8.1 TRANSISTORS AS AMPLIFIERS AND SWITCHES

A transistor is a three-terminal semiconductor device that can perform two functions that are fundamental to the design of electronic circuits: **amplification** and **switching**. Put simply, amplification consists of magnifying a signal by transferring energy to it from an external source; whereas a transistor switch is a device for controlling a relatively large current between or voltage across two terminals by means of a small control current or voltage applied at a third terminal. In this chapter, we provide an introduction to the two major families of transistors: **bipolar junction transistors**, or BJTs; and **field-effect transistors**, or FETs.

![Figure 8.1](Image)

**Figure 8.1** Controlled-source models of linear amplifier transistor operation

Bond graph models of controlled-sources (ref. Fig. 8.4, Transistors and Amplifiers)

**CCCS**
\[ \frac{\text{Vin}}{\text{Ri}} \rightarrow \frac{1}{\text{R}} \rightarrow \frac{\mu_{\text{Vin}}}{\text{R}} \rightarrow \text{O} \rightarrow \frac{\text{Rio}}{\text{R}} \]

**VCCS**
\[ \frac{\text{Vin}}{\text{Ri}} \rightarrow \text{O} \rightarrow \frac{\mu_{\text{Vin}}}{\text{R}} \rightarrow \text{O} \rightarrow \frac{\text{Rio}}{\text{R}} \]

**CCVS**
\[ \frac{\text{Vin}}{\text{Ri}} \rightarrow \text{A} \rightarrow \frac{\mu_{\text{Vin}}}{\text{R}} \rightarrow \text{O} \rightarrow \frac{\text{Rio}}{\text{R}} \]

**VCVS**
\[ \frac{\text{Vin}}{\text{Ri}} \rightarrow \text{O} \rightarrow \frac{\mu_{\text{Vin}}}{\text{R}} \rightarrow \text{O} \rightarrow \frac{\text{Rio}}{\text{R}} \]

**Notes:**
- ri: input resistance
- ro: output resistance