Lab 02: Simulator

Part (1)

Matlab result for the two circuits:

```
Command Window
the first netlist:
V_1 = 30.000000
V_2 = 16.956522
I_Vb = -0.260870
the second netlist:
V_1 = 40.000000
V_2 = 14.634146
V_3 = 32.195122
V_4 = 112.195122
I_Vb = -1.268293
```

LTSpice result for Circuit_1:

```
V(1):       30          voltage
V(2):       16.9565     voltage
I(Is):      2           device_current
I(R3):      1.69565     device_current
I(R2):      0.565217    device_current
I(R1):      0.26087     device_current
I(Vb):      -0.26087    device_current
```

LTSpice result for Circuit_2:

```
V(1):       40          voltage
V(2):       14.6341     voltage
V(3):       32.1951     voltage
V(4):       112.195     voltage
I(Is):      1           device_current
I(R6):      0.804878    device_current
I(R4):      1.46341     device_current
I(R3):      -1          device_current
I(R2):      -0.195122   device_current
I(R1):      1.26829     device_current
I(Vb):      -1.26829    device_current
```

<u>Comment:</u> the results are exactly the same.

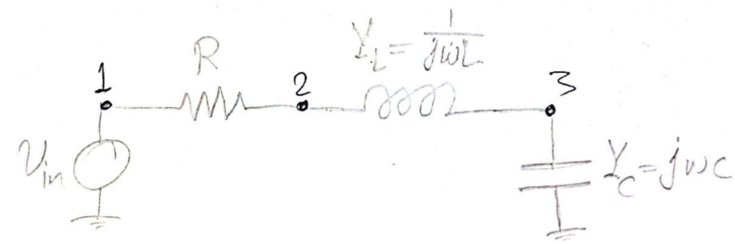
Matlab symbolic solution for circuit_1:

```
sum1 =

                                               Vb
       (R2*R3*(Vb + Is*R1))/(R1*R2 + R1*R3 + R2*R3)
 -(R2*Vb + R3*Vb - Is*R2*R3)/(R1*R2 + R1*R3 + R2*R3)
```

Matlab symbolic solution for circuit_2:

```
sum2 =

                                                                                                                                          Vb
                                                                                    (R4*(R2*Vb + R6*Vb + Is*R1*R6))/(R1*R2 + R1*R4 + R2*R4 + R1*R6 + R4*R6)
                                                                        (R6*(R4*Vb + Is*R1*R2 + Is*R1*R4 + Is*R2*R4))/(R1*R2 + R1*R4 + R2*R4 + R1*R6 + R4*R6)
 (R4*R6*Vb + Is*R1*R2*R3 + Is*R1*R3*R4 + Is*R1*R2*R6 + Is*R2*R3*R4 + Is*R1*R3*R6 + Is*R1*R4*R6 + Is*R2*R4*R6 + Is*R3*R4*R6)/(R1*R2 + R1*R4 + R2*R4 + R1*R6 + R4*R6)
                                                                                      -(R2*Vb + R4*Vb + R6*Vb - Is*R4*R6)/(R1*R2 + R1*R4 + R2*R4 + R1*R6 + R4*R6)
```

Part (2)



let $C = 10\,nF$, $L = 10\,\mu H$

$\therefore\ w_0 = \sqrt{\frac{1}{LC}} = 3.1623$ rad/s

$f_0 = 503292$ Hz

for critically-damped circuit,

$R = 2\sqrt{\frac{L}{C}} = 63.246$

for underdamped circuit,

$R = 10 < 2\sqrt{\frac{L}{C}}$

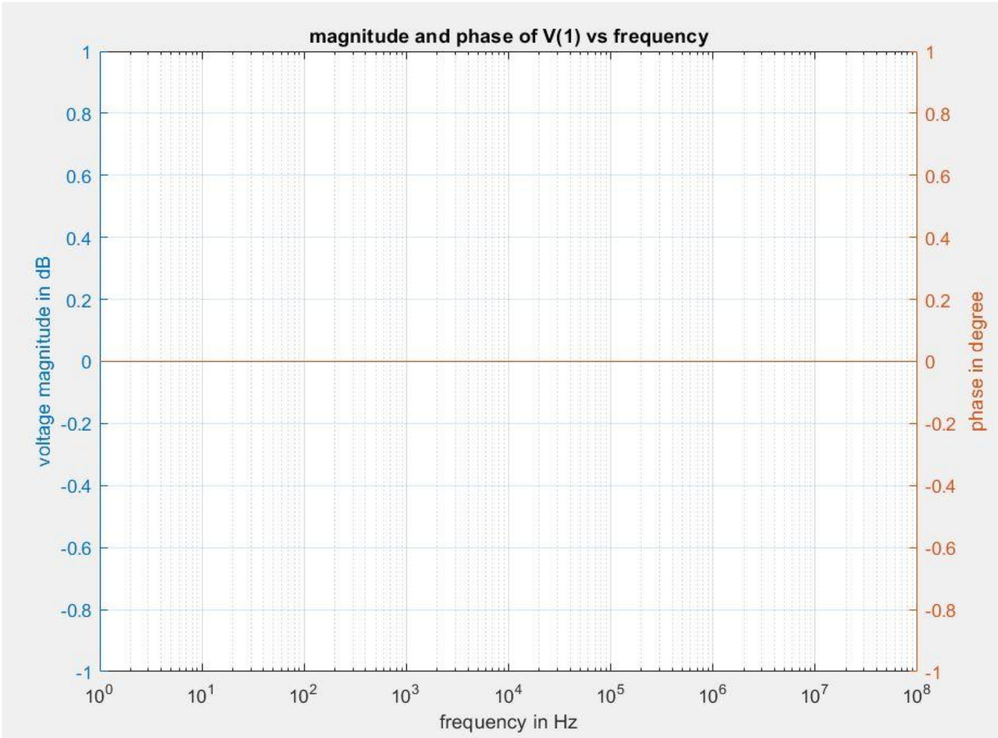
for overdamped circuit,

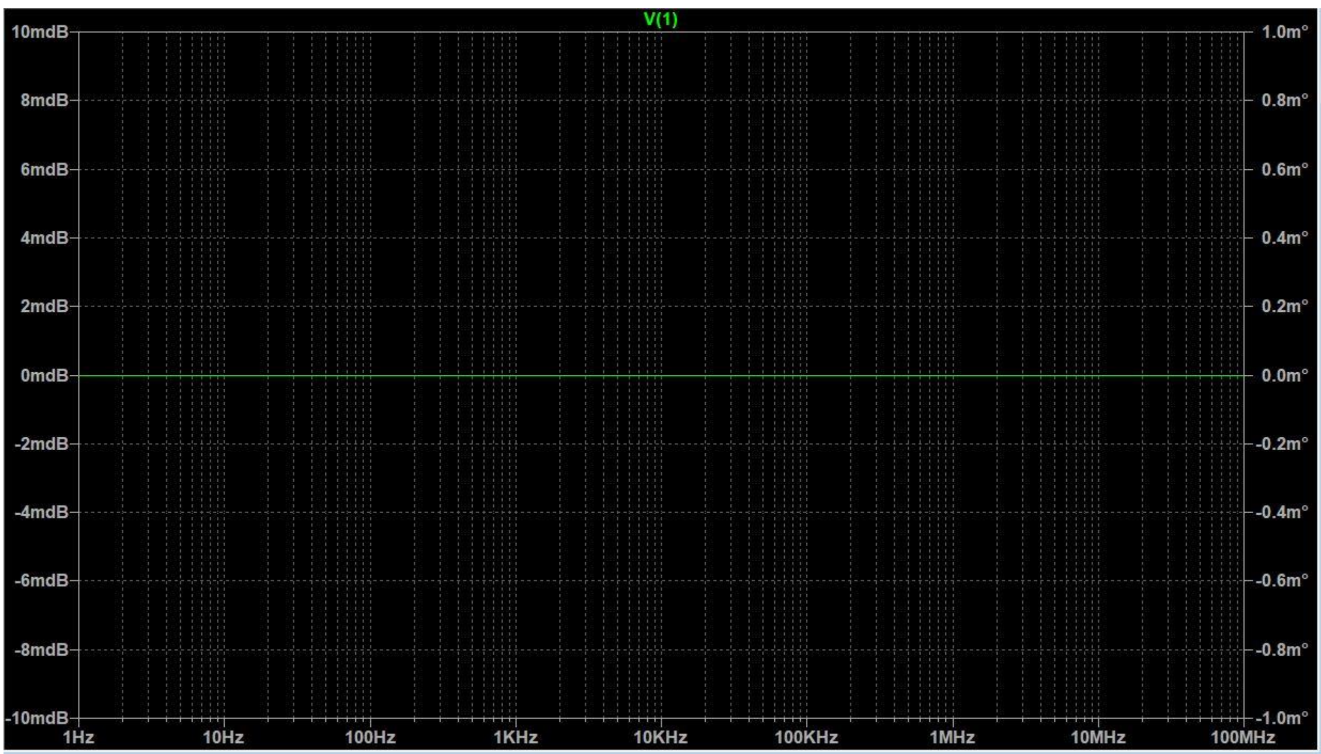
$R = 200 > 2\sqrt{\frac{L}{C}}$

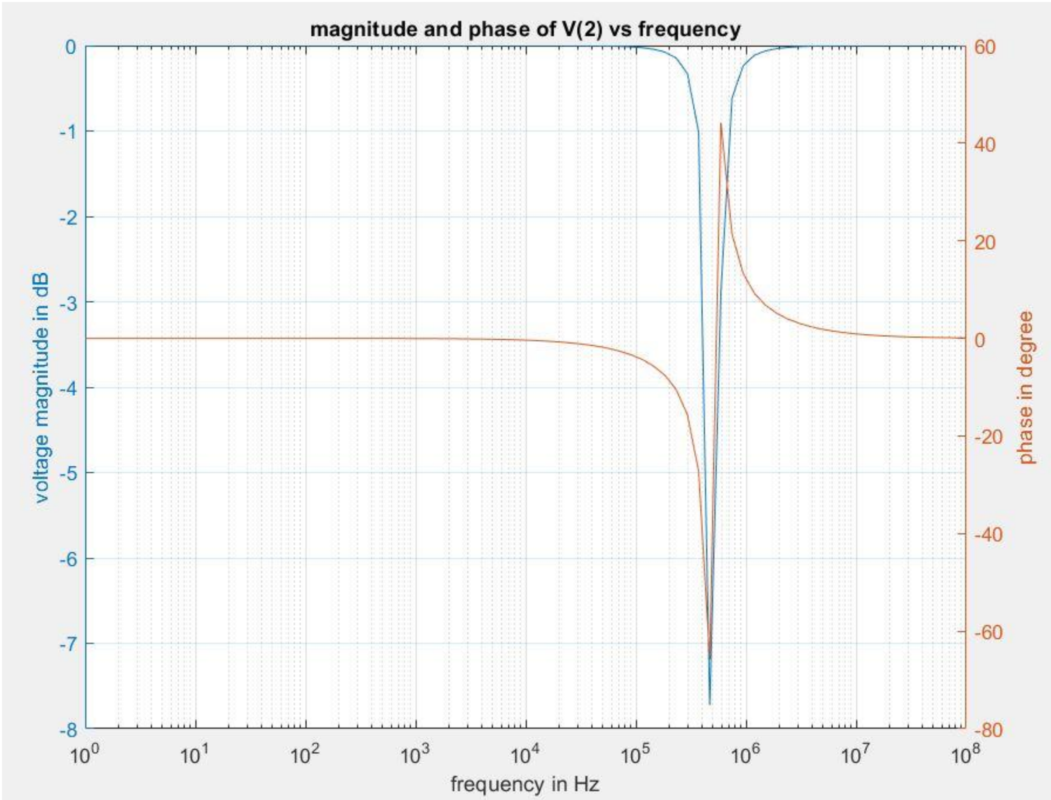
underdamped series RLC circuit

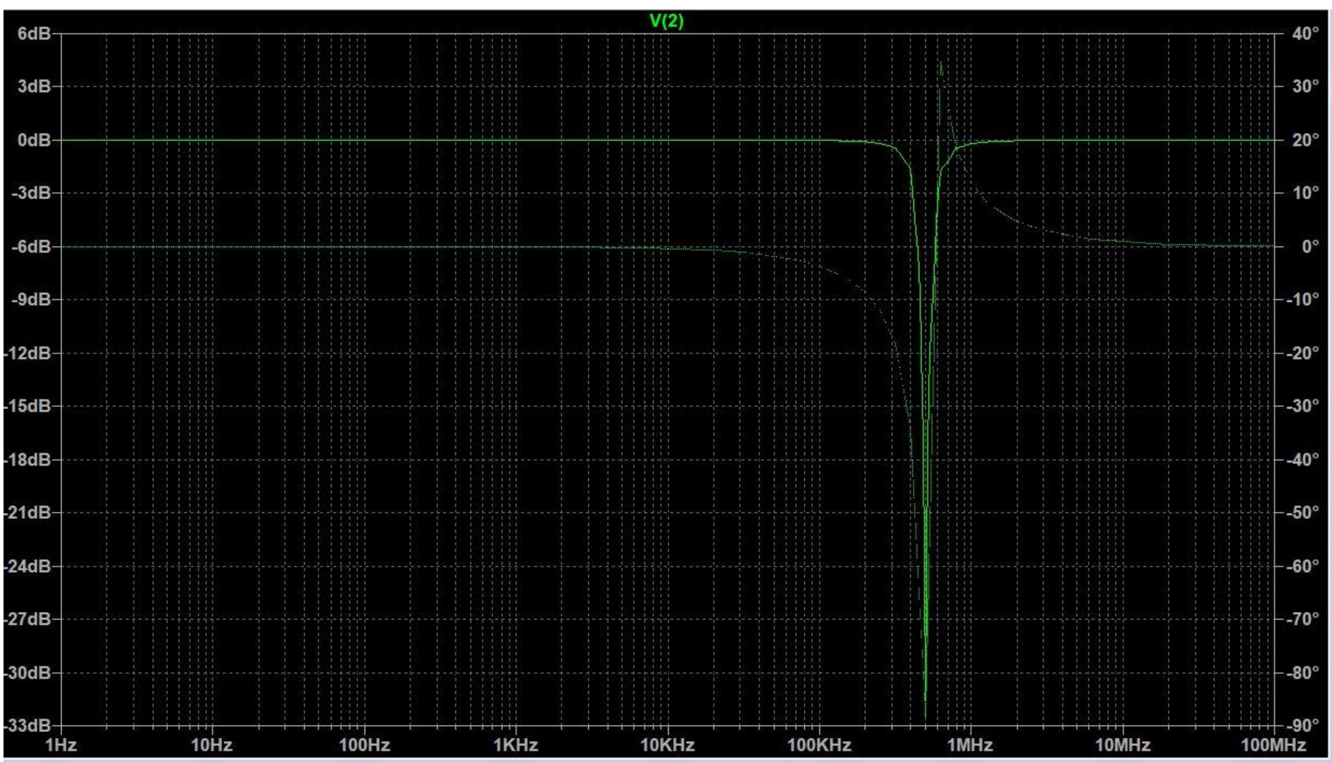
RLC_underDamped.cir

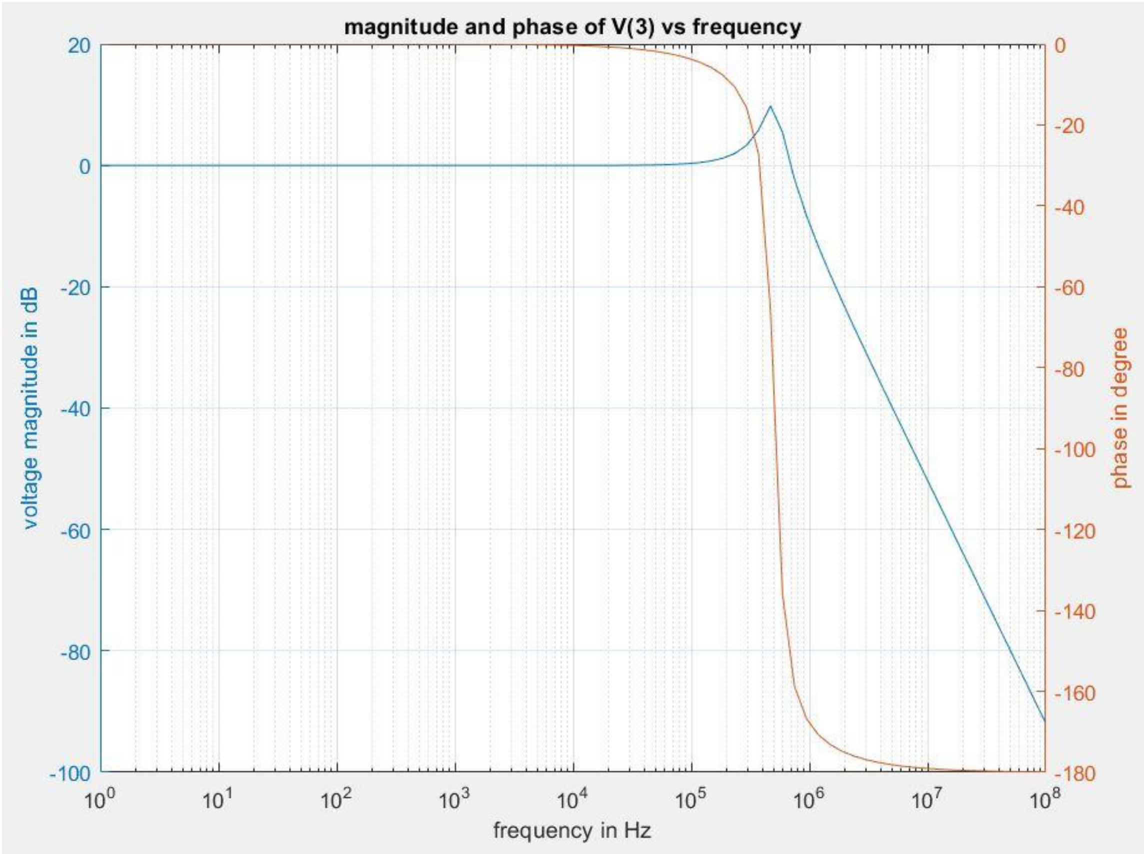
```
UnderDamped RLC Circuit

Vac 1 0 AC 1
R1 1 2 10
L1 2 3 10u
C1 3 0 10n
.AC DEC 10 1 100meg
.END
```

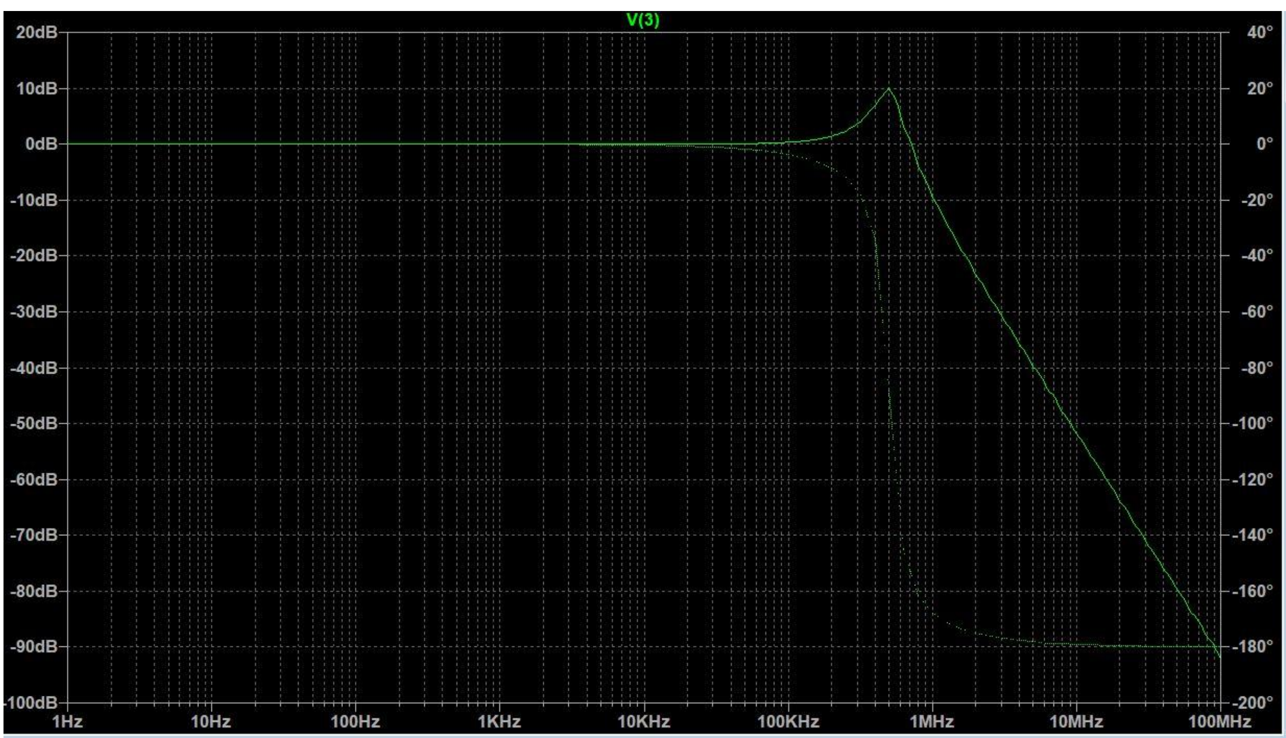

magnitude and phase of V(1) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(1)
10mdB
8mdB
6mdB
4mdB
2mdB
0mdB
-2mdB
-4mdB
-6mdB
-8mdB
-10mdB
1.0m°
0.8m°
0.6m°
0.4m°
0.2m°
0.0m°
-0.2m°
-0.4m°
-0.6m°
-0.8m°
-1.0m°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz


magnitude and phase of V(2) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-1
-2
-3
-4
-5
-6
-7
-8
60
40
20
0
-20
-40
-60
-80
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(2)
6dB
3dB
0dB
-3dB
-6dB
-9dB
-12dB
-15dB
-18dB
-21dB
-24dB
-27dB
-30dB
-33dB
40°
30°
20°
10°
0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

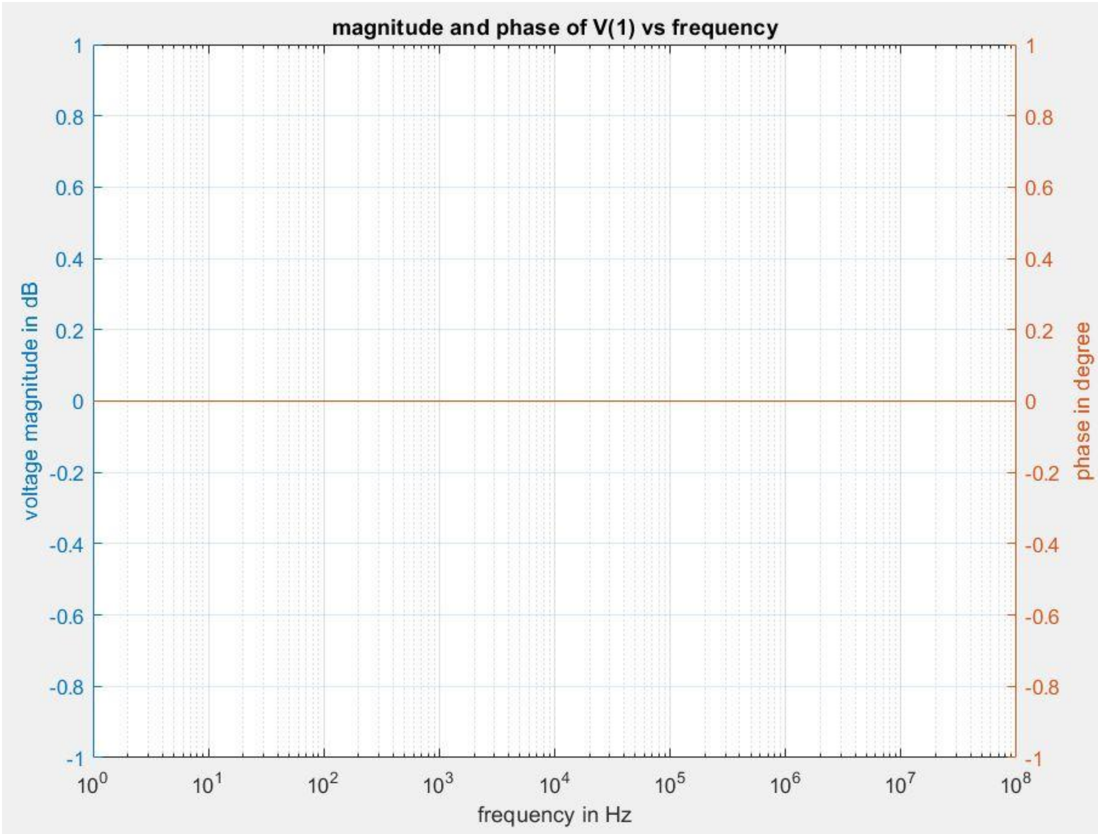

magnitude and phase of V(3) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
20
0
-20
-40
-60
-80
-100
-20
-40
-60
-80
-100
-120
-140
-160
-180
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8

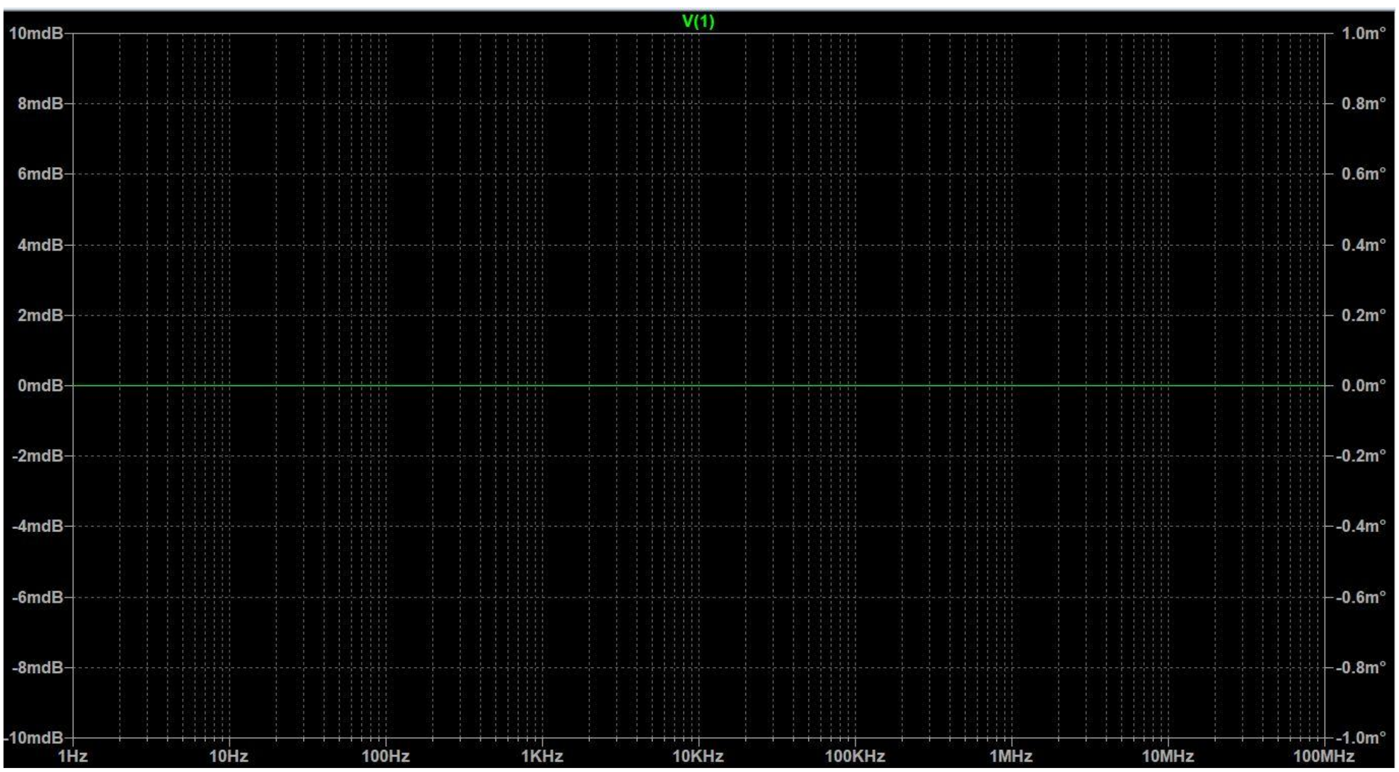

V(3)
20dB
10dB
0dB
-10dB
-20dB
-30dB
-40dB
-50dB
-60dB
-70dB
-80dB
-90dB
-100dB
40°
20°
0°
-20°
-40°
-60°
-80°
-100°
-120°
-140°
-160°
-180°
-200°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

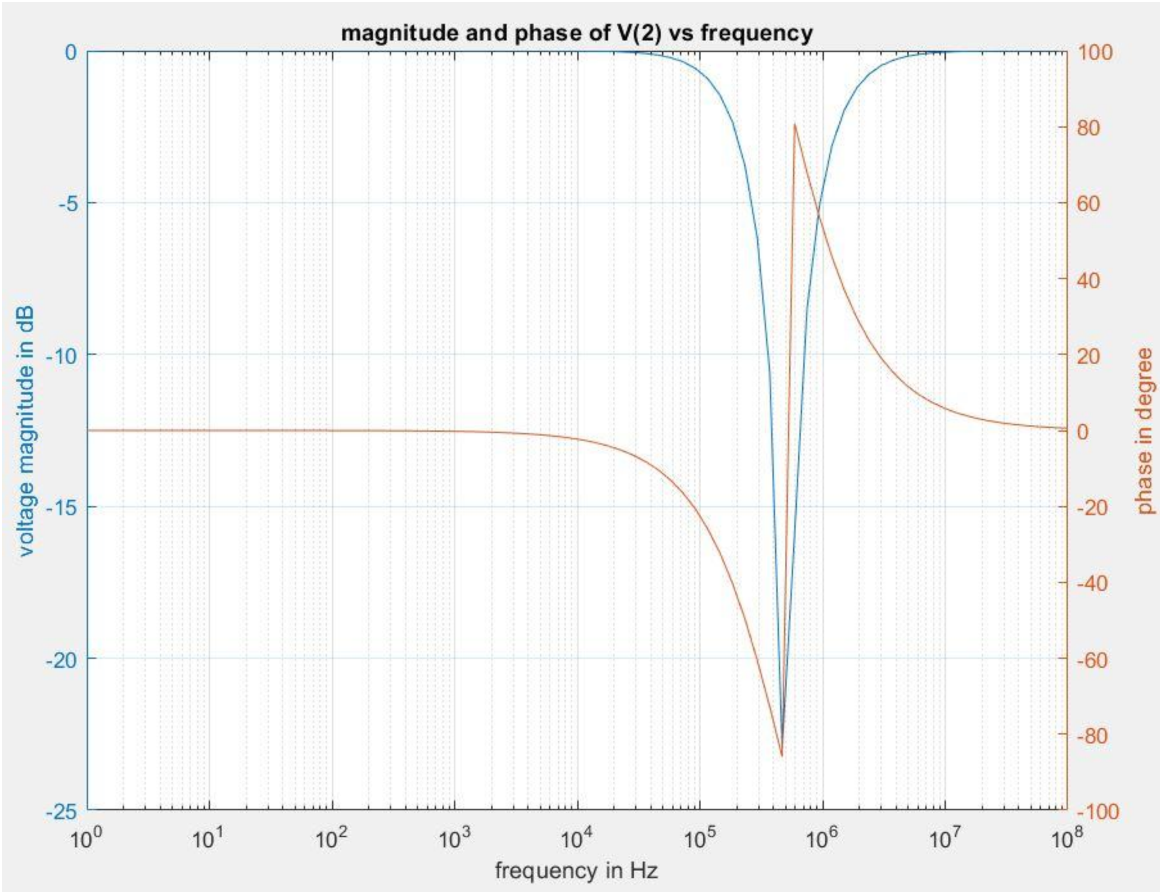
Critically-damped series RLC circuit

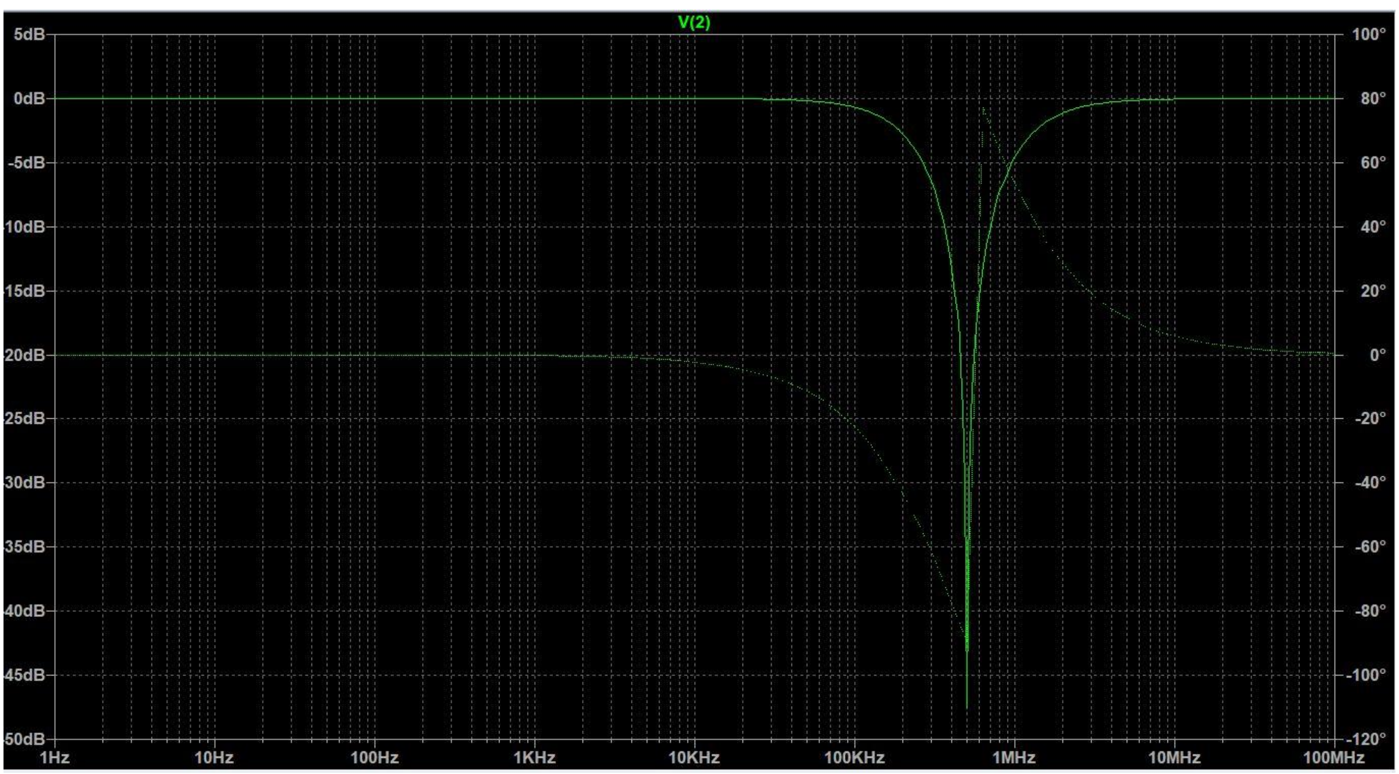
RLC_criticalDamped.cir

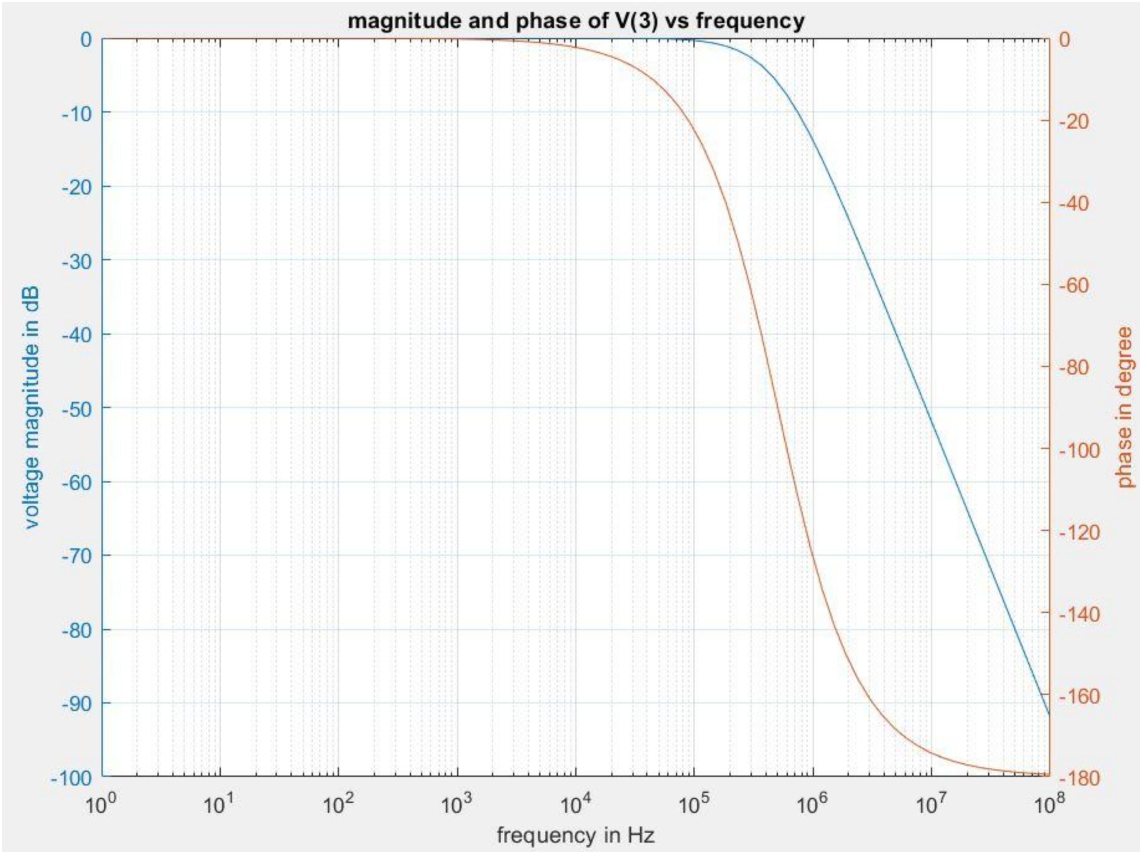
```
Critically-Damped RLC Circuit

Vac 1 0 AC 1
R1 1 2 63.246
L1 2 3 10u
C1 3 0 10n
.AC DEC 10 1 100meg
.END
```

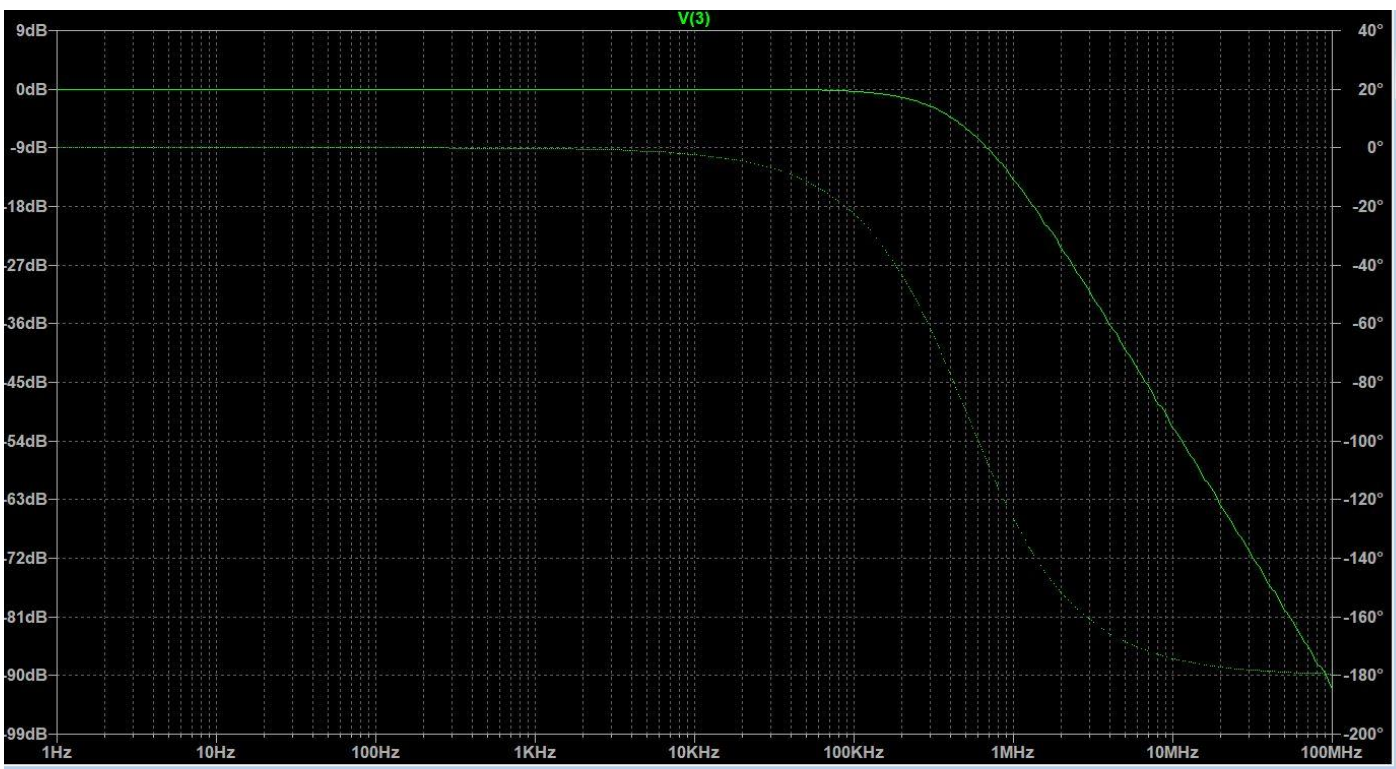

magnitude and phase of V(1) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(1)
10mdB
8mdB
6mdB
4mdB
2mdB
0mdB
-2mdB
-4mdB
-6mdB
-8mdB
-10mdB
1.0m°
0.8m°
0.6m°
0.4m°
0.2m°
0.0m°
-0.2m°
-0.4m°
-0.6m°
-0.8m°
-1.0m°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz


magnitude and phase of V(2) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-5
-10
-15
-20
-25
100
80
60
40
20
0
-20
-40
-60
-80
-100
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(2)
5dB
0dB
-5dB
10dB
15dB
20dB
25dB
30dB
35dB
40dB
45dB
50dB
100°
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
-100°
-120°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

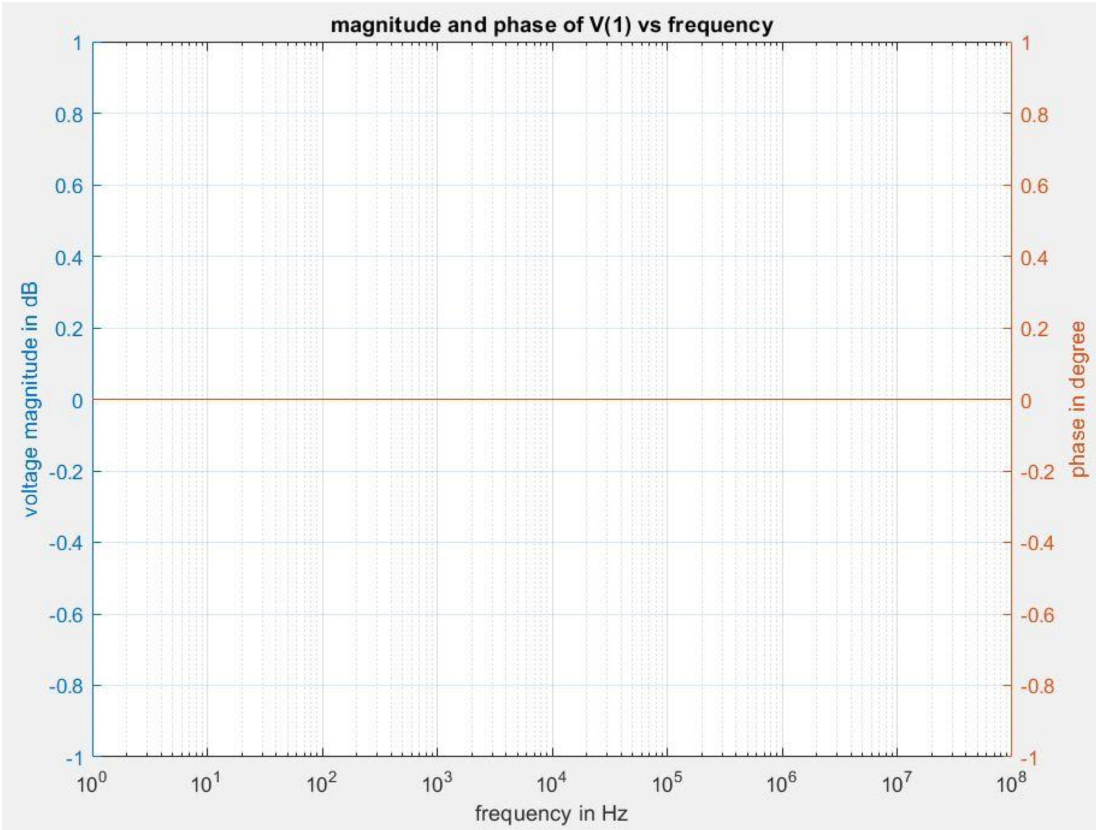

magnitude and phase of V(3) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8

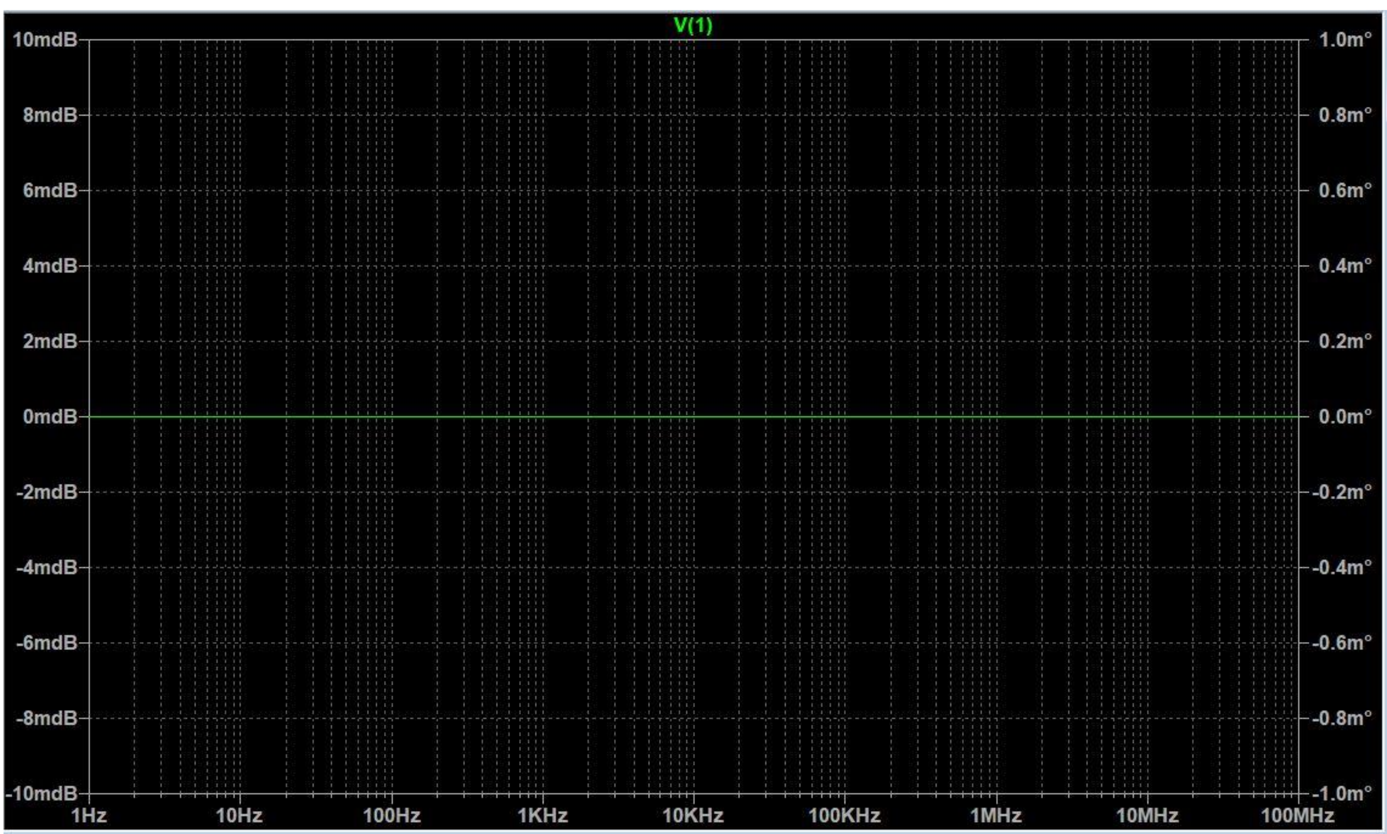

V(3)
9dB
0dB
-9dB
-18dB
-27dB
-36dB
-45dB
-54dB
-63dB
-72dB
-81dB
-90dB
-99dB
40°
20°
0°
-20°
-40°
-60°
-80°
-100°
-120°
-140°
-160°
-180°
-200°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

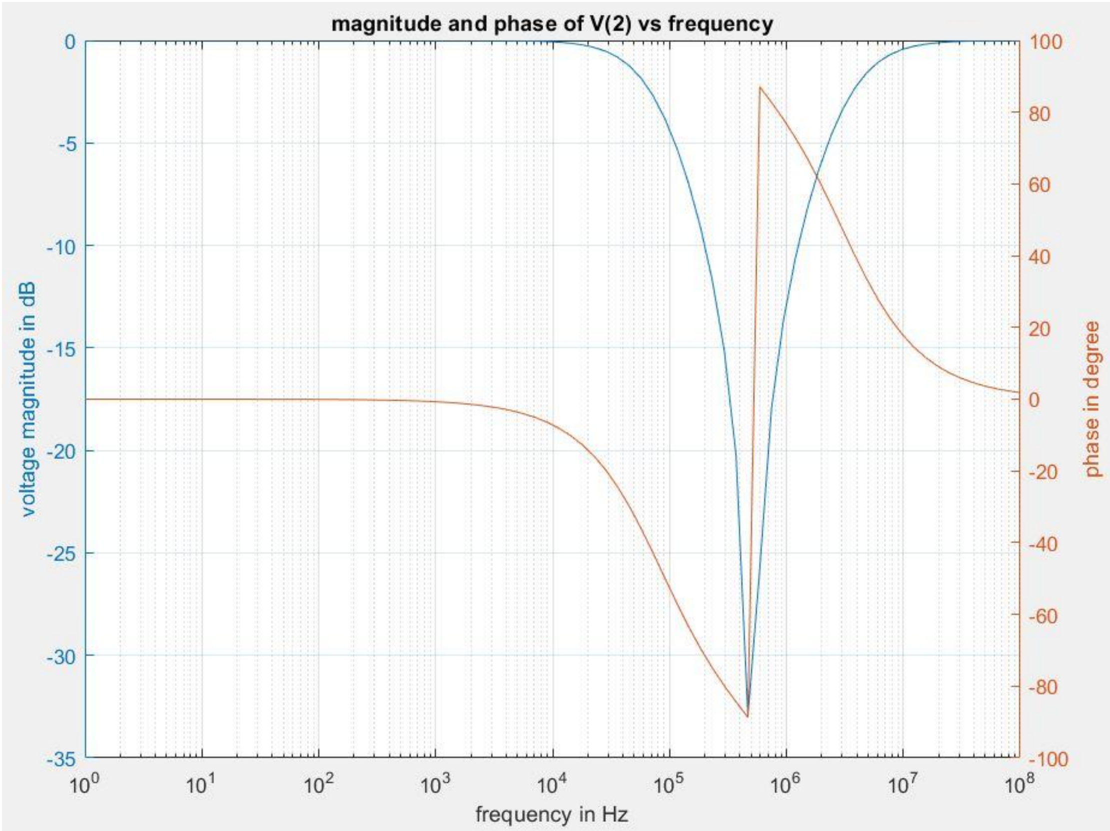
Overdamped series RLC circuit

RLC_overdamped.cir

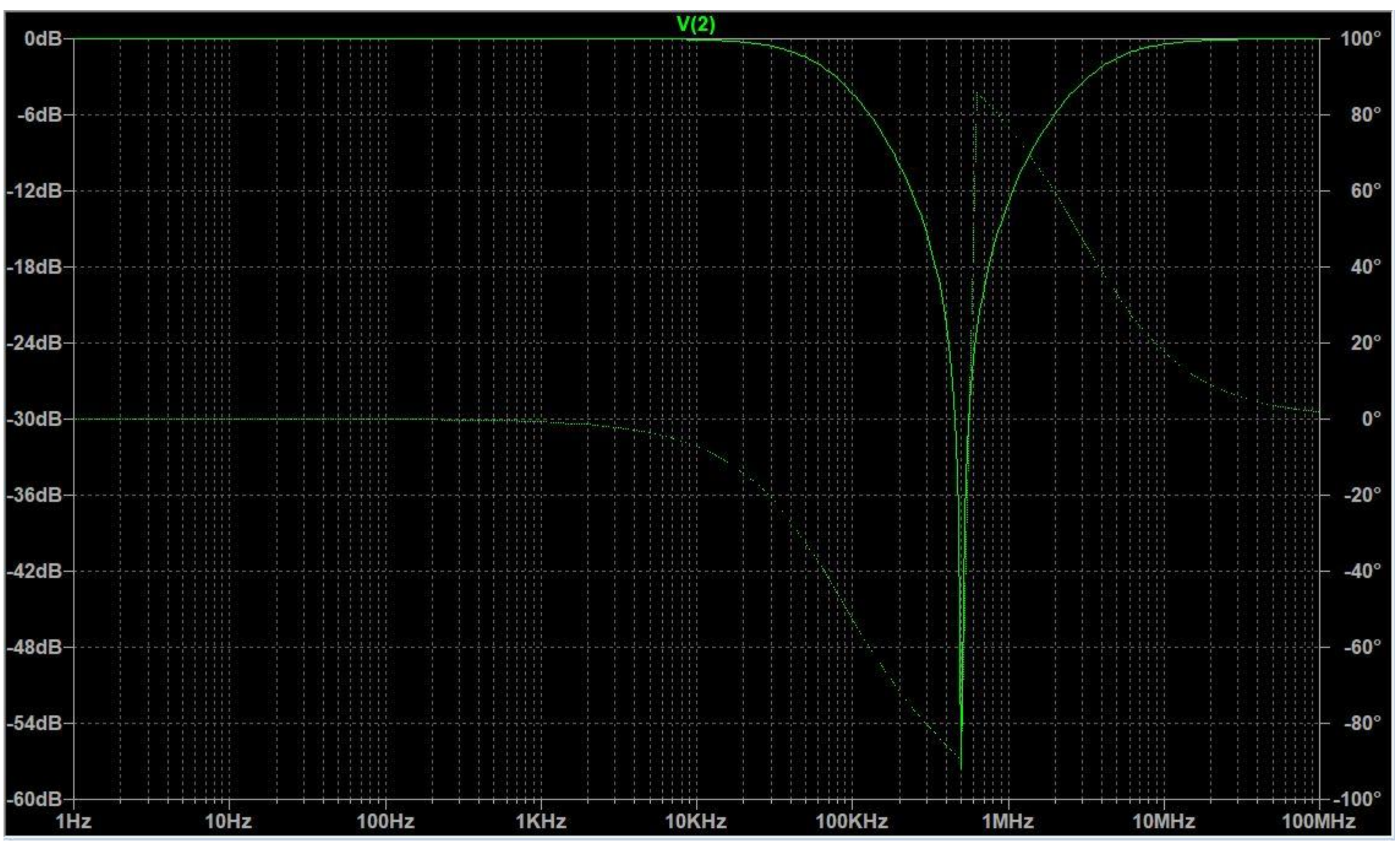
```
OverDamped RLC Circuit

Vac 1 0 AC 1
R1 1 2 200
L1 2 3 10u
C1 3 0 10n
.AC DEC 10 1 100meg
.END
```


magnitude and phase of V(1) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8

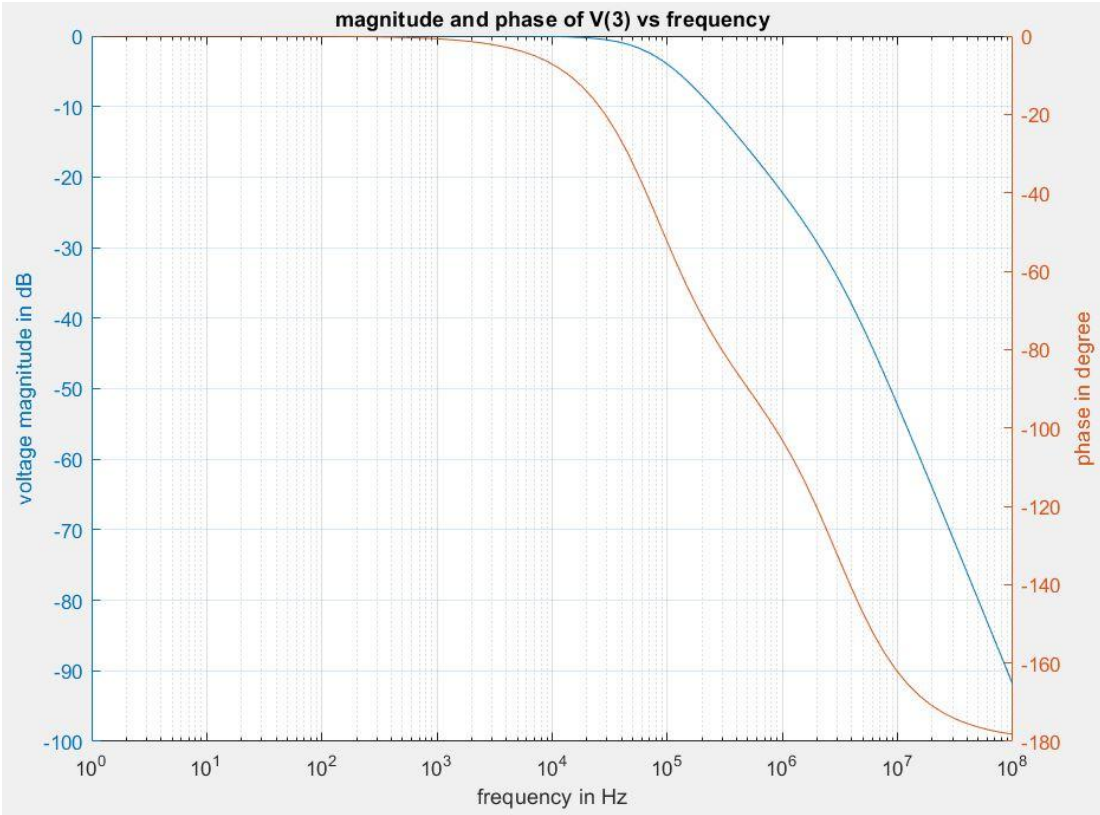

V(1)
10mdB
8mdB
6mdB
4mdB
2mdB
0mdB
-2mdB
-4mdB
-6mdB
-8mdB
-10mdB
1.0m°
0.8m°
0.6m°
0.4m°
0.2m°
0.0m°
-0.2m°
-0.4m°
-0.6m°
-0.8m°
-1.0m°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

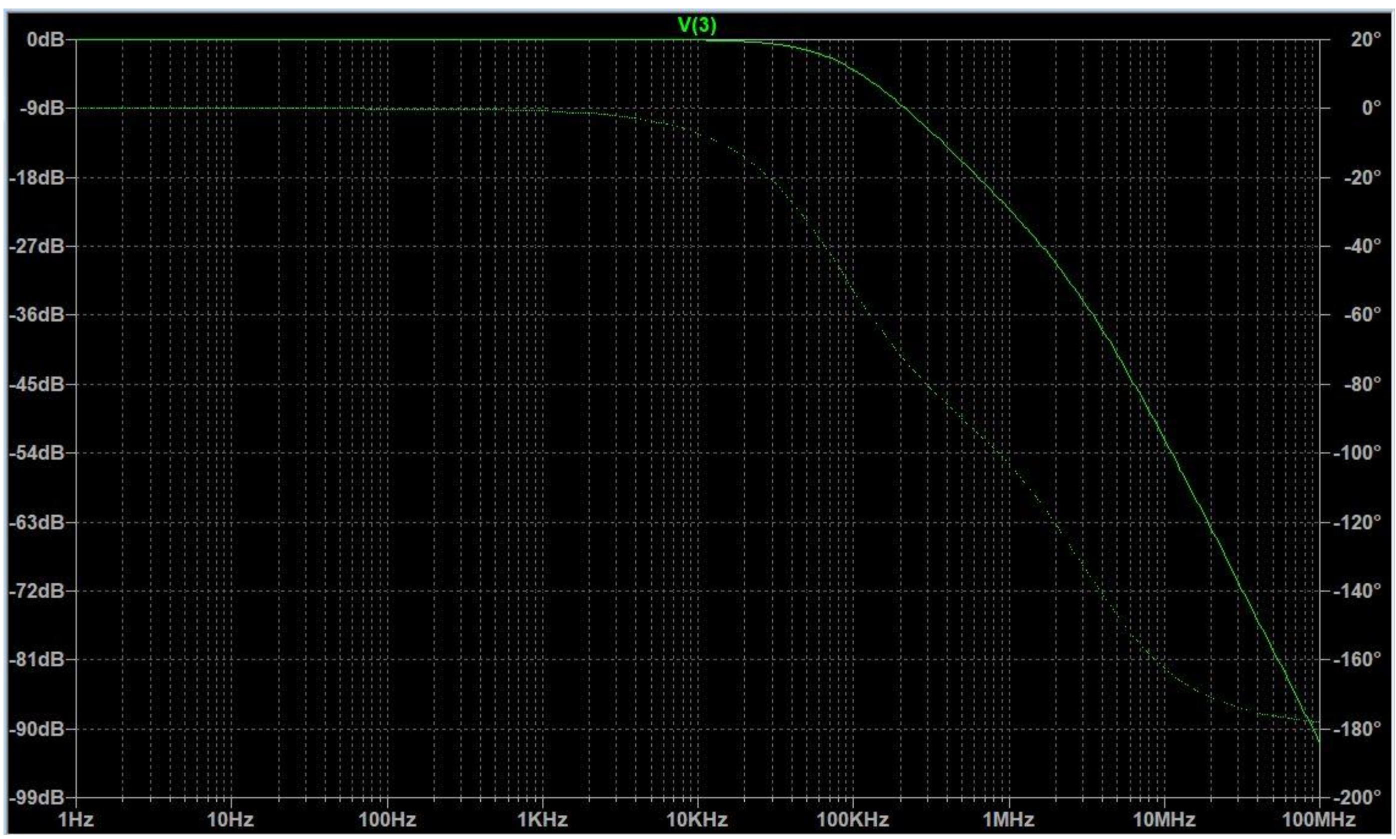


magnitude and phase of V(2) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz



V(2)

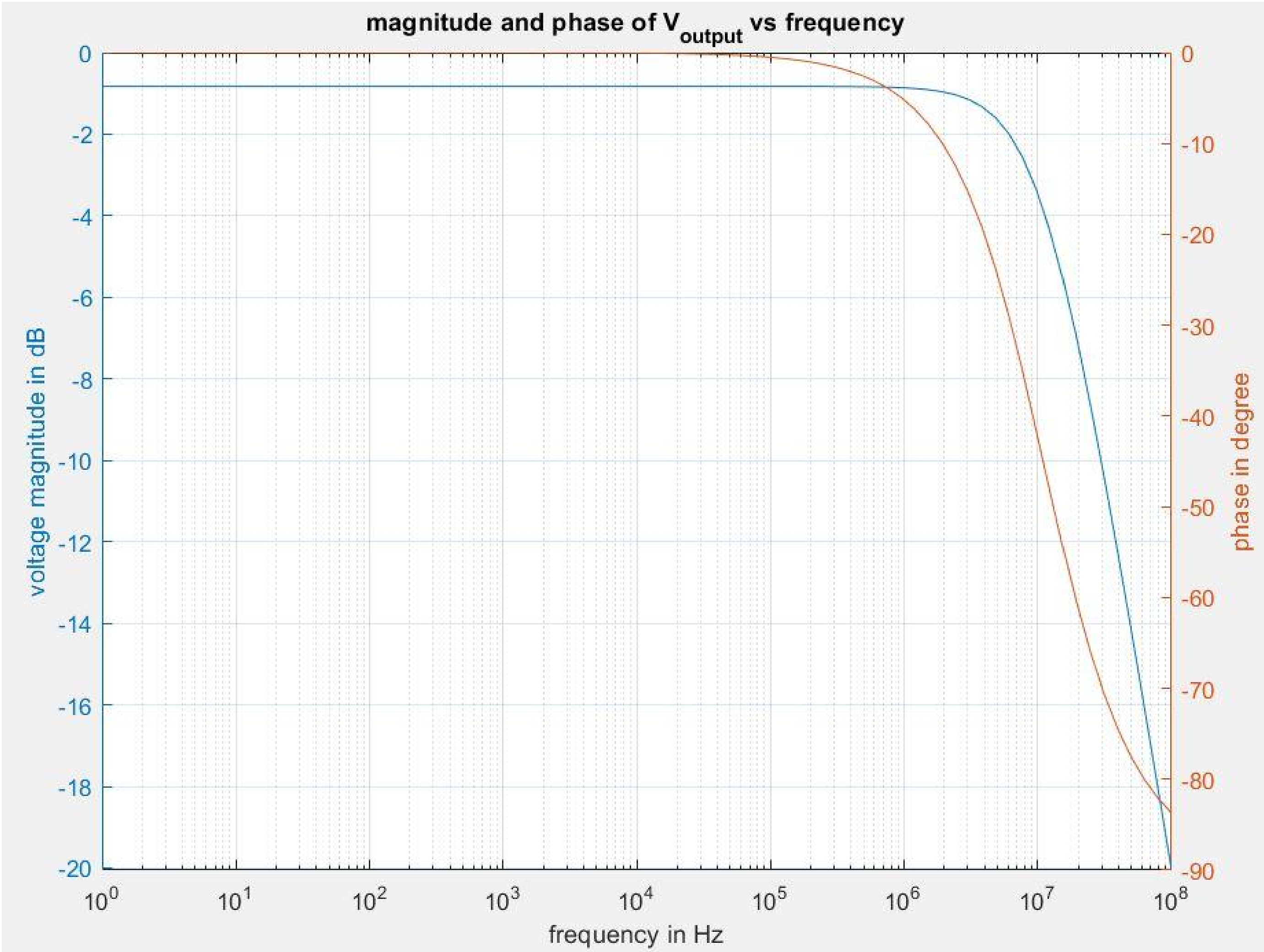

magnitude and phase of V(3) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-20
-40
-60
-80
-100
-120
-140
-160
-180
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8

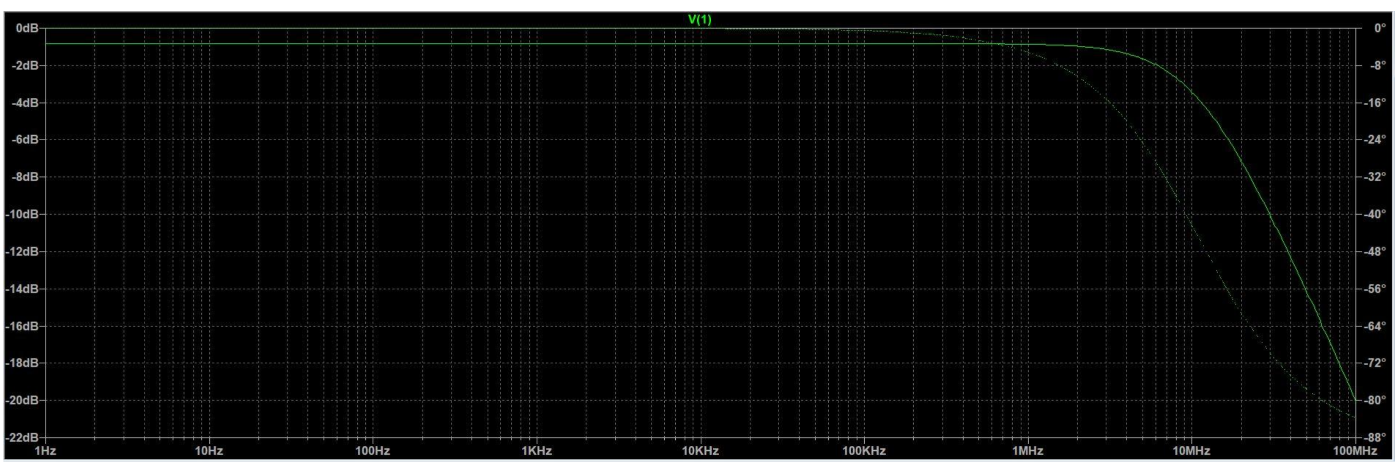

V(3)
0dB
-9dB
-18dB
-27dB
-36dB
-45dB
-54dB
-63dB
-72dB
-81dB
-90dB
-99dB
20°
0°
-20°
-40°
-60°
-80°
-100°
-120°
-140°
-160°
-180°
-200°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

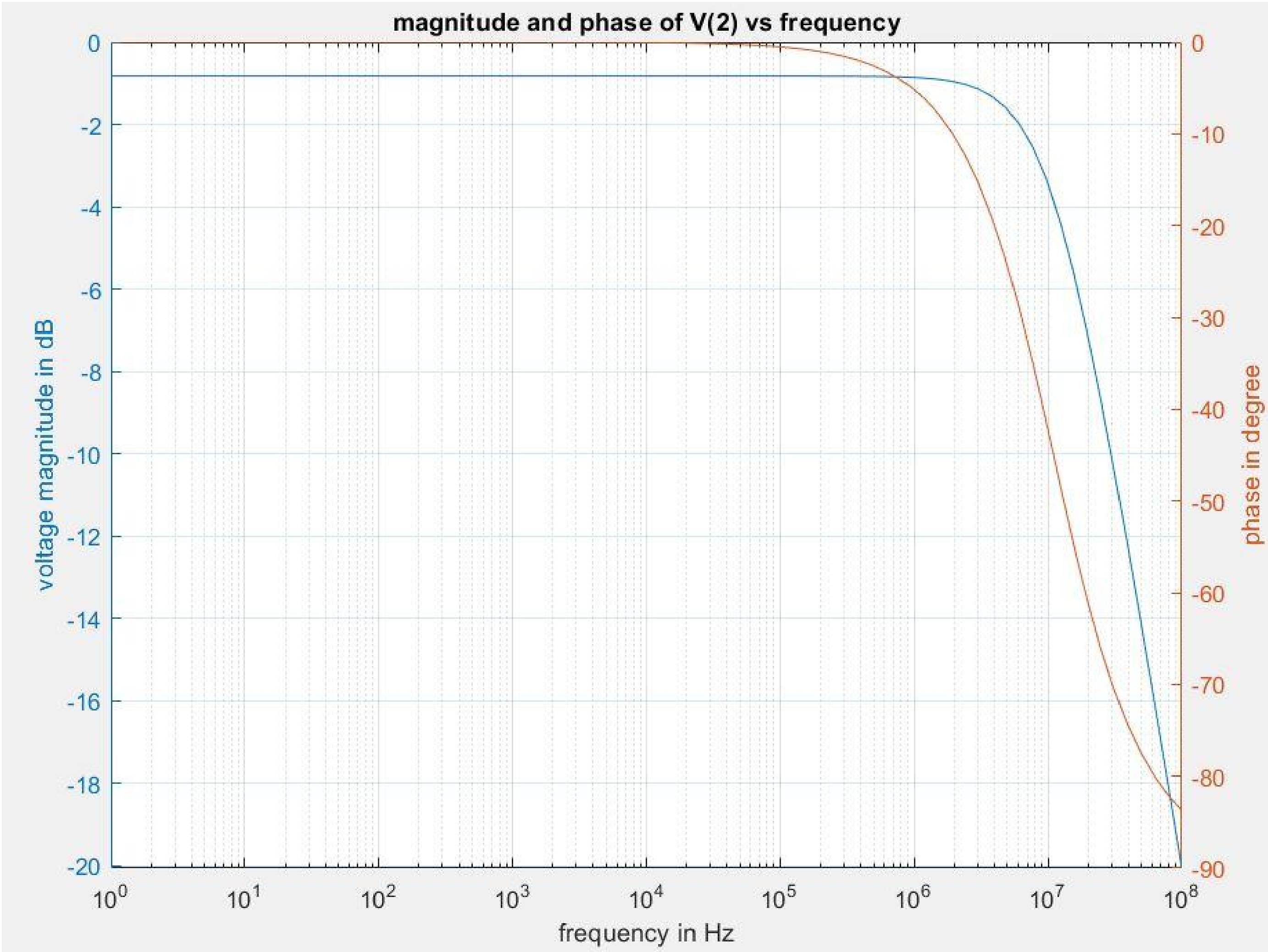
Part (3)

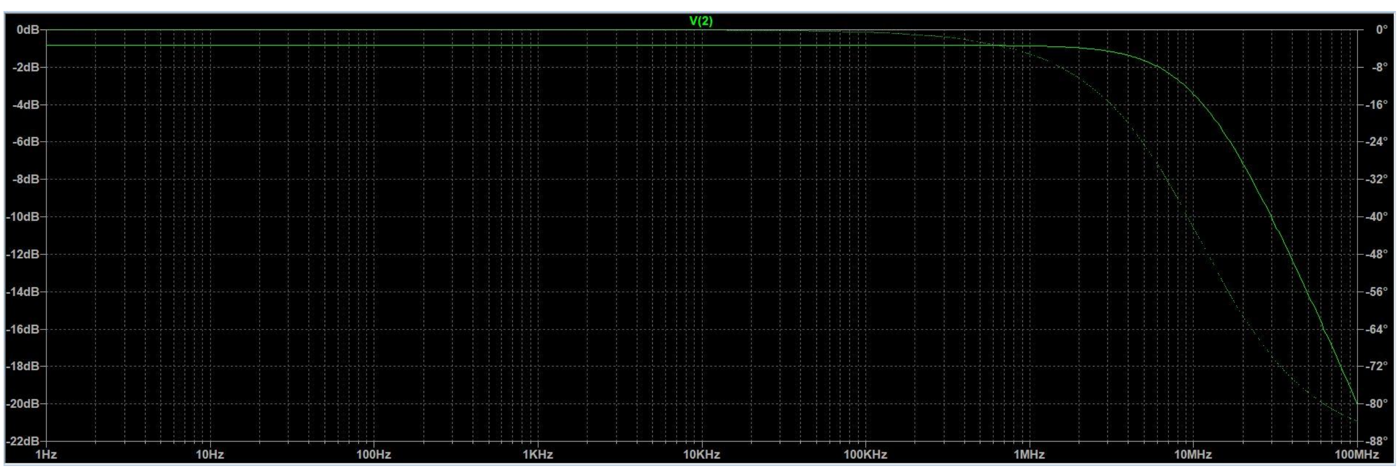
non_inverting_amplifier_with_ac_analysis.cir

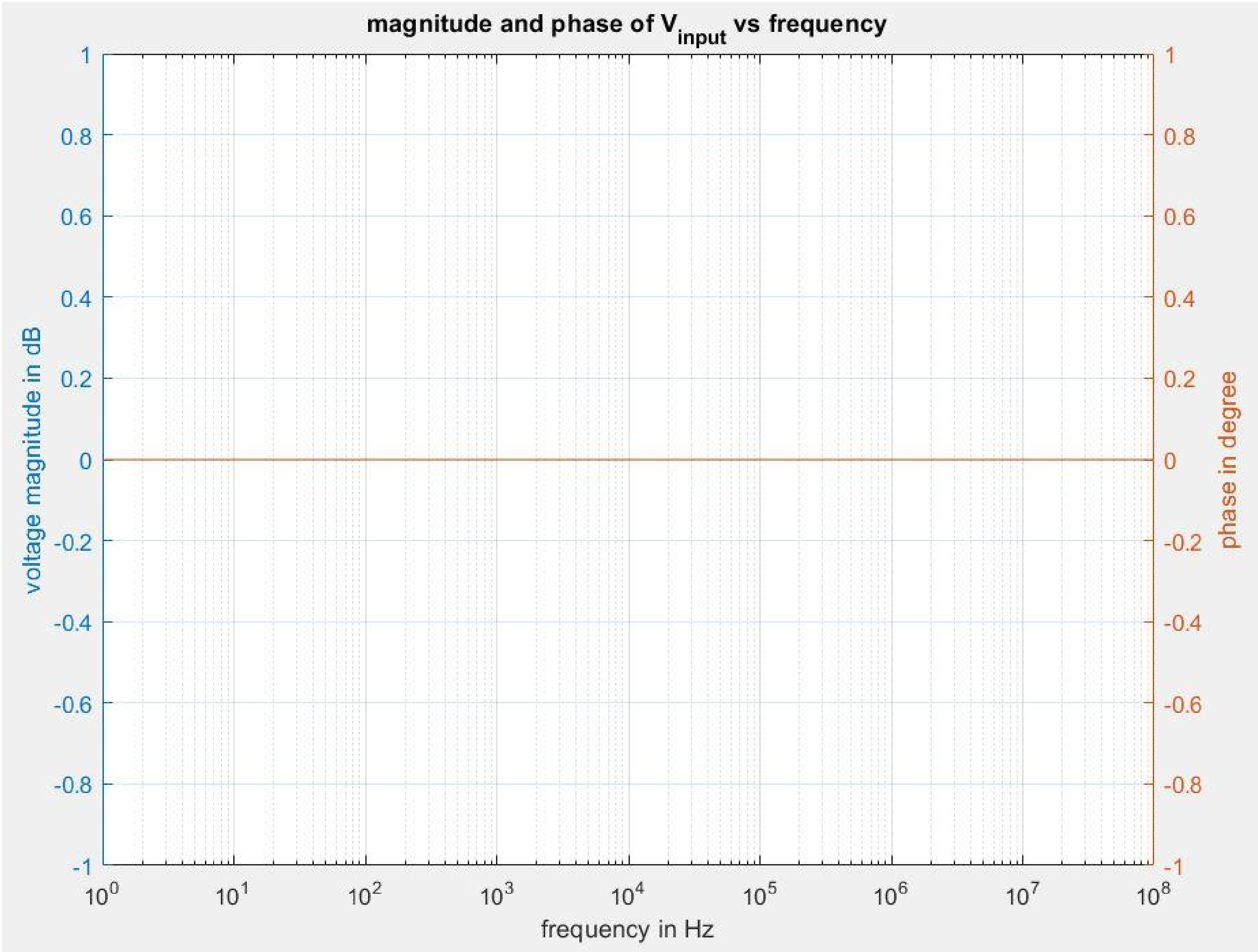
```
Non-inverting Amplifier

Vac 3 0 AC 1
Rf 2 1 1

Ginput 0 4 3 2 10
R1 4 0 1
C1 4 0 159.155n
Eoutput 1 0 4 0 1

.AC DEC 10 1 100meg

.END
```

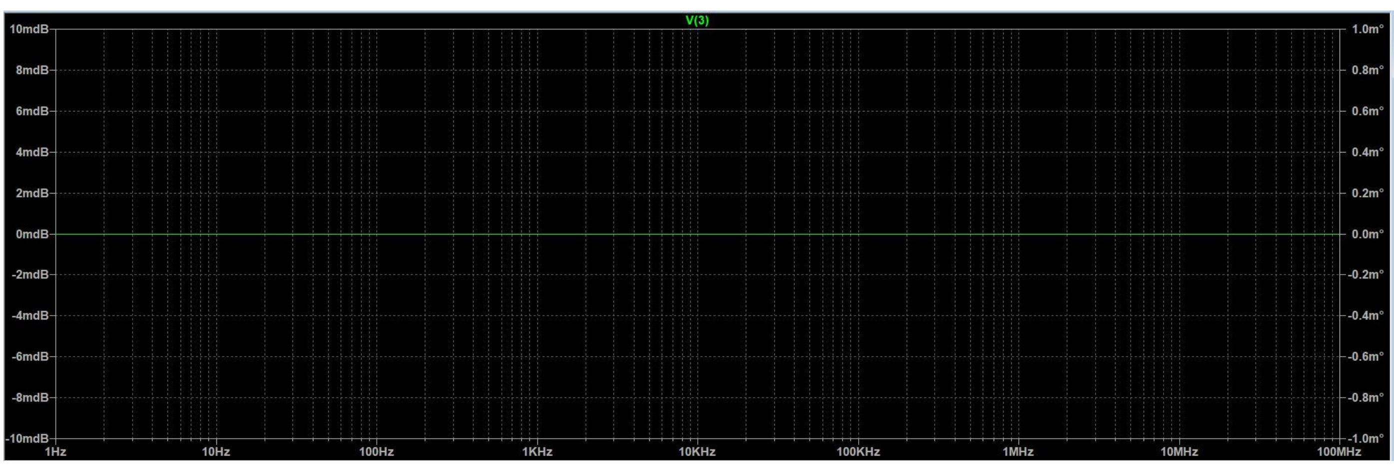

magnitude and phase of V_{output} vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(1)
0dB
-2dB
-4dB
-6dB
-8dB
-10dB
-12dB
-14dB
-16dB
-18dB
-20dB
-22dB
0°
-8°
-16°
-24°
-32°
-40°
-48°
-56°
-64°
-72°
-80°
-88°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz


magnitude and phase of V(2) vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(2)
0dB
-2dB
-4dB
-6dB
-8dB
-10dB
-12dB
-14dB
-16dB
-18dB
-20dB
-22dB
0°
-8°
-16°
-24°
-32°
-40°
-48°
-56°
-64°
-72°
-80°
-88°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz


magnitude and phase of V_{input} vs frequency
voltage magnitude in dB
phase in degree
frequency in Hz
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


V(3)
10mdB
8mdB
6mdB
4mdB
2mdB
0mdB
-2mdB
-4mdB
-6mdB
-8mdB
-10mdB
1.0m°
0.8m°
0.6m°
0.4m°
0.2m°
0.0m°
-0.2m°
-0.4m°
-0.6m°
-0.8m°
-1.0m°
1Hz
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz