ECE 3043

Spring 2077

Section L01 Tu 12-3

Homework No 1

Due February 31

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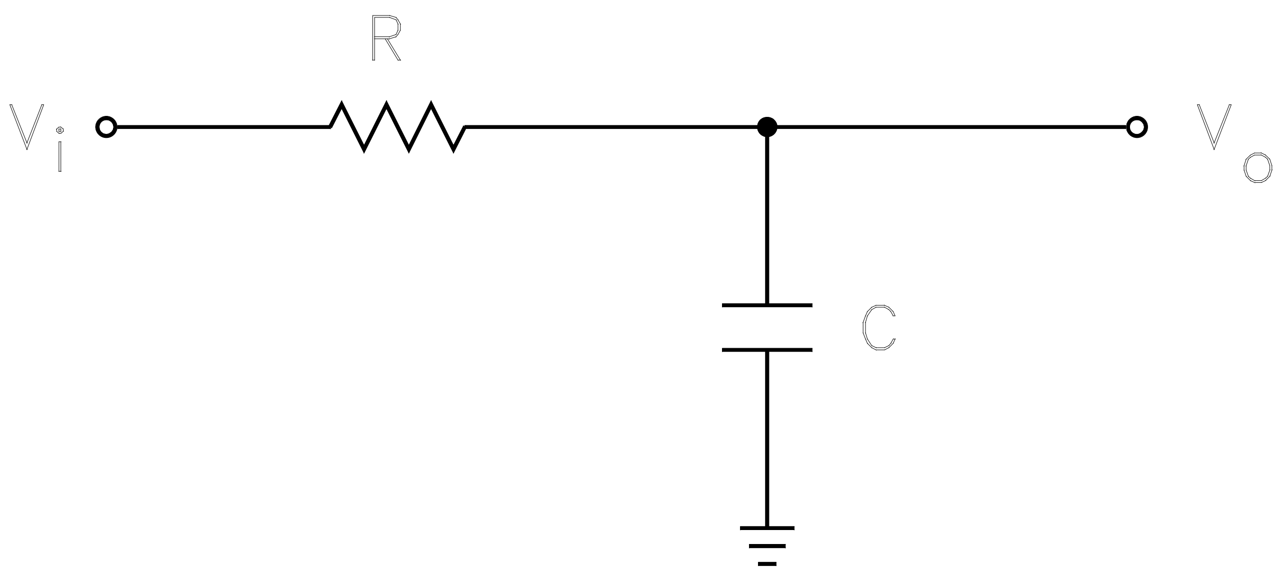
ECE 3043 Spring 2077
Homework Problem Set No 1 for Experiment No. 2

Due Week of February 31



1. For the circuit shown above derive the complex transfer function $T(s) = V_o/V_i$. Express it as a function of the symbols for the resistor and capacitor and the complex frequency variable s. Simplify it as
$$T(s) = K\frac{1+s\tau_z}{1+s\tau_p} \tag{1}$$
Compute the dc gain in dB and the pole and zero frequencies in Hz.

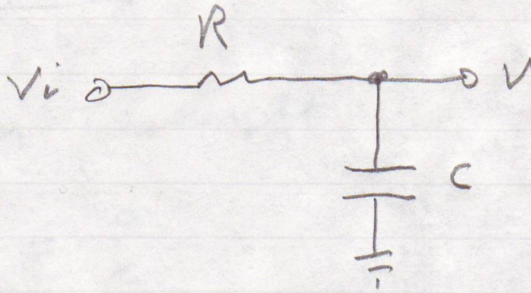
2. Plot the Bode plot for the circuit using Mathcad. Plot the frequency response one decade below the lowest critical frequency and one decade above the highest critical frequency. Plot the magnitude in dB and the phase in degrees. The values of the circuit components are $R = 10\,\text{k}\Omega$ and $C = 0.1\,\mu\text{F}$.

3. Make the same plot as in Problem 2 using Matlab.

4. Make the same plot as in Problem 2 using National Instruments SPICE (Multisim).

5. Make the same plot as in Problem 2 using LTSpice (text editor input mode).

Derivation of Transfer Function



$R = 10 k\Omega$

$C = 0.1 \mu F$

$$T(s) = \frac{V_o}{V_i} = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} = \frac{1}{1 + sRC}$$

$$T(s) = K \frac{1 + s\tau_z}{1 + s\tau_p}$$

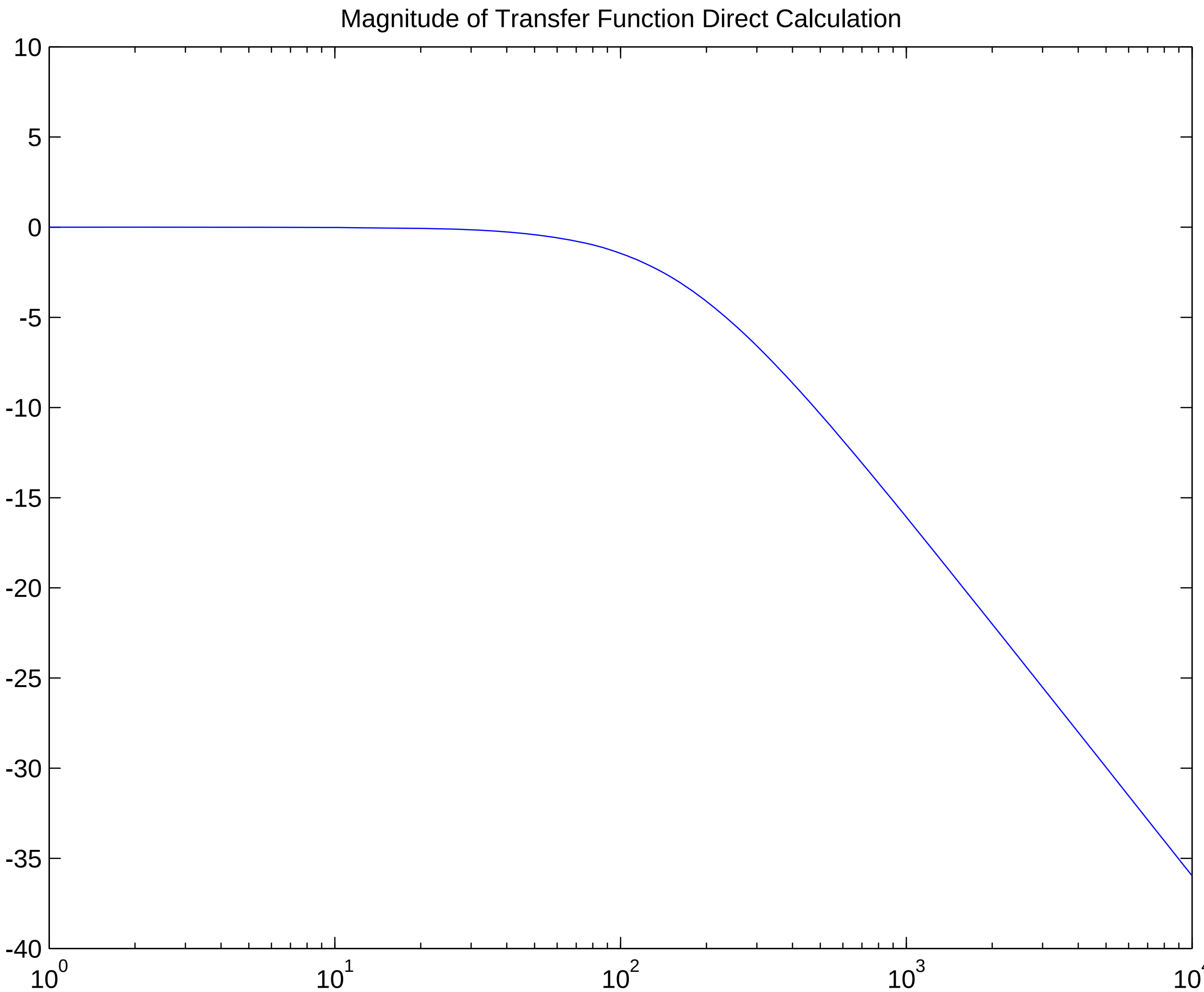
$K = 1 \quad \tau_z = 0$

$\tau_p = RC$

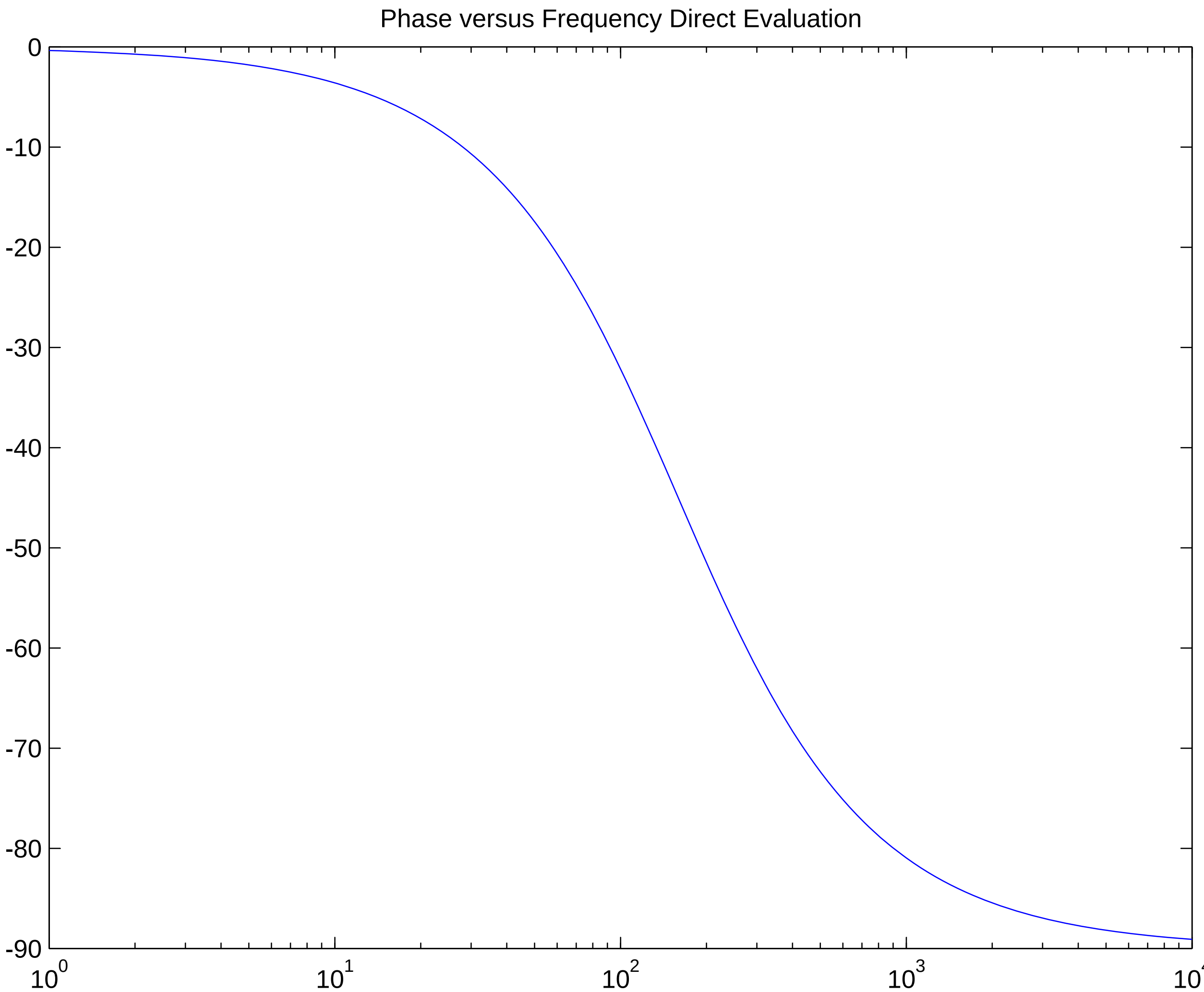
$$\text{DC gain} = 20 \log_{10} |T(0)| = 0 \text{ dB}$$

$$f_p = \frac{1}{2\pi\tau_p} = \frac{1}{2\pi RC} = 159.1549 \text{ Hz}$$

```
    ----------------------------------------------------------
        Your MATLAB license will expire in 53 days.
        Please contact your system administrator or
        MathWorks to renew this license.
    ----------------------------------------------------------
>> %Transfer Function Direct Evaluation
>> f=logspace(0,4,100);%Specify Frequency Range 10^0 to 10^4 100 pts per decade
>> j=sqrt(-1);R=10e3;C=0.1e-6;%Specify Component Values
>> tau=R*C;fo=1/(2*pi*tau);%Compute Pole frequency
>> T=1./(1+j*f/fo);%Transfer Function Specification
>> plot(f,20*log10(abs(T)));%Plot Mag of Transfer Function Change Freq to log in Graph↙
Properties
>> plot(f,180*angle(T)/pi);%Plot Phase of Transfer Function Change Freq to log in Graph↙
Properties
>> %Transfer Function Using Bode Function
>> N=[1];D=[tau 1];bode(N,D);%Numerator Poly, Denominator Poly, bode function
>> %Use Graph Properties to change freq units to Hz
```

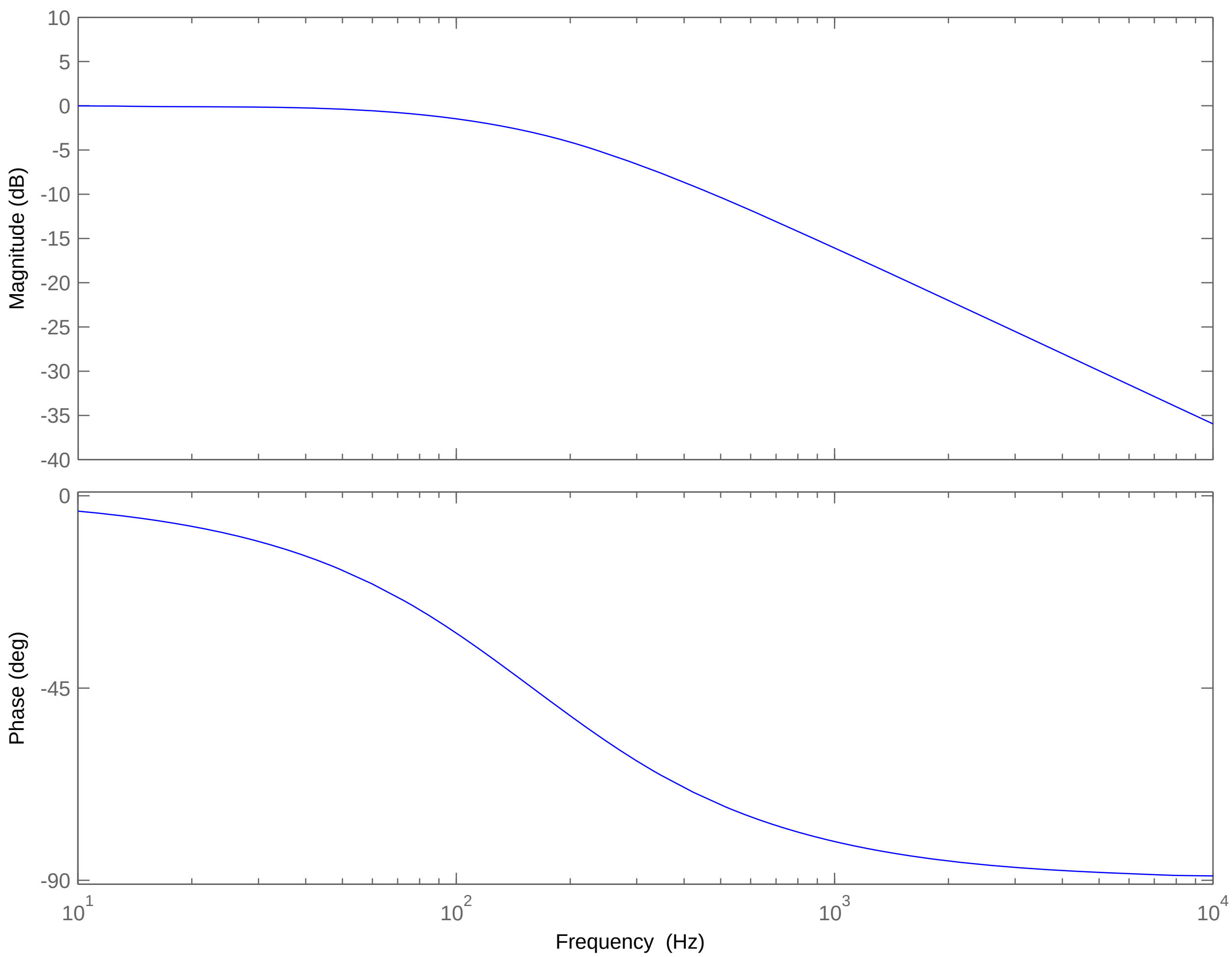


Magnitude of Transfer Function Direct Calculation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10^0
10^1
10^2
10^3
10^4



Phase versus Frequency Direct Evaluation
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
10^0
10^1
10^2
10^3
10^4

Bode Diagram Using Bode Function



Spring 2077 Hwk No 1 Transfer Function

Mathcad

$j := \sqrt{-1}$ $R := 10k\Omega$

$C := 0.1 \cdot \mu F$

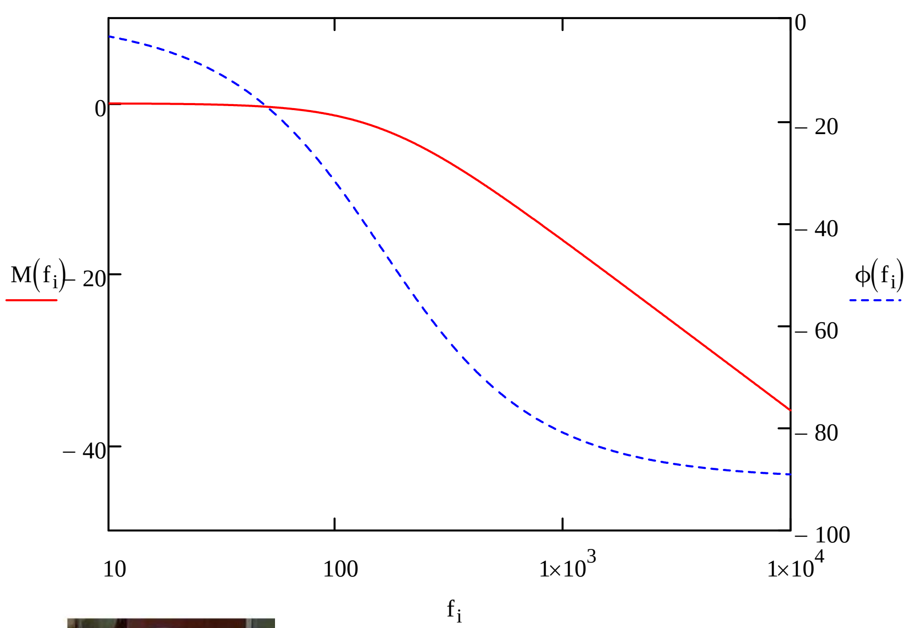
$K := 1$ $R_p(A,B) := \frac{A \cdot B}{A + B}$

$\tau_p := R \cdot C$

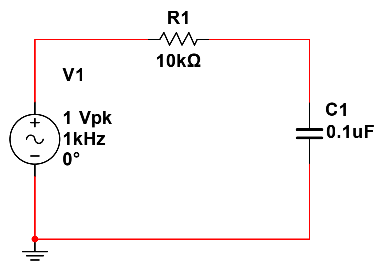
$T(f) := K \cdot \frac{1}{1 + \tau_p \cdot (j \cdot 2 \cdot \pi \cdot f)}$ $f_p := \frac{1}{2 \cdot \pi \cdot \tau_p} = 159.155 \cdot Hz$

$f_{start} := 10Hz$ $f_{stop} := 10kHz$ $N := 1024$ $i := 0 .. N - 1$

$f_i := f_{start} \cdot \left(\frac{f_{stop}}{f_{start}}\right)^{\frac{i}{N-1}}$ $M(f) := 20 \cdot \log(|T(f)|)$ $\phi(f) := \frac{180}{\pi} \cdot \arg(T(f))$




Thomas E. Brewer
Academic Factotum



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Example

AC Analysis

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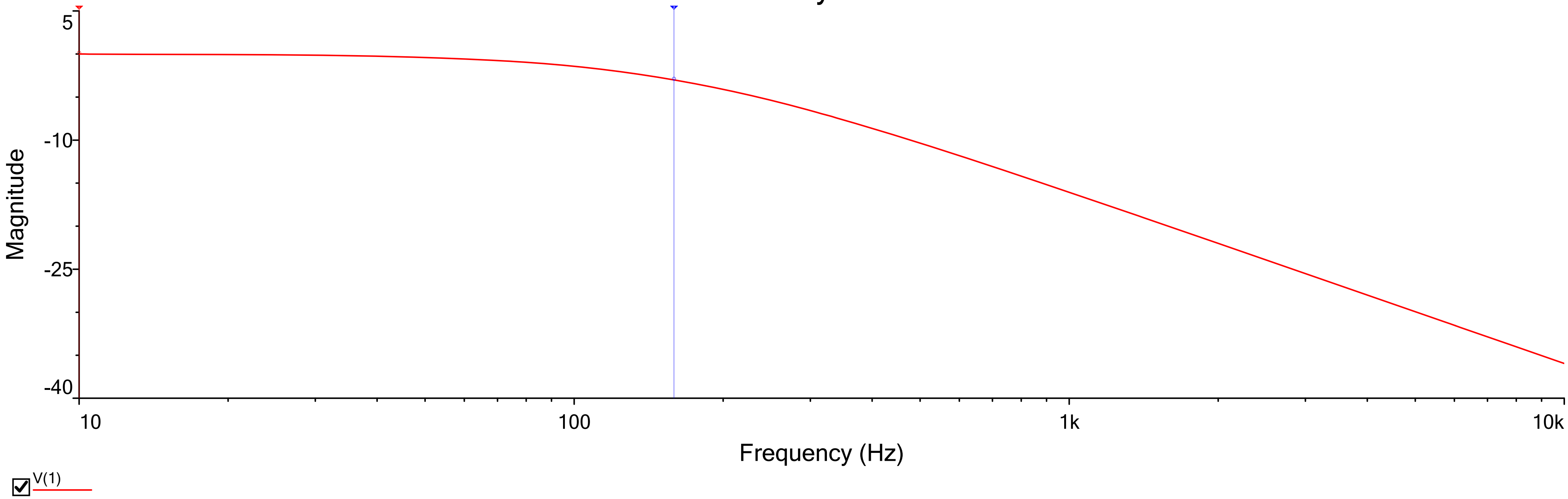
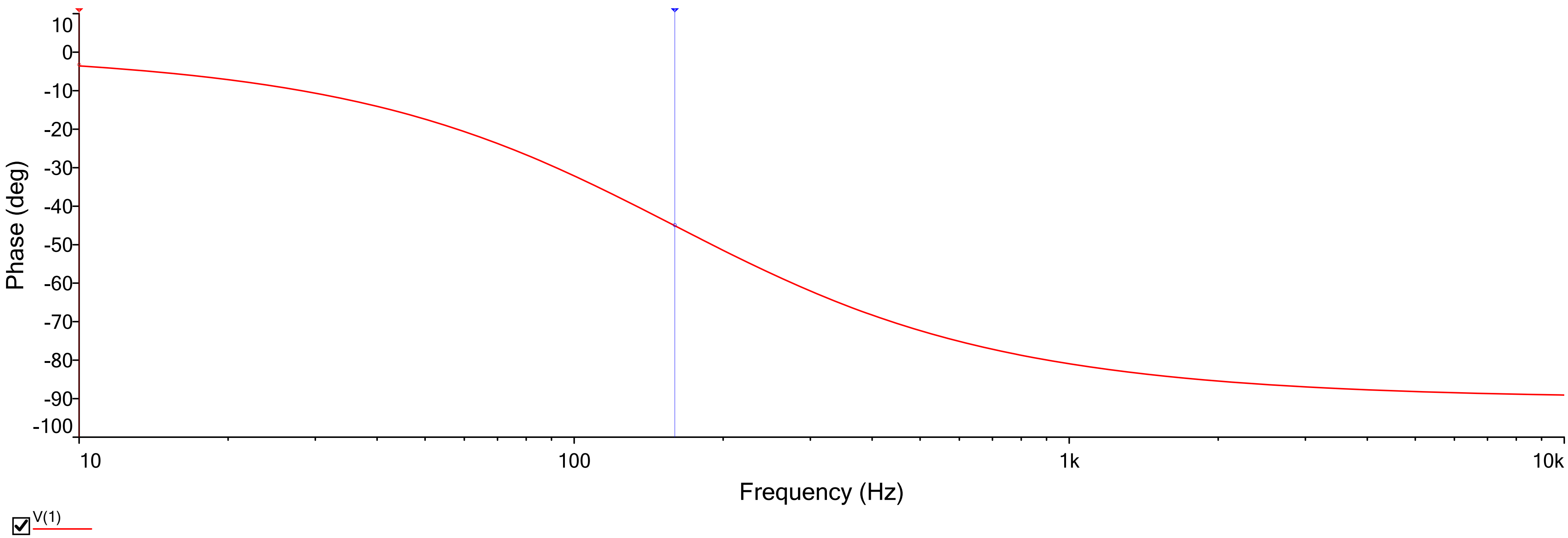
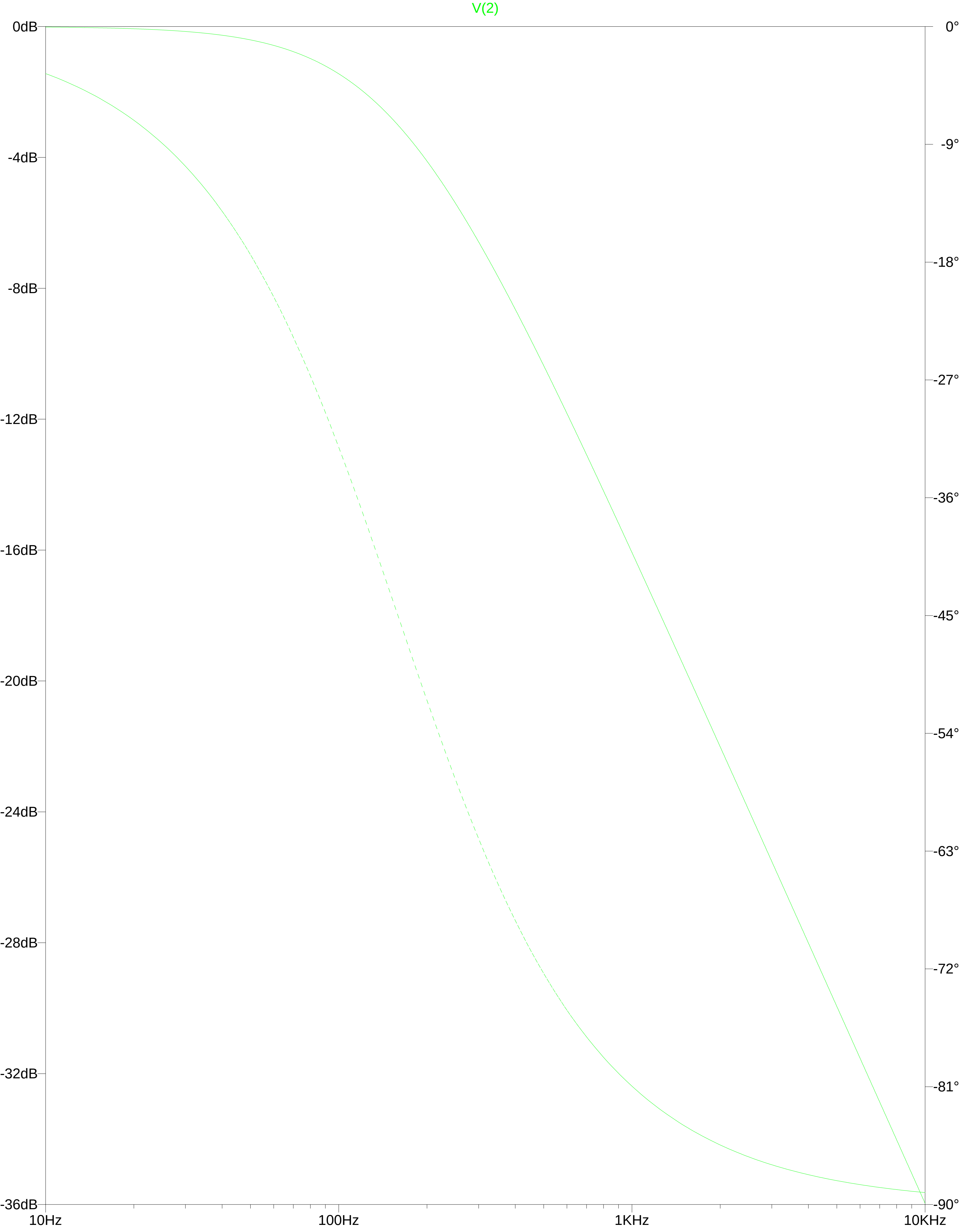


	x1	y1	x2	y2	dx	dy	dy/dx	1/dx
V(1):	10.0000	-17.1116m	159.0903	-3.0087	149.0903	-2.9916	-20.0656m	6.7073m



	x1	y1	x2	y2	dx	dy	dy/dx	1/dx
V(1):	10.0000	-3.5953	159.6937	-45.0968	149.6937	-41.5015	-277.2430m	6.6803m

```
George P. Burdell
Vi 1 0 ac 1
R 1 2 10k
C 2 0 0.1u
.ac dec 100 10 10k
.probe
.end
```



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