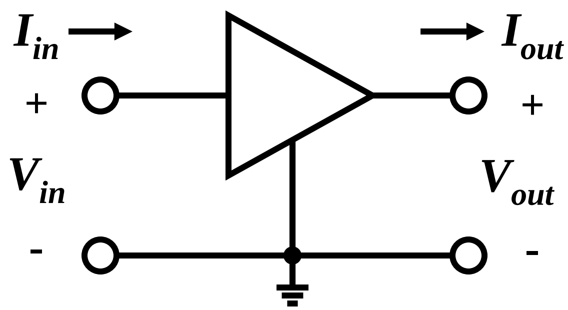
# Linear Amplifiers

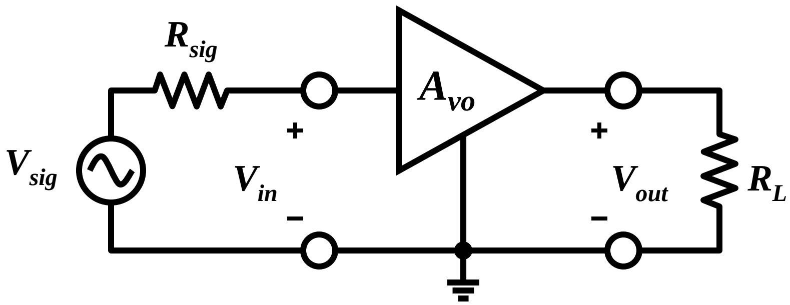
- **An amplifier is a two-port device that takes a small input signal and generates a proportionally larger output signal**
- **The amplifier is "linear" if the output depends linearly on the input, e.g.** $V_{out} = A_v V_{in}$
- **Real amplifiers use nonlinear devices and hence can only approximate this behavior**

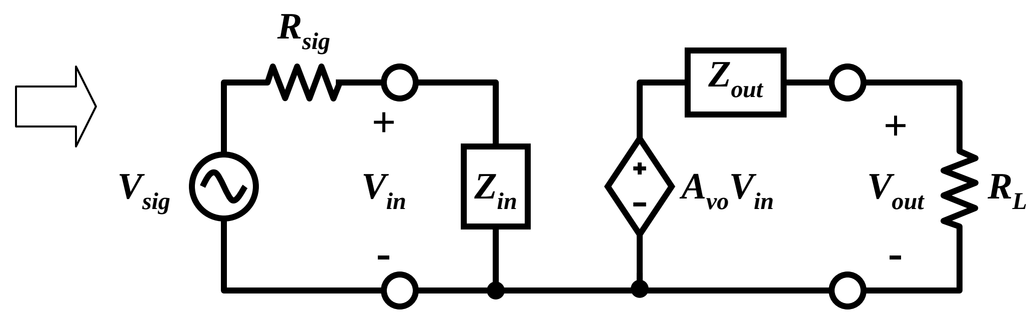



- **Amplifiers may respond to the input *voltage* or input *current* depending on the amplifying device used (eg. FET, BJT, tube) and the circuit**
- **Choice of equivalent two-port model depends on the type of amplifier**

# Impact of Input/Output Impedance

## Voltage Amplifier




$$V_{in} = V_{sig}\left(\frac{R_{in}}{R_{in}+R_{sig}}\right) \qquad V_{out} = A_{vo}V_{in}\left(\frac{R_L}{R_{out}+R_L}\right)$$

***$R_{in}$* forms a voltage divider with *$R_{sig}$***
***$R_{out}$* forms a voltage divider with *$R_L$***

$$V_{out} = A_{vo}V_{sig}\left(\frac{R_{in}}{R_{in}+R_{sig}}\right)\left(\frac{R_L}{R_{out}+R_L}\right)$$

**Note that if**

$$\left.\begin{array}{l} R_{in} \gg R_{sig} \\ R_{out} \ll R_L \end{array}\right\} \quad V_{out} \Rightarrow A_{vo}V_{sig}$$

**So a *voltage* amplifier will work best under arbitrary source and load conditions if:**

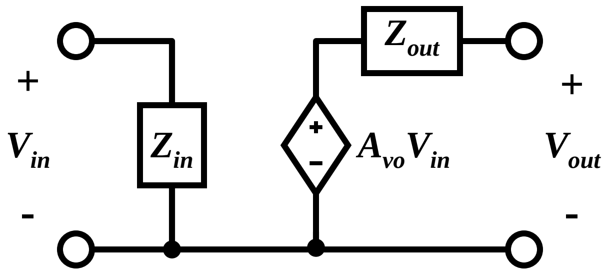
$$R_{in} \rightarrow \infty \qquad R_{out} \rightarrow 0$$



Back to TOC

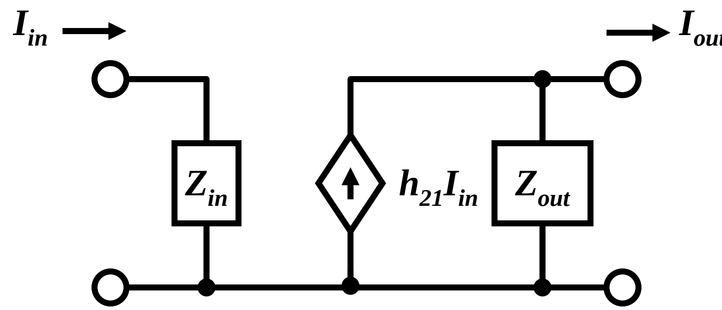
# Amplifier Equivalent Circuits

## Voltage Amplifier



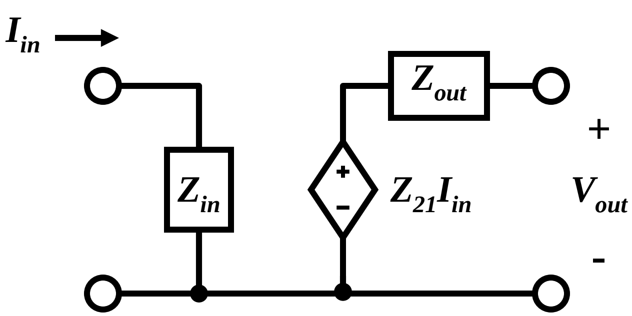

**Ideal:** $Z_{in} \to \infty$, $Z_{out} \to 0$

## Current Amplifier



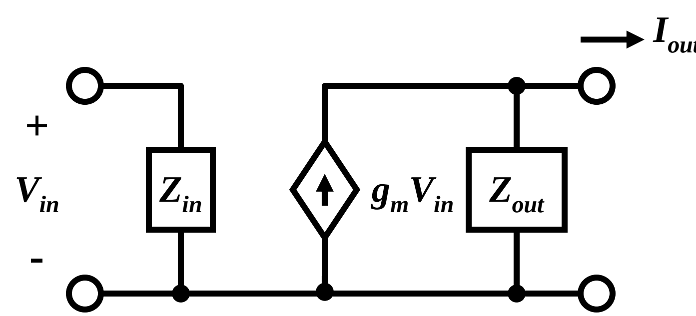

**Ideal:** $Z_{in} \to 0$, $Z_{out} \to \infty$

## Trans-Impedance Amplifier




**Ideal:** $Z_{in} \to 0$, $Z_{out} \to 0$

## Trans-Conductance Amplifier




**Ideal:** $Z_{in} \to \infty$, $Z_{out} \to \infty$



Back to TOC