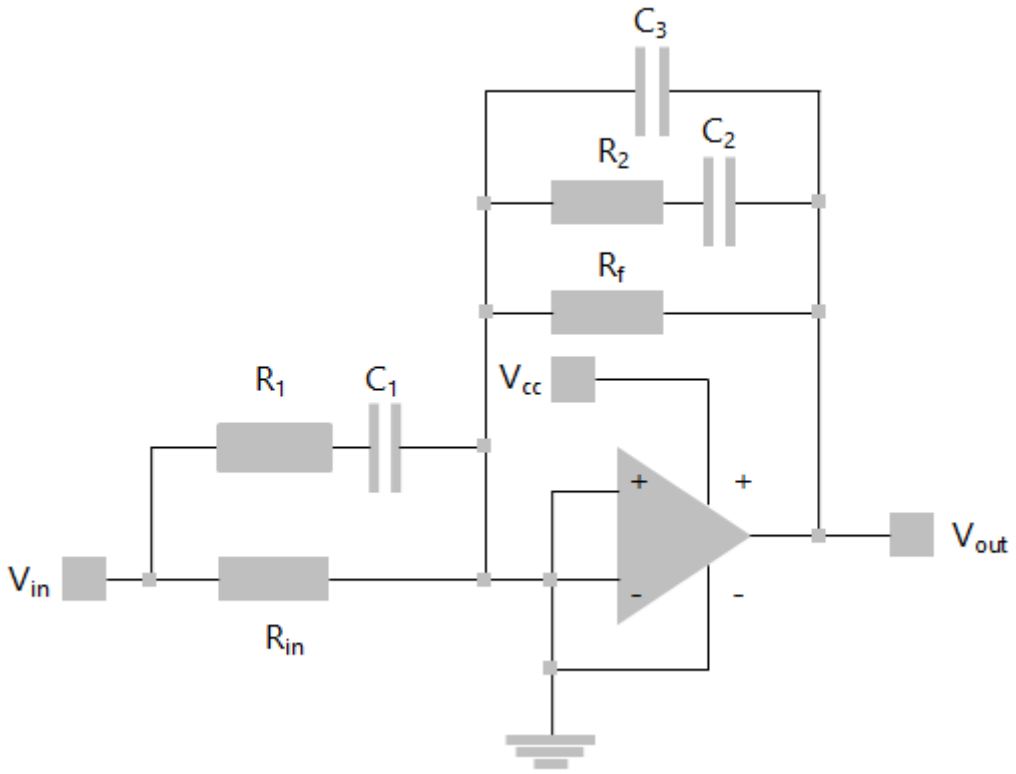
Amplifier Gain

In this application, we will plot the gain of this amplifier circuit, for both the ideal and non-ideal response.



Parameters

$R_1 := 1000$

$R_2 := 1000$

$R_{In} := 1000$

$R_f := 10^{102}$

$C_1 := 10^{-7}$

$C_2 := 4.7 \cdot 10^{-7}$

$C_3 := 4.7 \cdot 10^{-8}$

Amplifier bandwidth factors $GBP := 10^6$ $LPF := 300$

Support function $II := (Z_1, Z_2) \quad \frac{Z_1 \cdot Z_2}{Z_1 + Z_2}$

Derivation of transfer functions $Z_1 := R_1 + \frac{1}{s \cdot C_1} = 1.00 \times 10^3 + \frac{1.00 \times 10^7}{s}$

$Z_2 := R_2 + \frac{1}{s \cdot C_2} = 1.00 \times 10^3 + \frac{2.13 \times 10^6}{s}$

$Z_{In} := \text{simplify}(II(R_{In}, Z_1)) = \frac{5.00 \times 10^6 + 5.00 \times 10^2 \cdot s}{5.00 \times 10^3 + s}$

$$Z_{fb} := \mathrm{II}\left(R_f, \mathrm{II}\left(Z_2, \frac{1}{s \cdot C_3} \right) \right)$$

Ideal amplifier gain

$$G_{EAideal} := \mathrm{factor}\left(\frac{Z_{fb}}{Z_{In}} \right)$$

$$G_{EAideal} = \frac{\left(4.26 \times 10^4 \cdot s + 9.05 \times 10^7\right) \cdot \left(5.00 \times 10^3 + s\right)}{\left(s + 2.34 \times 10^4\right) \cdot \left(s + 1.93 \times 10^{-96}\right) \cdot \left(1.00 \times 10^4 + s\right)}$$

Finite open loop gain

$$A_{vo} := \frac{GBP}{LPF} \cdot \frac{1}{\left(1 + \frac{s}{2 \cdot \pi \cdot LPF}\right) \cdot \left(1 + \frac{s}{2 \cdot \pi \cdot GBP}\right)}$$

$$A_{vo} = \frac{3.33 \times 10^3}{\left(1 + 5.31 \times 10^{-4} \cdot s\right) \cdot \left(1 + 1.59 \times 10^{-7} \cdot s\right)}$$

Non-deal op-amp effect

$$\beta := \frac{1}{1 + G_{EAideal}}$$

$$\mathrm{fnormal}(\beta) = \frac{s \cdot \left(s + 2.34 \times 10^4\right) \cdot \left(1.00 \times 10^4 + s\right)}{s^3 + 7.60 \times 10^4 \cdot s^2 + 5.37 \times 10^8 \cdot s + 4.53 \times 10^{11}}$$

Non-ideal error amplifier gain

$$G_{EA} := \mathrm{simplify}\left(G_{EAideal} \cdot \frac{1}{1 + 1 / \left(A_{vo} \cdot \beta\right)} \right)$$

$$G_{EA} = \frac{1.79 \times 10^{25} + 1.68 \times 10^{18} \cdot s^2 + 1.20 \times 10^{22} \cdot s}{5.36 \times 10^{21} + s^5 + 6.36 \times 10^6 \cdot s^4 + 4.00 \times 10^{13} \cdot s^3 + 1.32 \times 10^{18} \cdot s^2 + 9.25 \times 10^{21} \cdot s}$$

Plot the frequency response

$$\mathrm{sys1} := \mathrm{DynamicSystems:-TransferFunction}\left(G_{EA} \right)$$

$$\mathrm{sys2} := \mathrm{DynamicSystems:-TransferFunction}\left(G_{EAideal} \right)$$

$$\mathrm{p1} := \mathrm{DynamicSystems:-PhasePlot}\left(\mathrm{sys1},\ \mathrm{range} = 10 .. 10^5,\ \mathrm{hertz} = \mathrm{true},\ \mathrm{legend} = \text{"Non Ideal"} \right)$$

$$\mathrm{p2} := \mathrm{DynamicSystems:-PhasePlot}\left(\mathrm{sys2},\ \mathrm{range} = 10 .. 10^5,\ \mathrm{hertz} = \mathrm{true},\ \mathrm{legend} = \text{"Ideal"},\ \mathrm{color} = \mathrm{black} \right)$$

plots:-display(p1, p2, size = [800, 400], labelfont = [Arial],
axesfont = [Arial], legendstyle = [location = bottom, font = [Arial]],
axes = boxed, gridlines) =