High-Pass RC Circuit

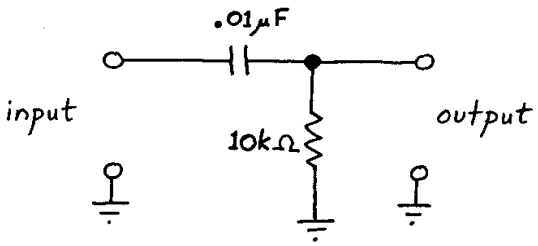
PHYSICS 258/259 D.S. Hamilton

Introduction

A high-pass filter will pass the high-frequency Fourier components, but not those components at lower frequencies.

Problem

Obtain the complex transfer function H(ω) for the circuit shown below over the range $0 < \omega < \infty$. Plot the magnitude of H and the phase angle as a function of ω on a log scale.



The figure is simple four-terminal RC high-pass filter.

Parameters

$C := 0.01 \cdot \mu F$ $R := 10 \cdot k\Omega$

Solution

The complex transfer function can be written down by inspection:

$$H(\omega) := \frac{R}{R + \frac{1}{j \omega \cdot C}}$$

Parameters for plotting

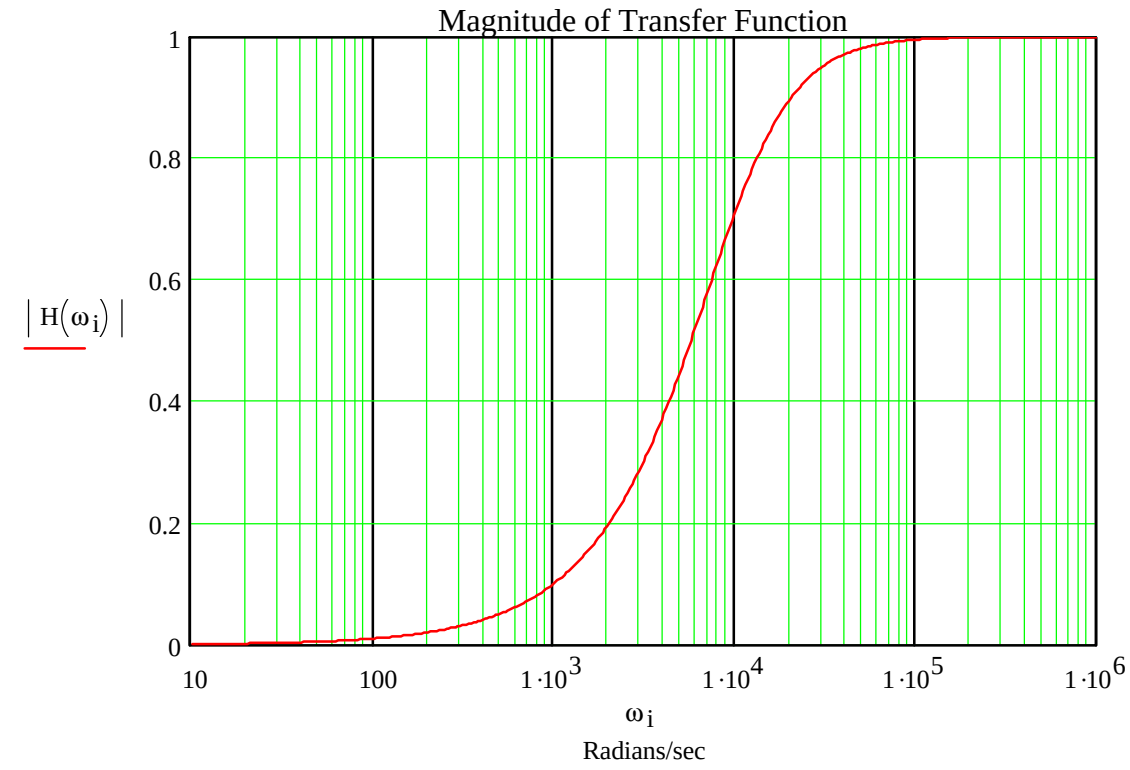
characteristic frequency: $\omega_0 := \frac{1}{R \cdot C}$ $\omega_0 = 1 \cdot 10^4 \, s^{-1}$

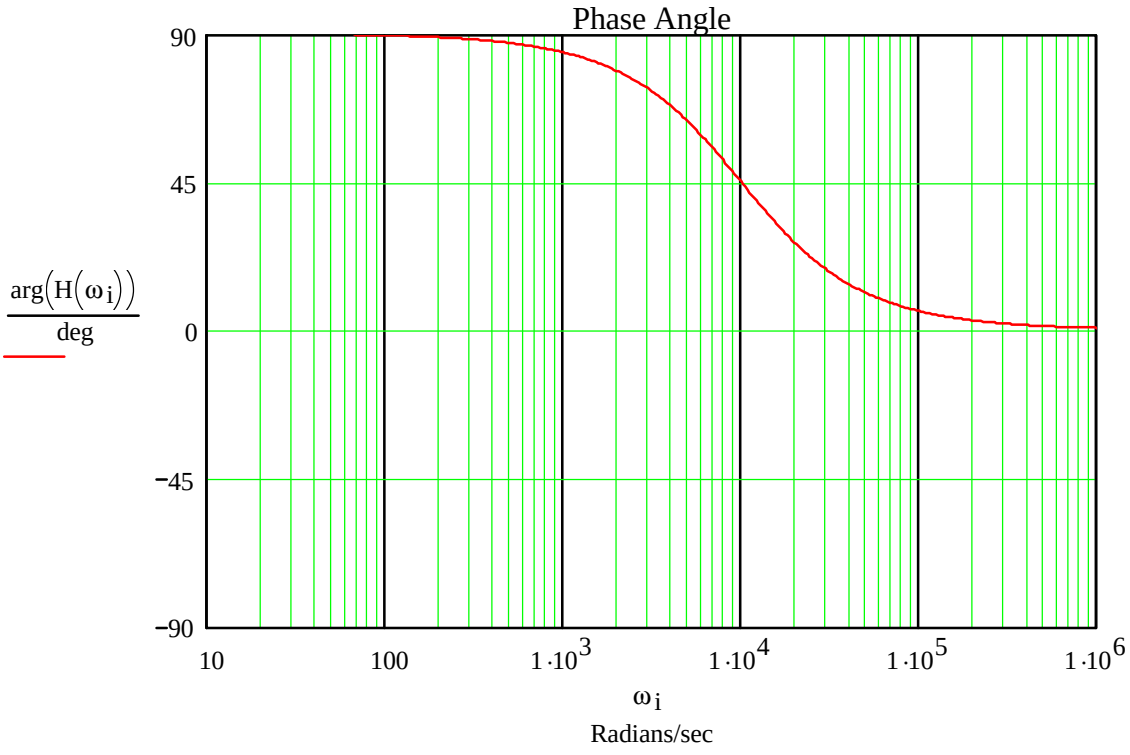
Low/High values to plot: $\omega_{low} := .001 \cdot \omega_0$ $\omega_{high} := 100 \cdot \omega_0$

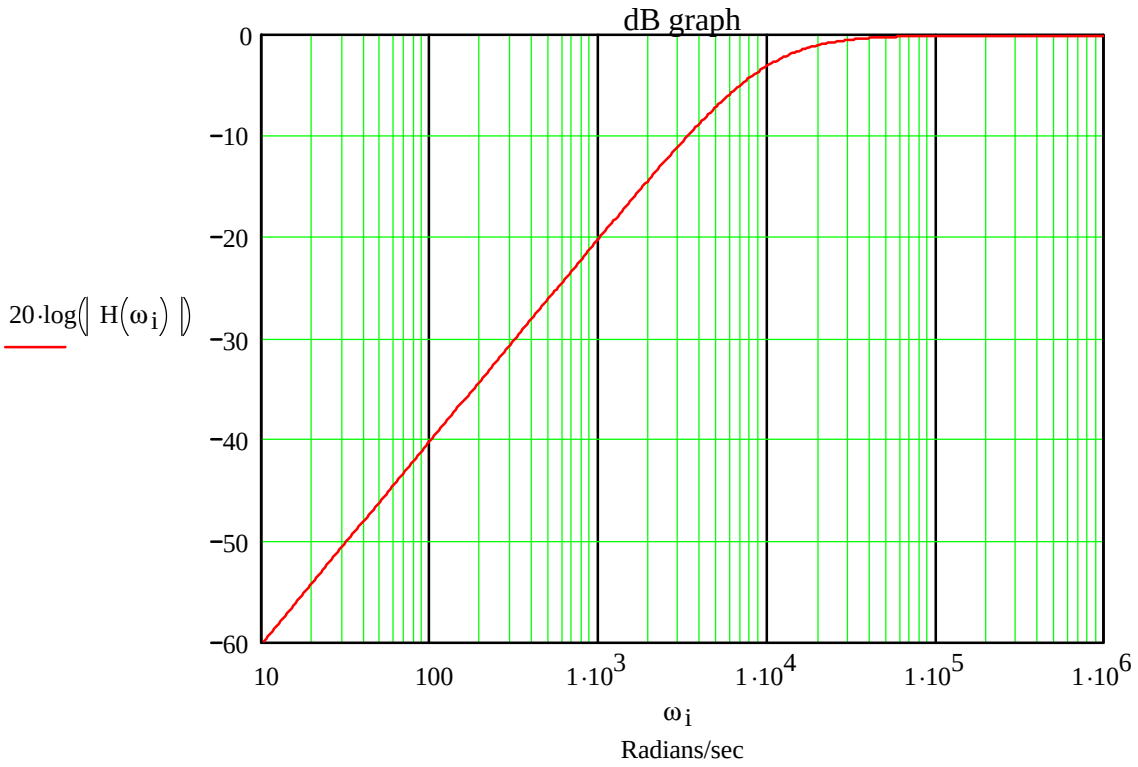
Number of points: $N := 400$ $i := 0 .. N - 1$

Step size: $r := \log\left(\frac{\omega_{low}}{\omega_{high}}\right) \cdot \frac{1}{N}$ $r = -0.012$

Range variable: $\omega_i := \omega_{high} \cdot 10^{i \cdot r}$


Magnitude of Transfer Function
|H(ωi)|
1
0.8
0.6
0.4
0.2
0
10
100
1·10^3
1·10^4
1·10^5
1·10^6
ωi
Radians/sec


Phase Angle
arg(H(ωi))
deg
90
45
0
−45
−90
10
100
1·10^3
1·10^4
1·10^5
1·10^6
ωi
Radians/sec


dB graph
20·log(H(ω_i))
0
−10
−20
−30
−40
−50
−60
10
100
1·10^3
1·10^4
1·10^5
1·10^6
ω_i
Radians/sec