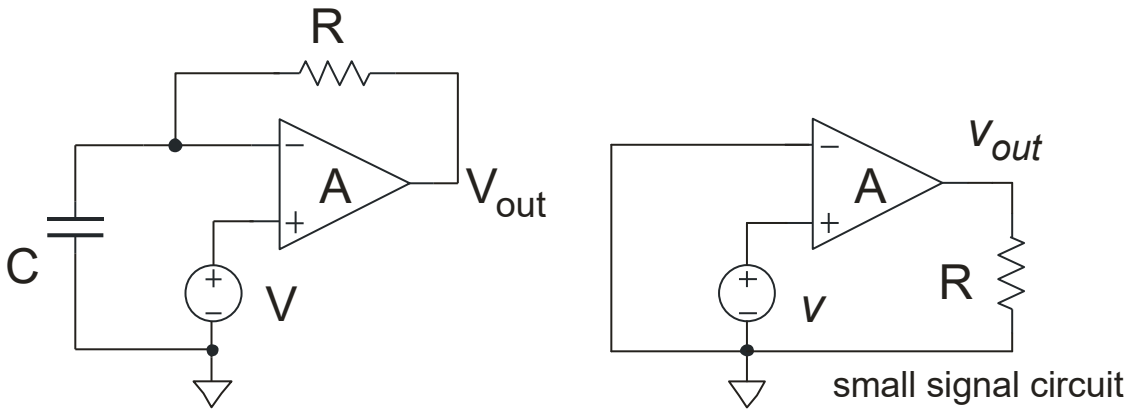
Simple configuration for simulating the frequency response of Op-amps



Hypothesis: Input bias currents =0 (Valid approximation in CMOS amplifiers)

Operating point: Vout=V. The d.c. feedback provided by R self-bias the op-amp regardless of possible systematic input offsets. Choose a V value that belongs to both the input (common mode) and output ranges. In this way the amplifier is self-biased in a valid operating point.

The amplifier open loop frequency response is simply given by the v_{out}/v transfer function.

Demonstration:

$$A_L = \frac{v_{out}}{v} = \frac{A}{1-\beta A}$$

Where:

$$\beta = -\frac{1}{1+j\dfrac{f}{f_{p\beta}}} \qquad f_{p\beta} = \frac{1}{2\pi RC}$$

If: $|\beta A| << 1 \quad \Rightarrow \quad A_L \cong A$

Note that:

$$|\beta A| \le \frac{A_0}{\sqrt{1+\left(\dfrac{f}{f_{p\beta}}\right)^2}} < \left(\frac{A_0 f_{p\beta}}{f}\right)$$

$$f_{p\beta} << \frac{f_{MIN}}{A_0}$$

Example: R=1GΩ, C=1F (1 Farad !) -> $f_{p\beta}=1.6\text{x}10^{-10}$ Hz
With $A_0=10^5$: our analysis is valid for $f >> A_0 f_{p\beta}=1.6\text{x}10^{-5}$ Hz.

An additional condition is clearly $R >> R_{out}$, where R_{out} is the open loop output resistance of the amplifier.