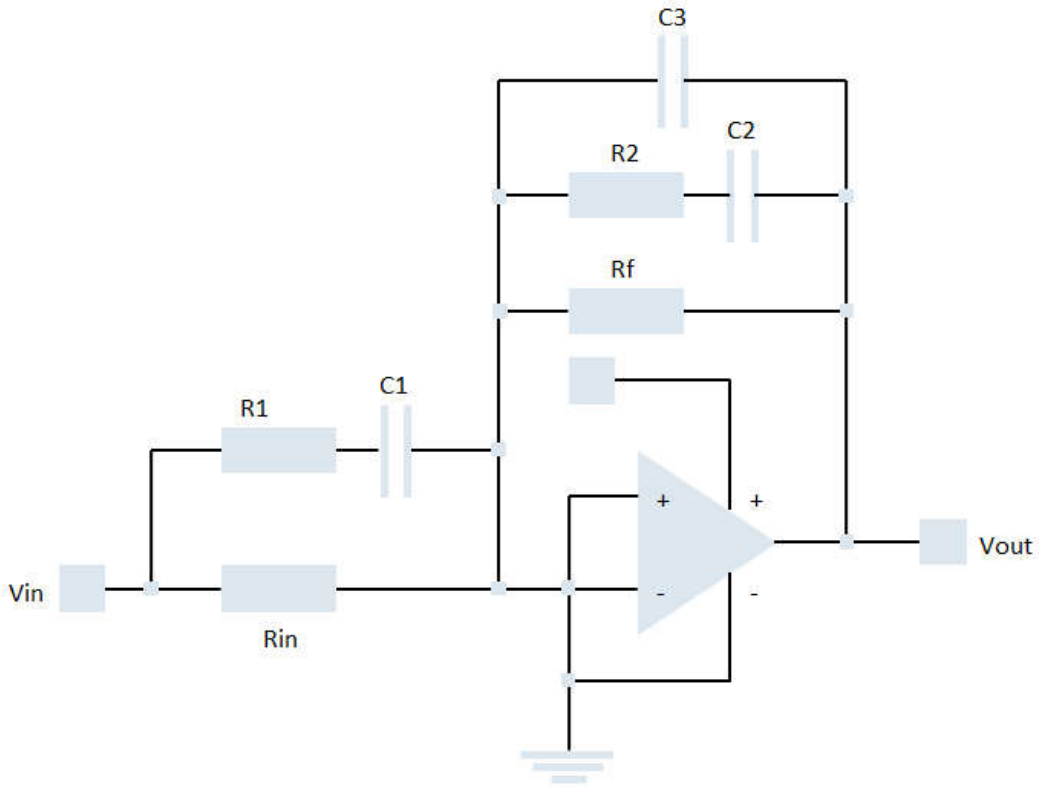
Amplifier Gain

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 := 4.7·10^-8 :
> R_2 := 1000 :
> C_2 := 4.70·10^-7 :
> R_f := 10^102 :
```

Amplifier bandwidth factors

> $GBP := 10^6$:

> $LPF := 300$:

Support Function

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

Transfer functions

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

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

> $Z_{In} := ll(R_{In}, Z_1)$:

> factor(Z_{In})

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

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

Ideal Amplifier Gain

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

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

Nonideal Op-Amp effects: Finite open loop gain

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

Finite open loop gain

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

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

> simplify($A_{vo} := \frac{10000}{3\left(1+\frac{1}{600}\frac{s}{\pi}\right)\left(1+\frac{1}{2000000}\frac{s}{\pi}\right)}$, 'size')

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

Nonideal error amplifier gain

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

$$G_{EA} := (42553.19148\,(s+5000.)\,(s+2127.659574)) \Big/ (1.012406241\,s^3 + 33512.60113\,s^2 + 2.34275827310^8\,s + 1.3580805781\,0^8 + 1.6112671411\,0^{-7}\,s^4 + 2.533029591\,0^{-14}\,s^5)$$

Analysis

> with(DynamicSystems) :

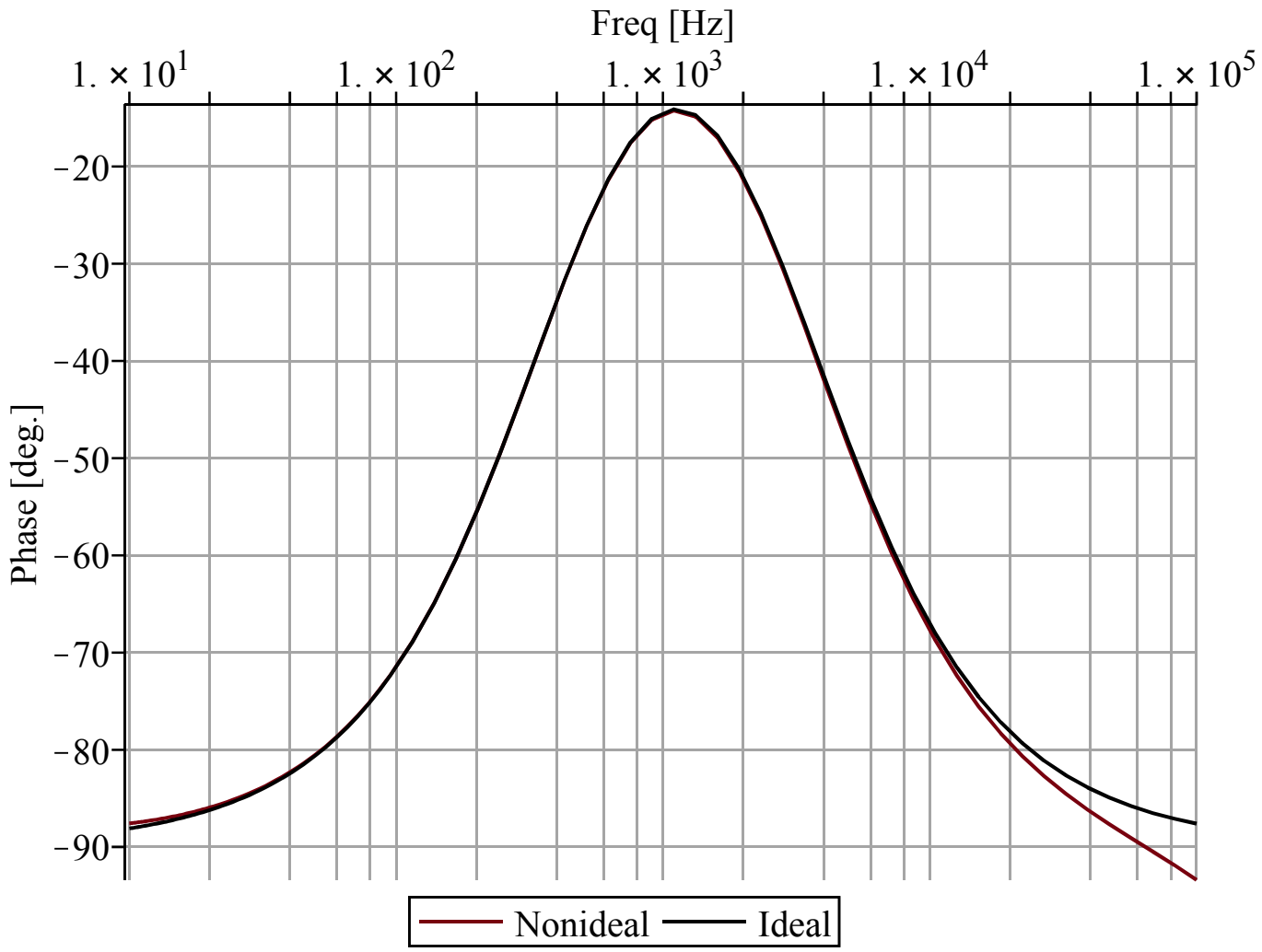
> sys1 := TransferFunction(G_{EA}) :

> 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)


Freq [Hz]
1. × 10^1
1. × 10^2
1. × 10^3
1. × 10^4
1. × 10^5
Phase [deg.]
−20
−30
−40
−50
−60
−70
−80
−90
Nonideal
Ideal