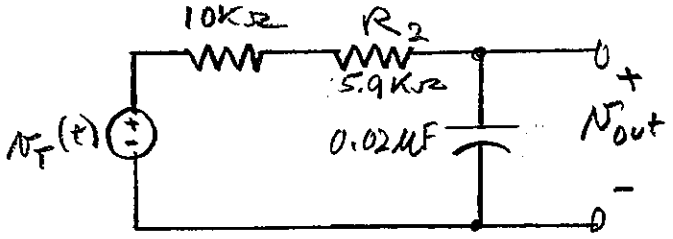
ECE 252 *Introduction* to Electrical Engineering Quiz 15P
100 Points **Show your work.** Practice Solution

1 (70) A sensor has a Thevenin equivalent circuit which is a voltage source $v_T(t)$ in series with a 10 kΩ resistor. It is to be connected to a low-pass filter so that the cutoff frequency of the entire circuit is 500 Hz. You have a 0.02 μF capacitor and an assortment of resistors. Sketch the circuit and label the components with their values. If $v_T(t)$ has a magnitude of 3 V at a frequency of 400 Hz, what is the magnitude and frequency of the output voltage of the circuit?



$\omega_c = 2\pi f_c = 2\pi(500) = 3142$ rad/s

$\omega_c = \frac{1}{RC} \rightarrow R = \frac{1}{\omega_c C}$

$R = \frac{1}{(3142)(.02\times10^{-6})} = 15.9\text{K}\Omega$

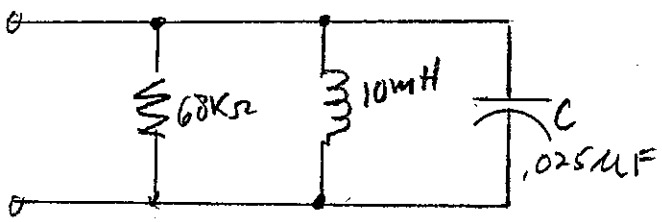
$R_2 = R - 10\text{K} = 5.9\text{K}\Omega$

$G = \frac{1}{\sqrt{1+(f/f_c)^2}} = \frac{1}{\sqrt{1+(400/500)^2}} = .781$

$G = \frac{V_{out}}{V_T} \rightarrow V_{out} = G V_T = .781(3) = 2.34\text{V}$ (magnitude of V_{out})

$f = 400\text{Hz}$ (the frequency at input is the same as the output)

2. (30) Design and sketch a parallel resonant circuit with a resonant frequency of 10 kHz and a maximum resistance of 68 kΩ. You have a 10 mH inductor and an assortment of capacitors and resistors.



$\omega_0 = 2\pi f_0 = 2\pi(10\text{K}) = 62{,}832$ rad/s

$\omega_0 = \sqrt{\frac{1}{LC}} \rightarrow \omega_0^2 = 1/LC$

$C = 1/\omega_0^2 L = \frac{1}{(62832)^2(.01)} = .025\mu\text{F}$

R will be 68KΩ because the maximum resistance occurs at resonance and the impedance at resonance is the parallel resistance.