

Comparators

- A comparator is a circuit which compares two input words and produces 1 if they are equal and 0 if they are not equal.
- Based on the Exclusive-OR gate, which returns 0 if its inputs are equal and 1 if they are unequal.
- A NOR gate decides whether to return 1 for equality or 0 for inequality.

Example: A Comparator

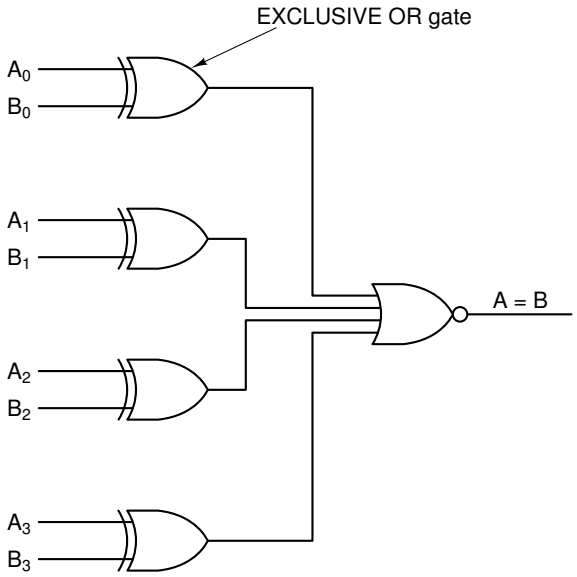

Figure 3-14. A simple 4-bit comparator.