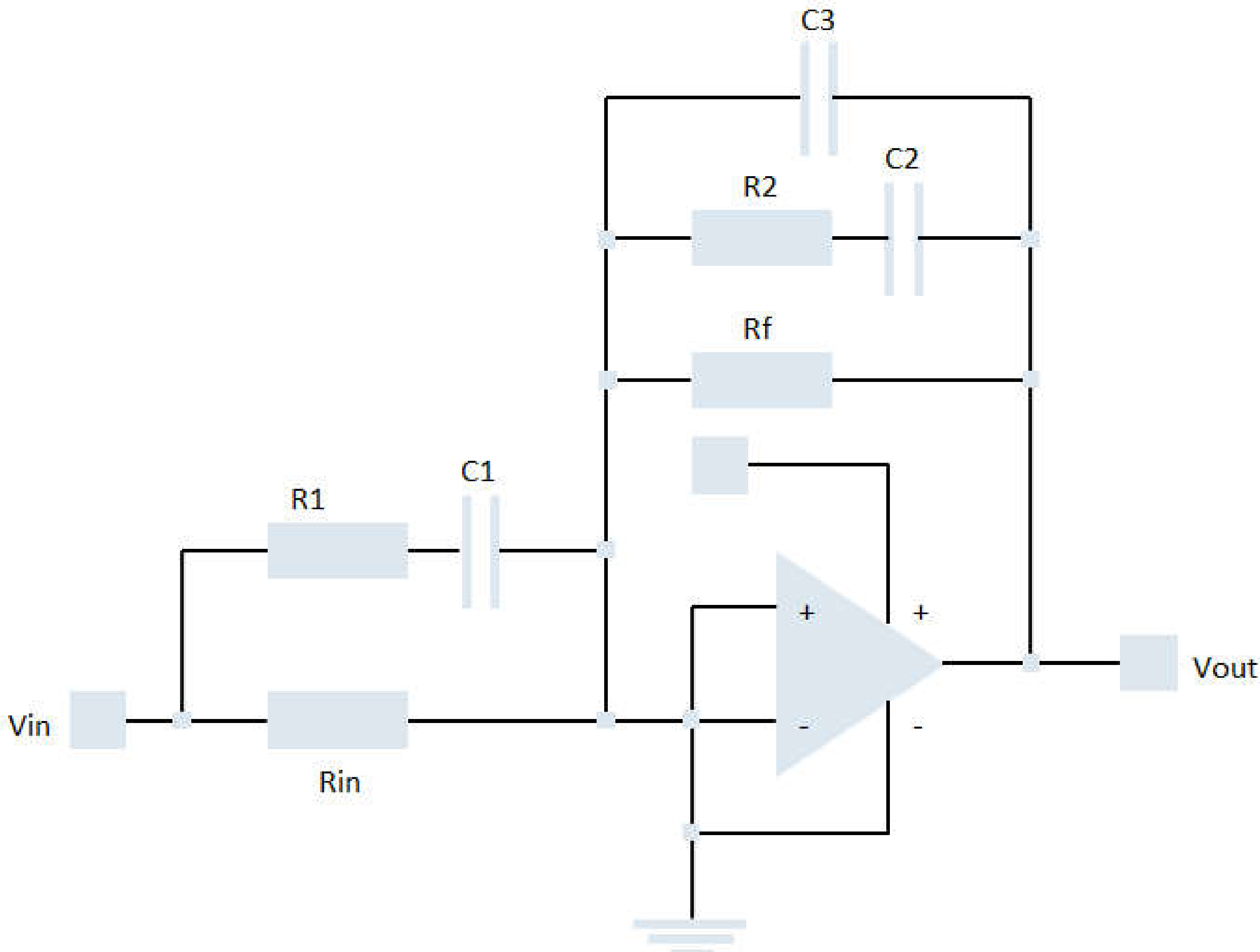
Amplifier Gain

Introduction

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




```
> restart :
  with( DynamicSystems ) :
  with( plots ) :
```

Parameters

> $R_1 := 1000 :$

$C_1 := 10^{-7} :$

$R_{In} := 1000 :$

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

$R_2 := 1000 :$

$C_2 := 4.70 \cdot 10^{-7} :$

$R_f := 10^{102}$:

Amplifier bandwidth factors

> $GBP := 10^6$:

> $LPF := 300$:

Support Function

> $\mathrm{ll} := (Z1, Z2) \rightarrow \frac{Z1 \cdot Z2}{Z1 + Z2}$:

Transfer functions

> $Z_1 := R_1 + \frac{1}{s \cdot C_1}$:

> $Z_2 := R_2 + \frac{1}{s \cdot C_2}$:

> $Z_{In} := \mathrm{ll}\left(R_{In}, Z_1\right)$:

> factor$\left(Z_{In}\right)$

$$\frac{500\,(s + 10000)}{s + 5000} \quad \textbf{(4.1)}$$

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

Ideal Amplifier Gain

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

$$G_{EAideal} := \frac{42553.19148\,(s + 2127.659574)\,(s + 5000.)}{\left(s + 1.93423597710^{-96}\right)\,(s + 23404.25531)\,(s + 10000.)} \quad \textbf{(4.2)}$$

Nonideal Op-Amp effects: Finite open loop gain

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

Finite open loop gain

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

$$A_{vo} := \frac{10000}{3\left(1 + \frac{1}{600}\,\frac{s}{\pi}\right)\left(1 + \frac{1}{2000000}\,\frac{s}{\pi}\right)} \quad \textbf{(4.3)}$$

> simplify(**(4.3)**, 'size')

$$\frac{4000000000000\,\pi^2}{(600\,\pi + s)\,(2000000\,\pi + s)} \quad \textbf{(4.4)}$$

Nonideal error amplifier gain

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

$$G_{EA} := (42553.19148\,(s + 5000.)\,(s + 2127.659574)) \Big/ (1.012406241\,s^3 + 33512.60113\,s^2 + 2.342758273\,10^8\,s + 1.35808057810^8 + 1.61126714110^{-7}\,s^4 + 2.533029591\,0^{-14}\,s^5) \quad \textbf{(4.5}$$

Analysis

```
> with( DynamicSystems ) :
> sys1 := TransferFunction( G_EA ) :
> sys2 := TransferFunction( G_EAideal ) :
> p1 := PhasePlot( sys1, range = 10 ..100000 , hertz = true, legend = "Non-ideal" ) :
> p2 := PhasePlot( sys2, range = 10 ..100000 , hertz = true, legend = "Ideal" , color = black ) :
> display( p1, p2 )
```