Universidad
Carlos III de Madrid
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Session 14
Introduction to electronic amplifiers

Electronic Components and Circuits

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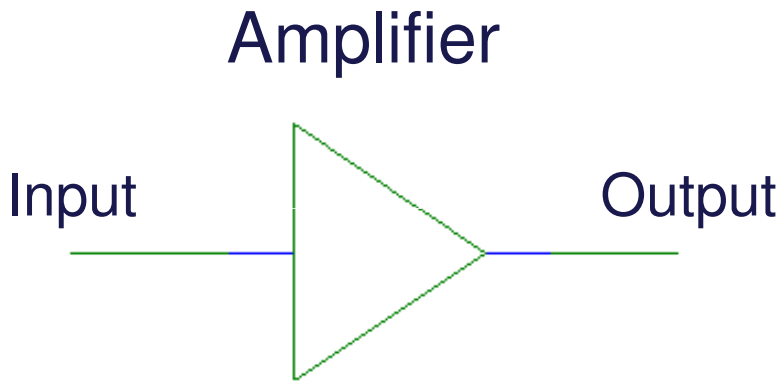
Introduction to electronic amplifiers

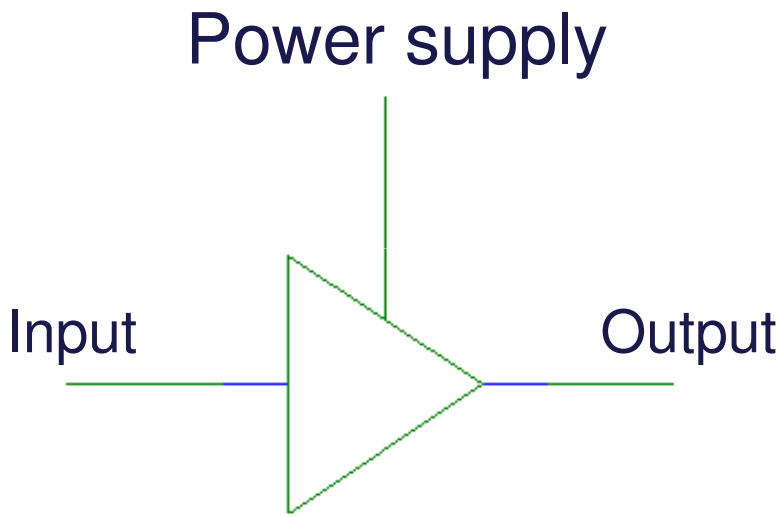
OBJECTIVES

- To know the basic parameters of an amplifier
- To understand the process of analyzing the characteristic parameters of amplifiers: gain, input impedance and output impedance
- To understand and use the loading effect
- To generalize the amplifiers frequency response: bandwidth

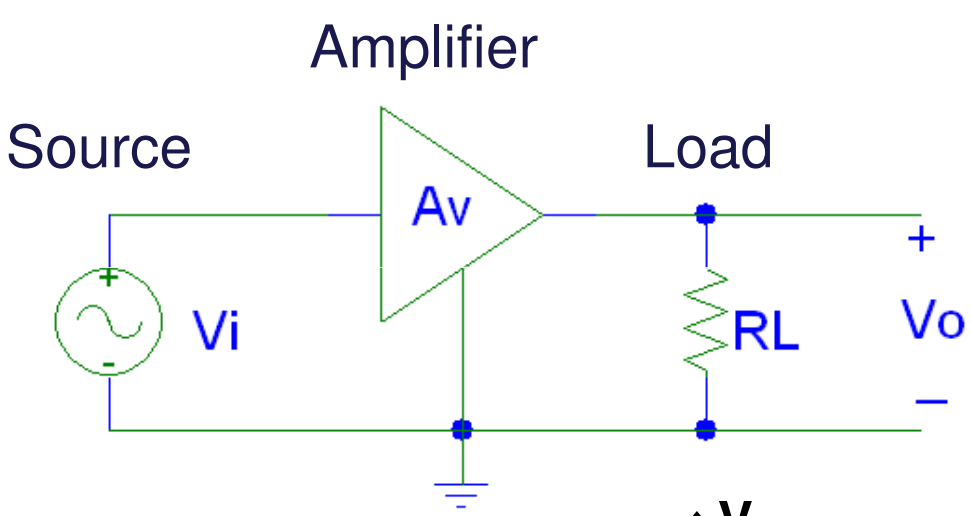
Amplification concept

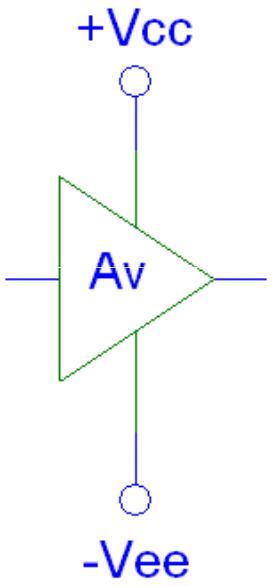
- Amplification
  - Output > Input
  - Pi, Po
- Power supply
  - Continuous sources
  - Pcc

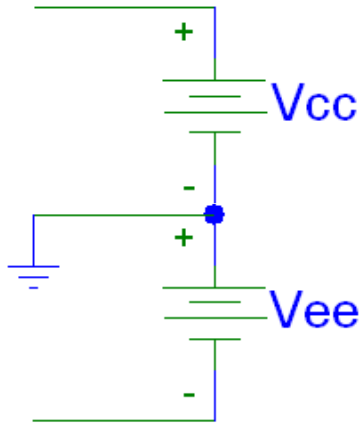


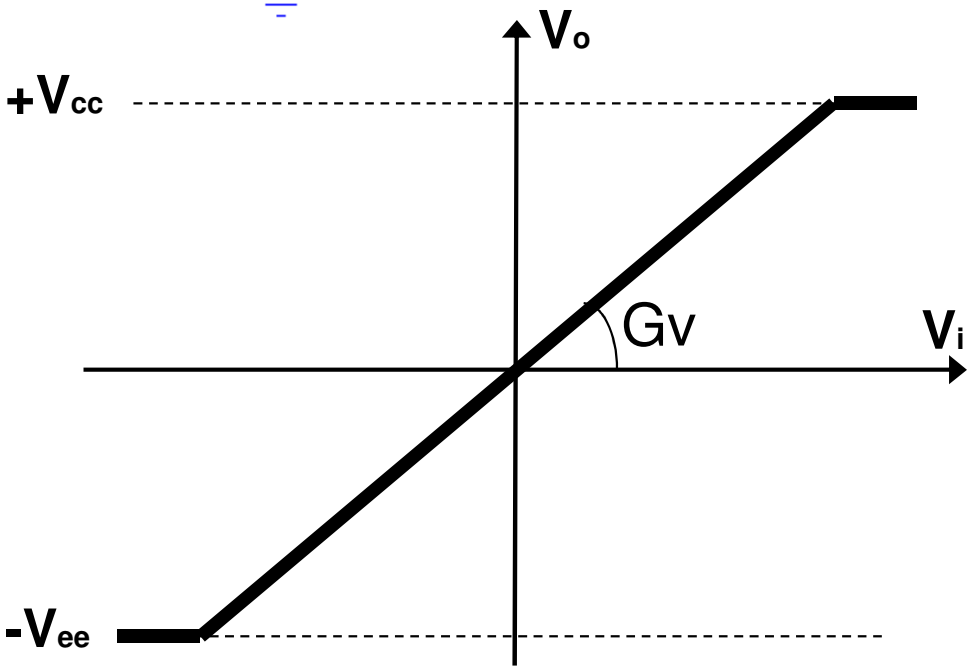


Gain and Dynamic Range



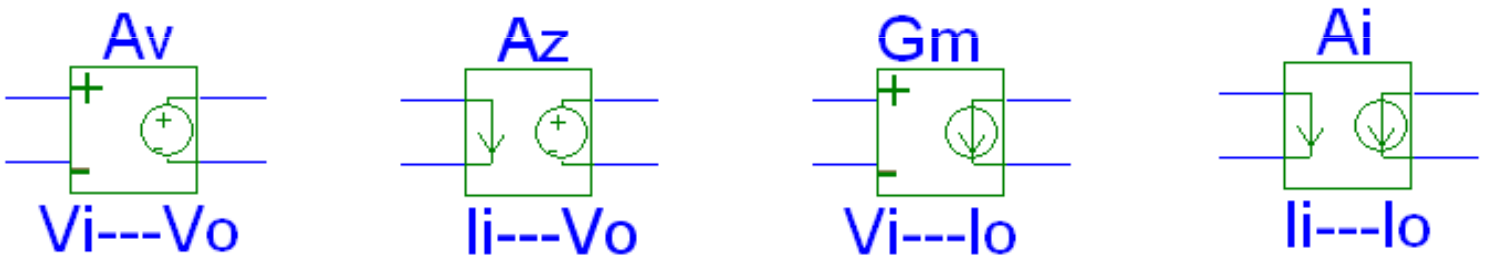






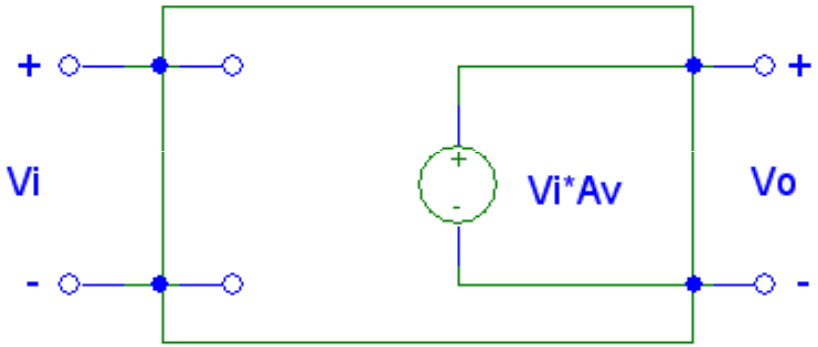
Amplification (gain)

- Idea of dependent sources
  - V controlled V generators (Av)
  - V controlled V generators (Az)
  - V controlled I generators (Gm)
  - I controlled I generators (Ai)

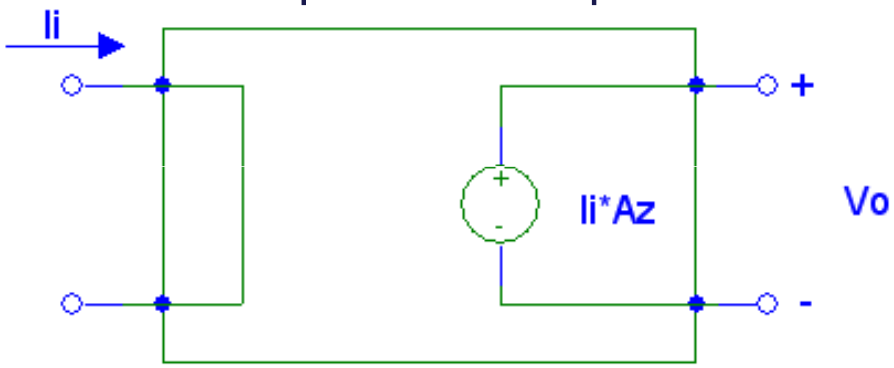


Ideal amplifiers

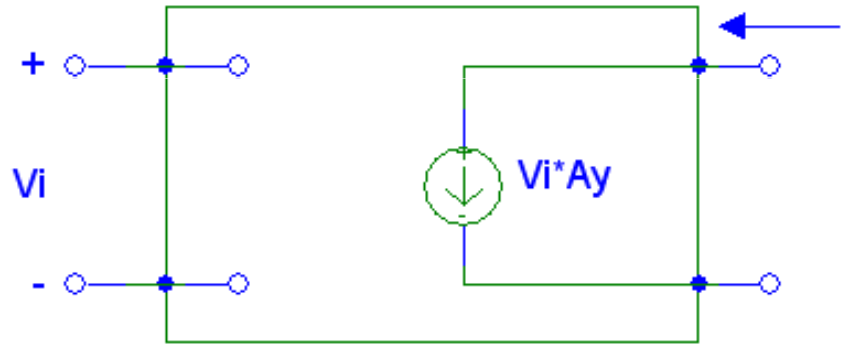
Voltage amplifier



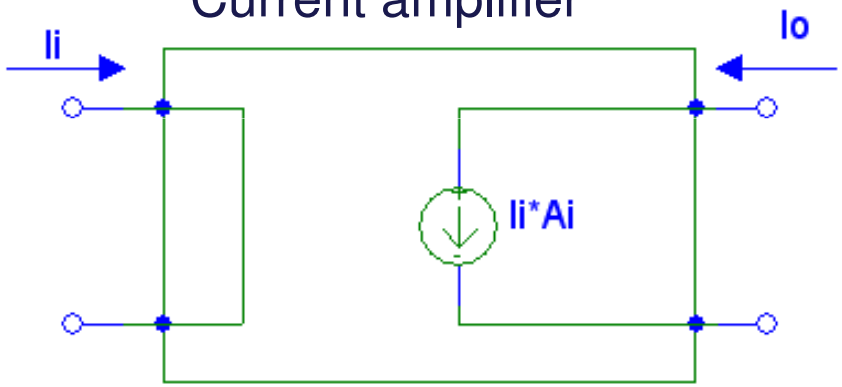
Transimpedance amplifier



Transconductance amplifier

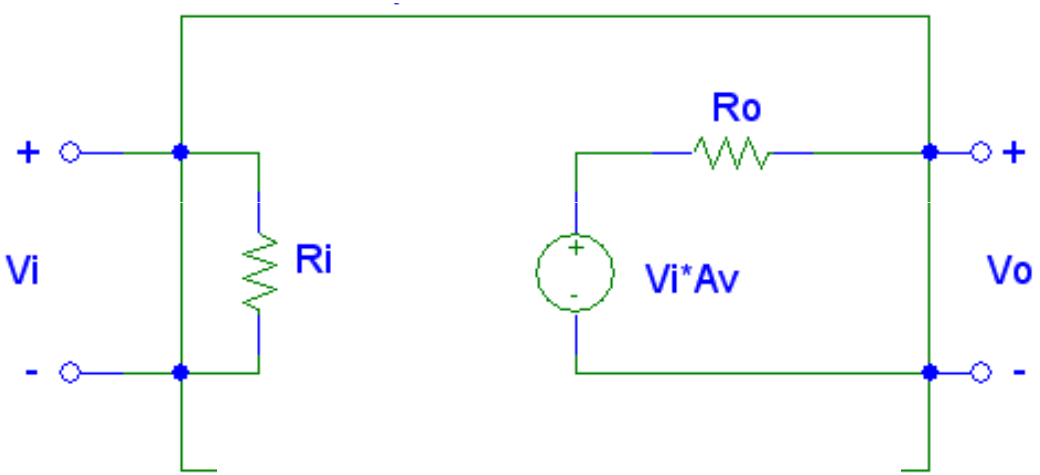


Current amplifier

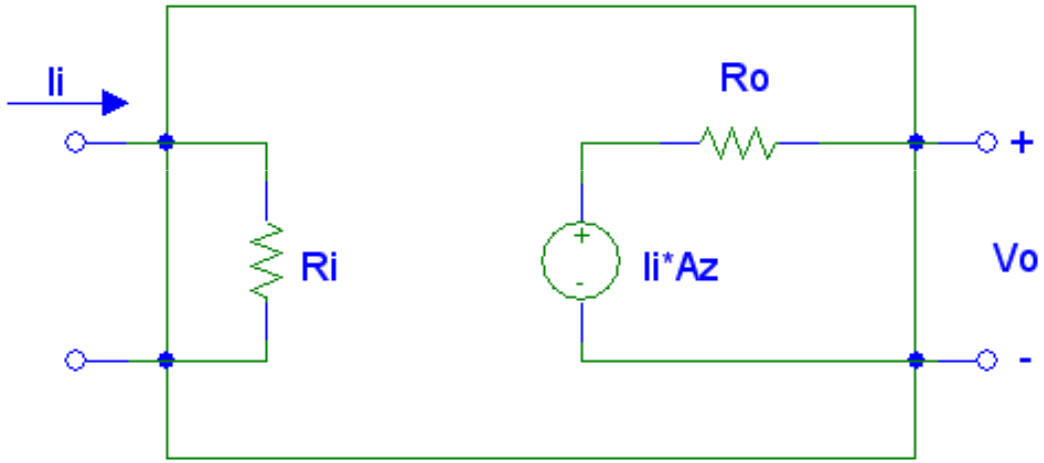


Real Amplifiers

Voltage amplifier

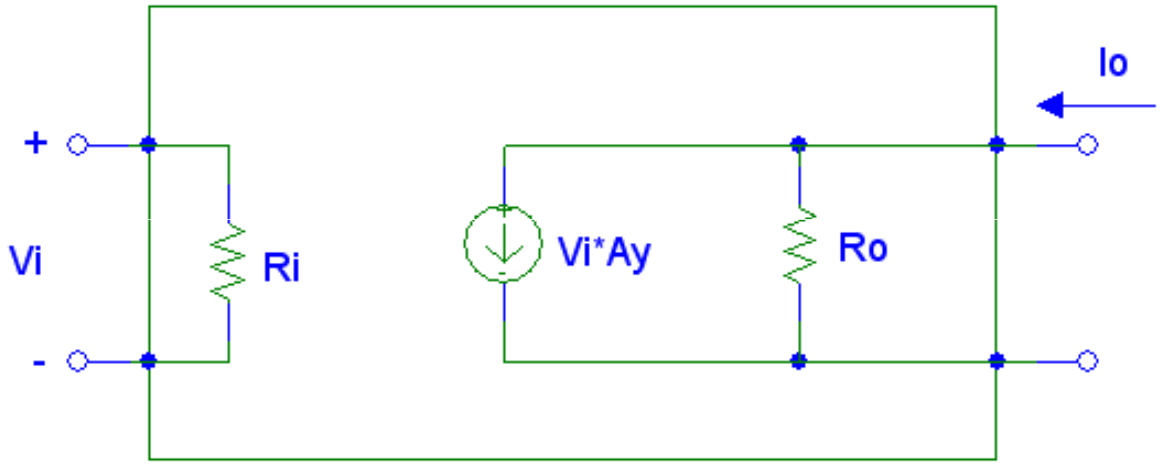


Transimpedance amplifier

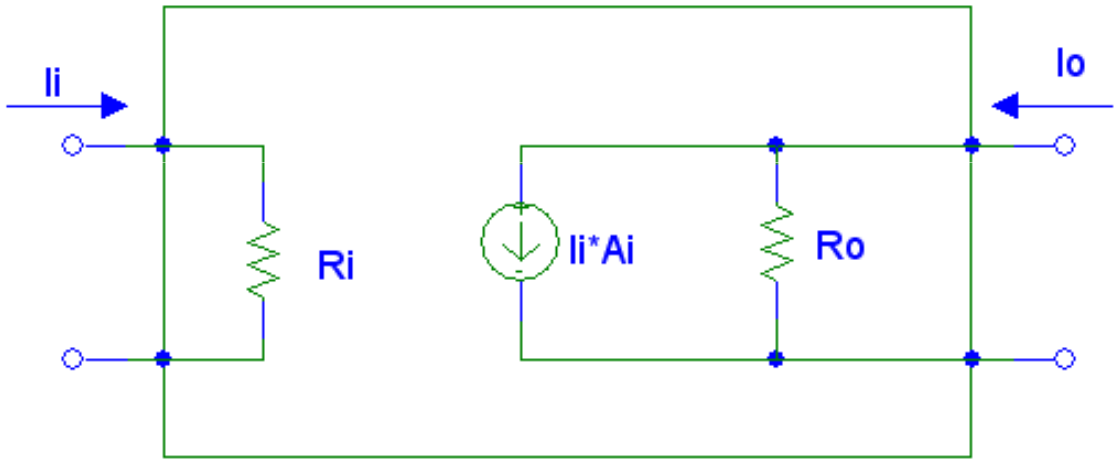


Real Amplifiers

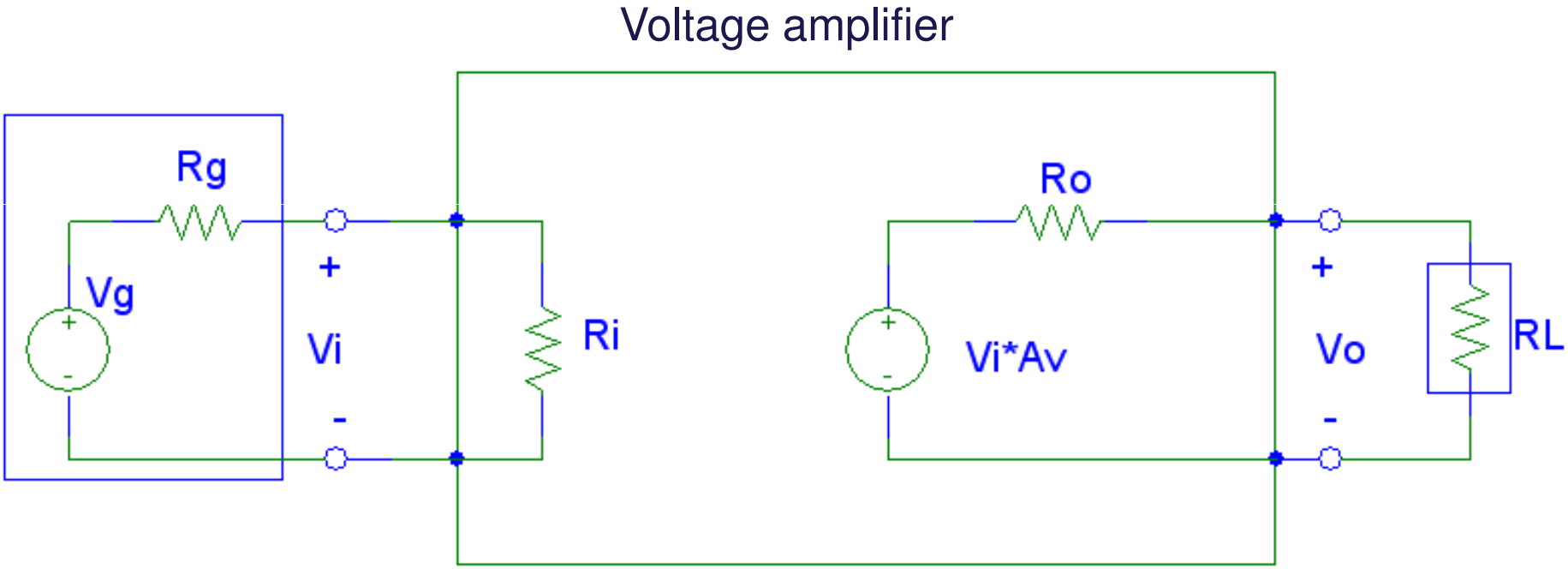
Transconductance amplifier



Current amplifier



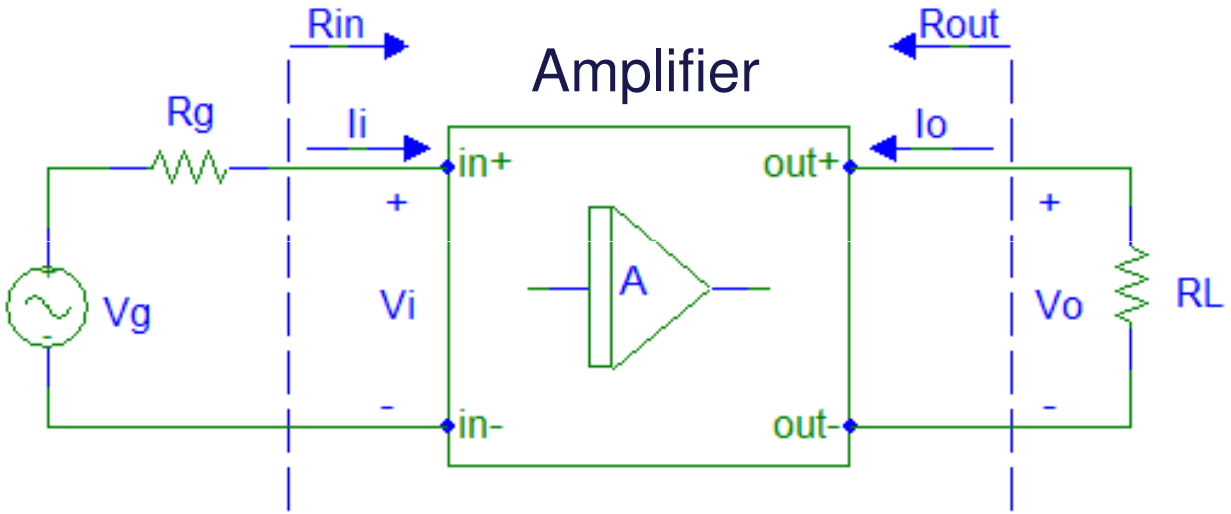
Loading Efects



Input Divider Rg – Ri (Ri input impedance)
Divisor de salida RL – Ro (Ro impedancia de salida)

$$V_o = A_V \cdot \frac{R_i}{R_i + R_g} \cdot \frac{R_L}{R_o + R_L} \cdot V_g$$

Characteristic parameters of amplifiers



- Voltage Gain, Av y Gv

$$A_v = \frac{V_o}{V_i} \qquad G_v = \frac{V_o}{V_g}$$

- Current Gain, Ai

$$A_i = \frac{i_o}{i_i}$$

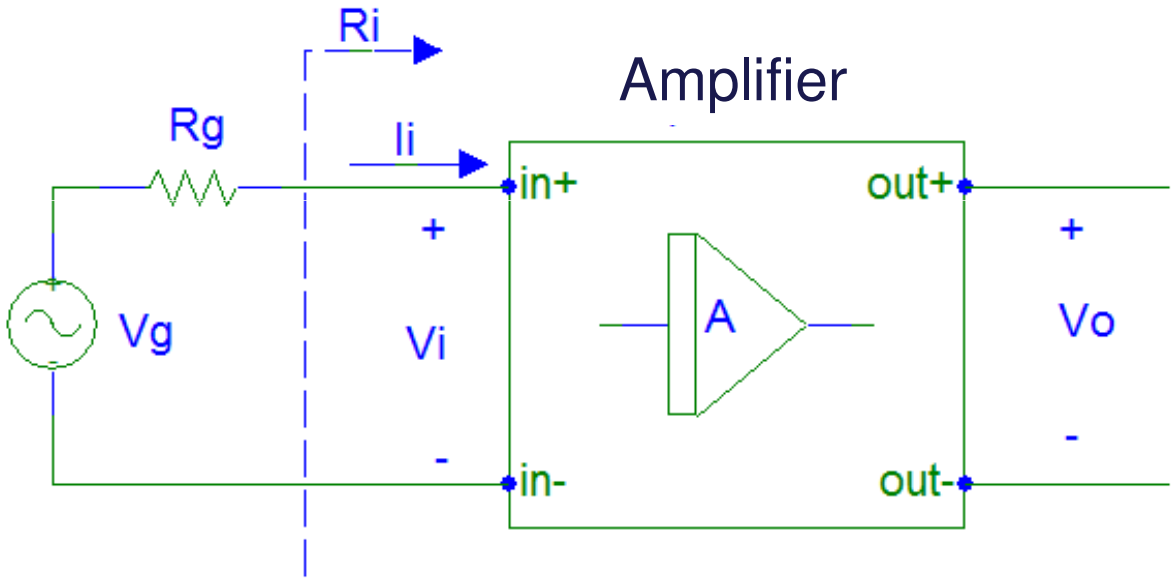
- Input resistance, Rin
  (generalizing: impedance Zin)

$$R_{in} = \frac{V_i}{i_i}$$

- Output Resistance, Rout
  (generalizing: impedance Zout)

$$R_{out} = \frac{V_o}{i_o}$$

Open circuit characteristic parameters



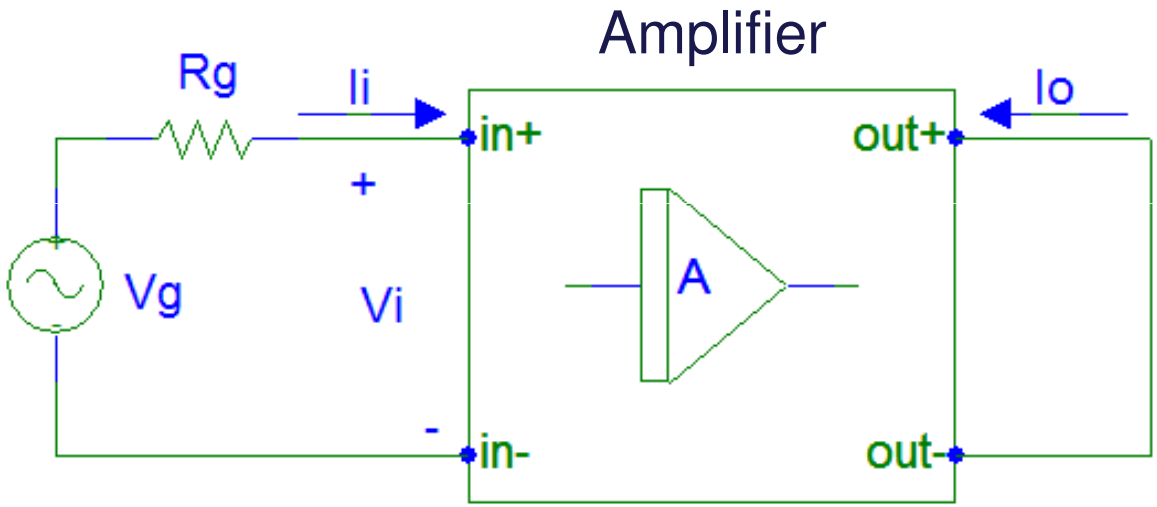
- No-load voltage gain, Avo

$$A_{vo} = \left.\frac{V_o}{V_i}\right|_{R_L \to \infty}$$

- No-load input resistance, Ri

$$R_i = \left.\frac{V_i}{i_i}\right|_{R_L \to \infty}$$

Short circit characteristic parameters



$$R_L = 0$$

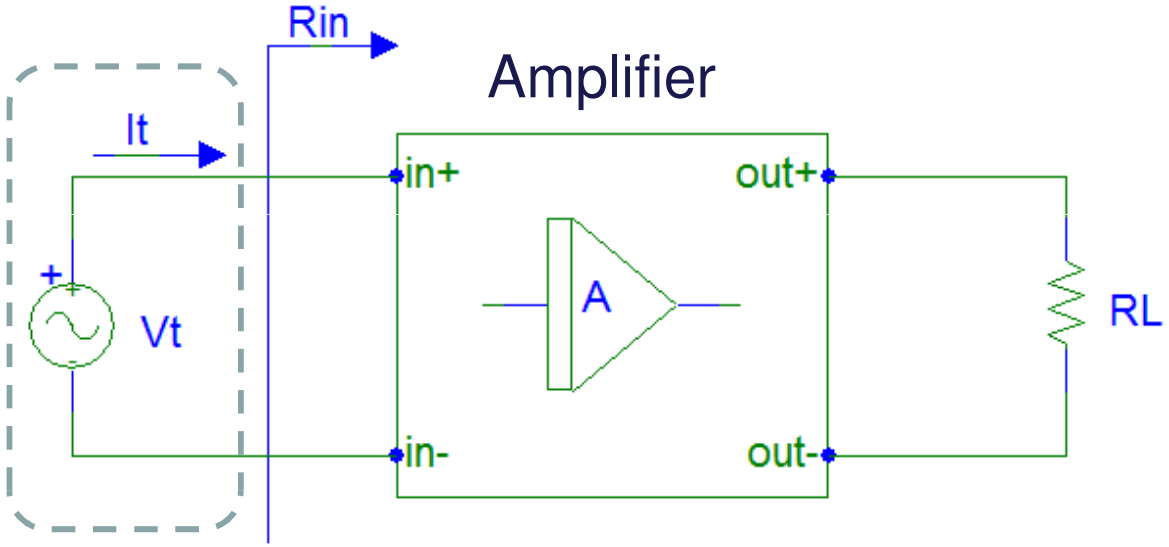
- Short circuit current gain, $A_{i(sc)}$

$$A_{i(sc)} = \left.\frac{i_o}{i_i}\right|_{R_L=0}$$

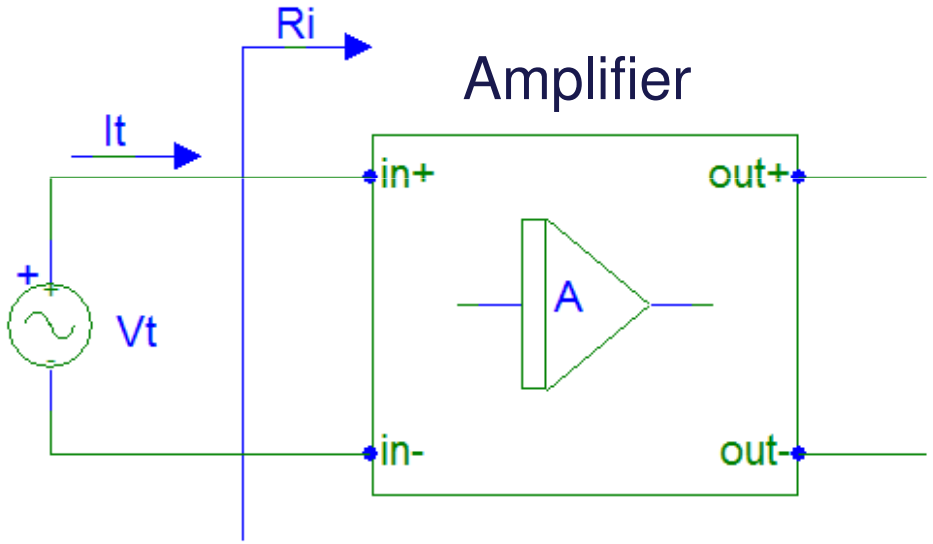
- Short-circuit transconductance, Gm

$$G_m = \left.\frac{i_o}{V_i}\right|_{R_L=0}$$

Input Impedance Analysis

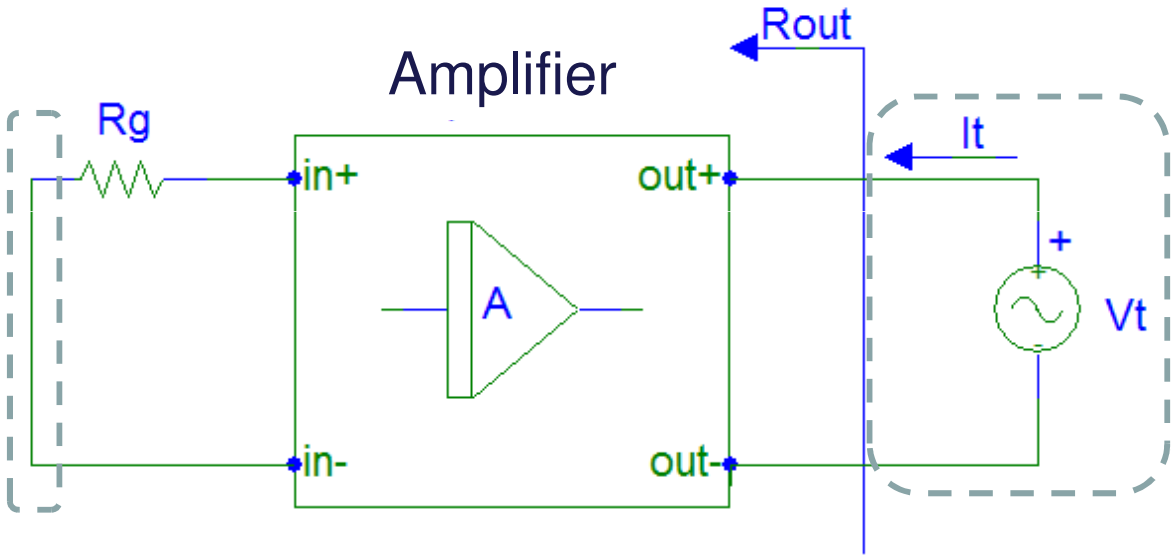


$$R_{in} = \frac{V_t}{i_t}$$

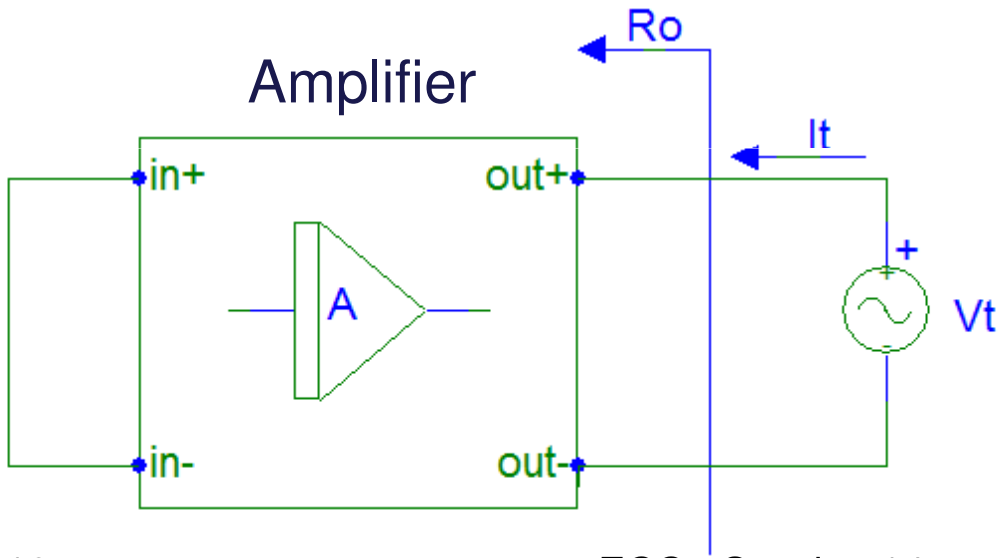


$$R_i = \left.\frac{V_t}{i_t}\right|_{R_L \to \infty}$$

Output Impedance Analysis



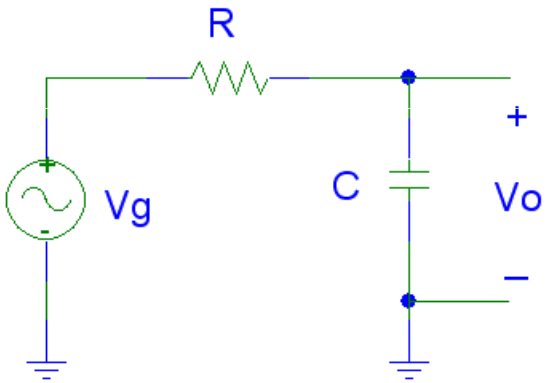
$$R_{out} = \left.\frac{V_t}{i_t}\right|_{V_g=0}$$

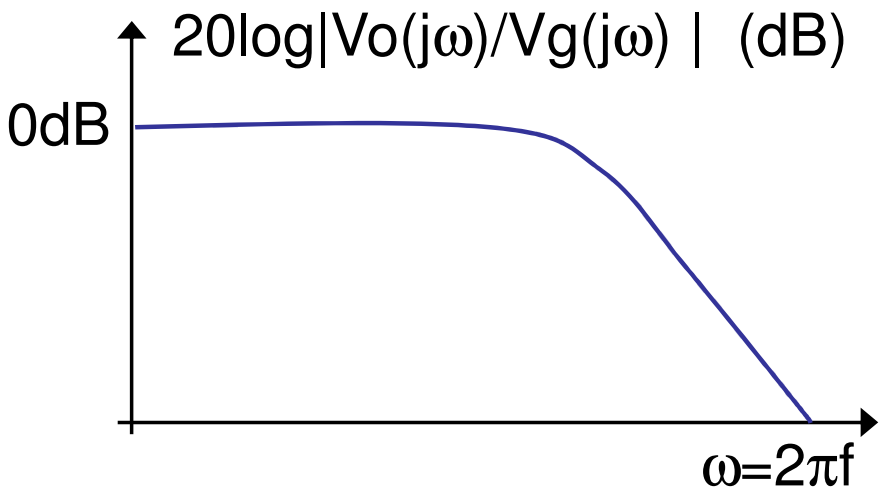


$$R_o = \left.\frac{V_t}{i_t}\right|_{V_i=0}$$

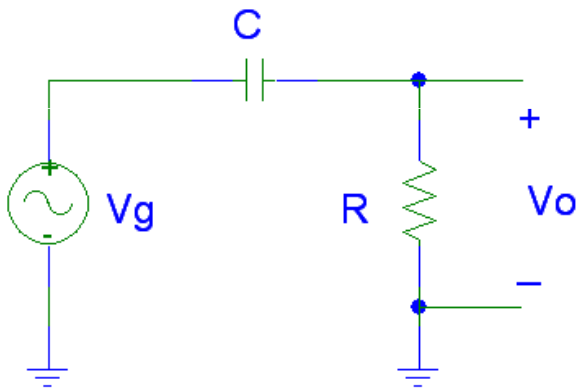
Generalization of frequency response

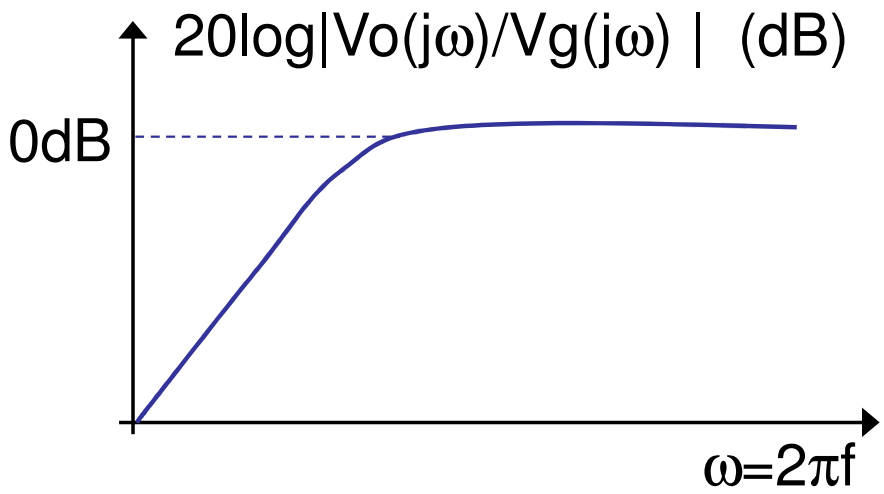
Lowpass RC



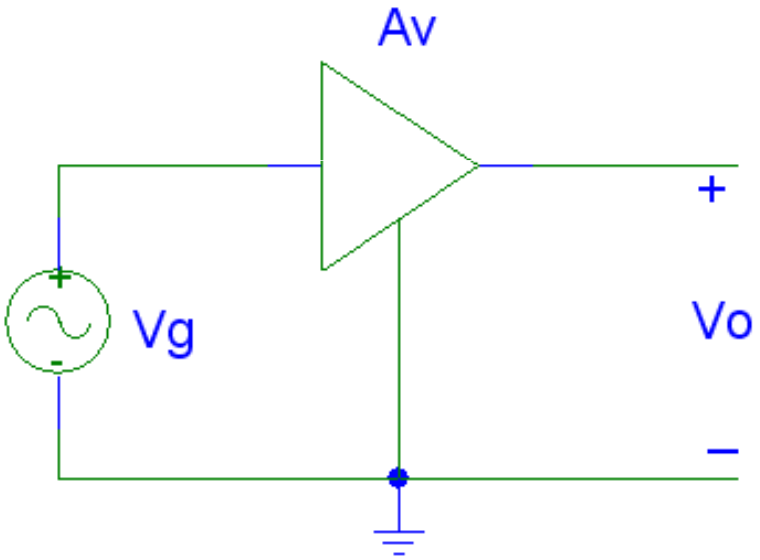


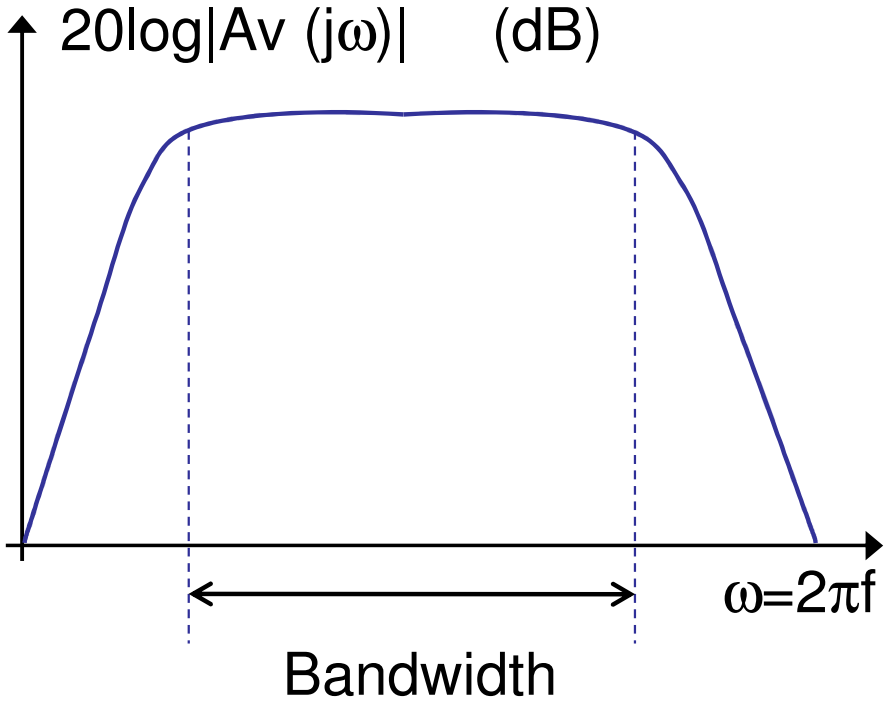
High-pass RC





Amplifier frequency response





$$V_g = V_{go} \cdot \sin(\omega t)$$

$$V_o = V_{go} \cdot \left| A_V(j\omega) \right| \cdot \sin(\omega t + \phi)$$

$$A_V(j\omega) = \frac{V_o(j\omega)}{V_g(j\omega)}$$