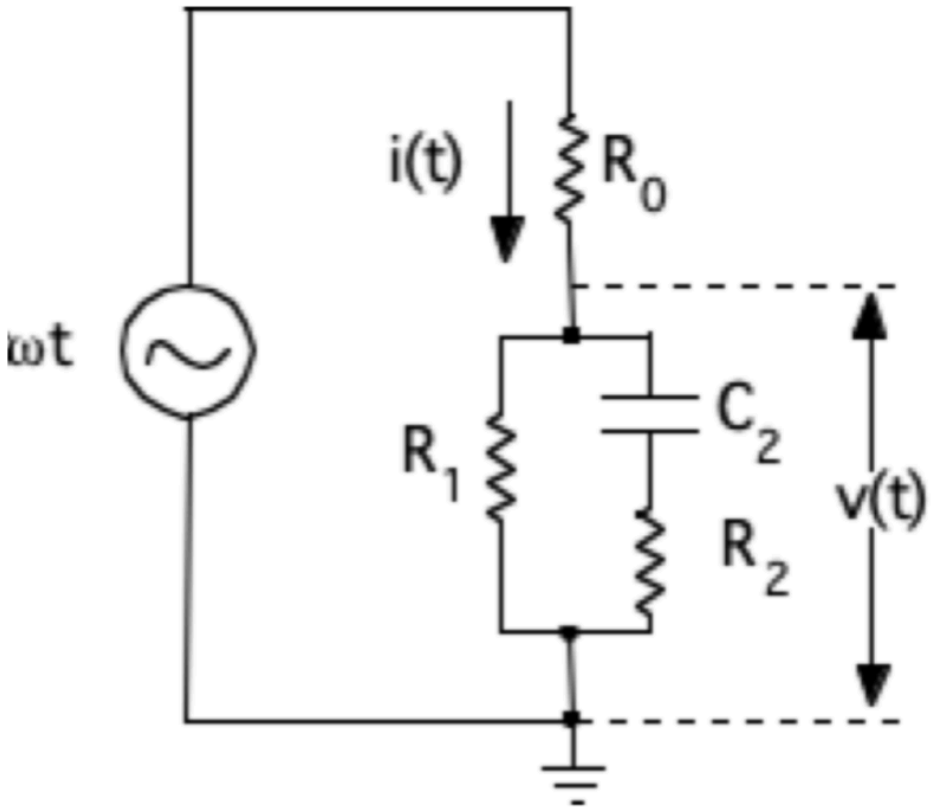
Instrument Calculations

Note: This is just to have something to turn in. There are some very obvious problems with our approach that we are still trying to iron out.



$R1 = 200\Omega$

$R2 = 20\Omega$

$C2 = 0.22 \times 10^{-6} F$

$$Z = \frac{\left[1+\left(\frac{\omega}{\omega_c}\frac{1}{1+\frac{R_1}{R_2}}\right)^2\right]R_1 - j\left[\frac{\omega}{\omega_c}\frac{\frac{R_1}{R_2}}{1+\frac{R_1}{R_2}}\right]R_1}{1+\left(\frac{\omega}{\omega_c}\right)^2}$$

$$|Z| = \sqrt{\frac{\left(\left[1+\left(\frac{\omega}{\omega_c}\frac{1}{1+\frac{R_1}{R_2}}\right)^2\right]R_1\right)^2 + \left(\left[\frac{\omega}{\omega_c}\frac{\frac{R_1}{R_2}}{1+\frac{R_1}{R_2}}\right]R_1\right)^2}{\left(1+\left(\frac{\omega}{\omega_c}\right)^2\right)^2}}$$

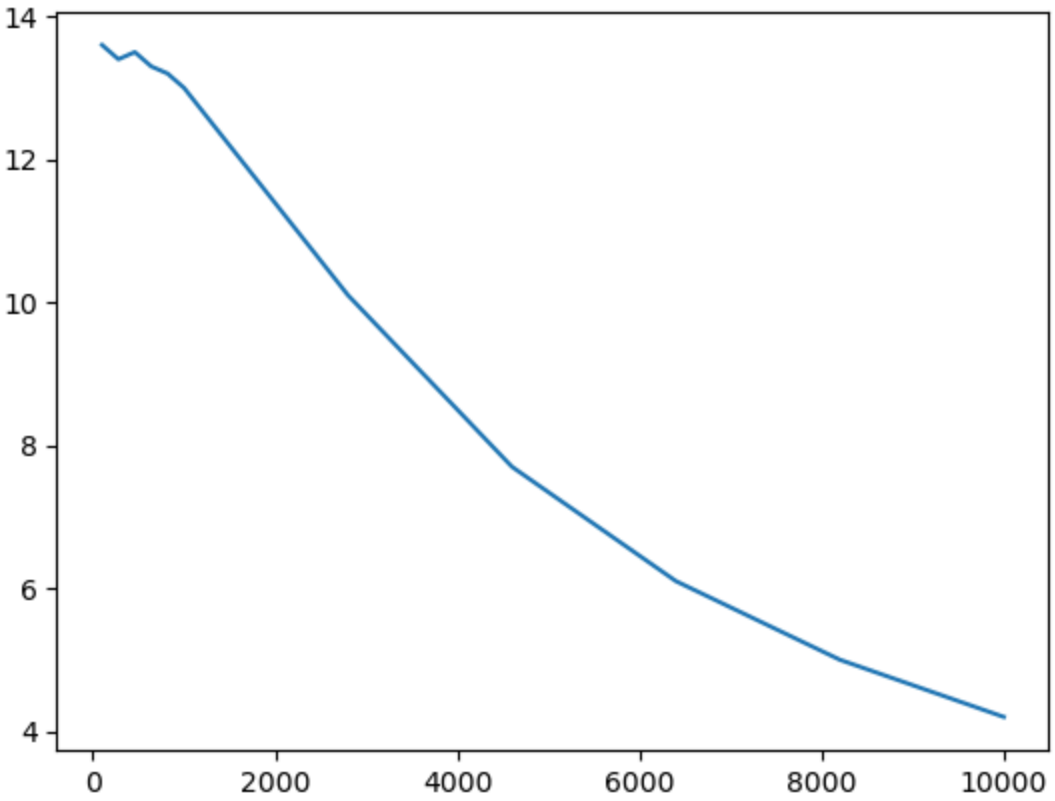
$$\omega_c \equiv \frac{1}{(R_1 + R_2)C_2}$$

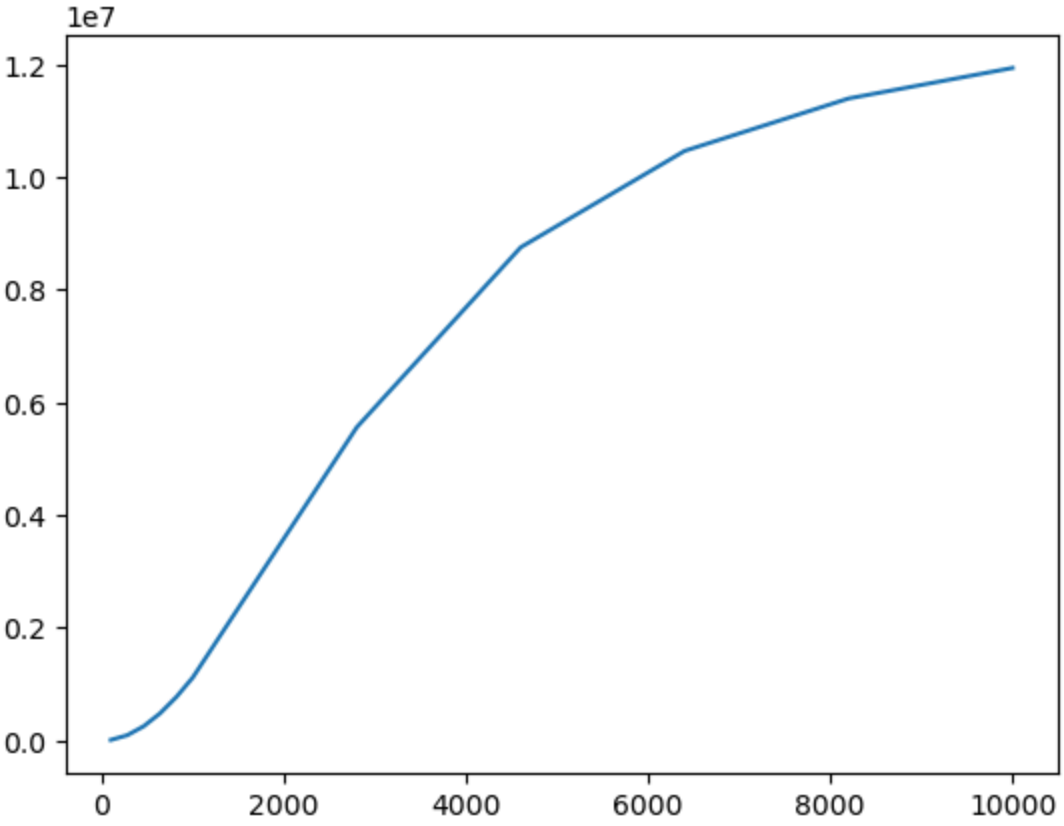
In [71]:

```
import numpy as np
import math
import matplotlib.pyplot as plt

n=10
#t = 0.00005

freq = np.array([100, 280, 460, 640, 820, 1000, 2800, 4600, 6400, 8200, 10
omega = 2*np.pi*freq

# collected voltages in mV
V = np.array([13.6, 13.4, 13.5, 13.3, 13.2, 13.0, 10.1, 7.7, 6.1, 5.0, 4.2

R1 = 200 # Ohms +/- 5%
R2 = 20 # Ohms +/- 5%
C2 = 0.22e-6 # F +/- 10%

omega_c = 1/((R1 + R2)*C2)


Z = np.sqrt(( (R1 + ((omega*R2*R1**2)/(omega_c*R2+omega_c*R1))**2)**2 +  (

phi = np.arctan(-omega_c/omega)

phi_D = phi*180/np.pi

# divide by V/1000 to convert from mV to V
i = V/(1000*Z)

print(f'Voltages: {V}')
print()
print(f'Impedances given different frequencies: {np.round(Z, -1)}')
print()
print(f'Currents: {np.round(i, 7)}')
print()
print(f'Phase angles (degrees): {np.round(phi_D, 2)}')
```

```
Voltages: [13.6 13.4 13.5 13.3 13.2 13.  10.1  7.7  6.1  5.   4.2]

Impedances given different frequencies: [   12420.    95380.   253990.
482800.   774320.  1119550.  5557880.
  8751230. 10461460. 11391300. 11932850.]

Currents: [1.1e-06 1.0e-07 1.0e-07 0.0e+00 0.0e+00 0.0e+00 0.0e+00 0.0e+
00 0.0e+00
 0.0e+00 0.0e+00]

Phase angles (degrees): [-88.26 -85.13 -82.04 -78.99 -76.   -73.09 -49.5
9 -35.56 -27.19 -21.85
 -18.2 ]
```

In [76]:
```
# preliminary plot for freq vs voltage

plt.plot(freq, V)
plt.show()

# freq vs impedance
plt.plot(freq, Z)
plt.show()
```





In [ ]: