Homework 4

This homework is due on Friday, September 23, 2022 at 11:59PM. Self-grades and HW Resubmissions are due the following Friday, September 30, 2022 at 11:59PM.

1. **Hambley P5.46**

   Find the phasors for the voltage and the currents of the circuit shown in Figure 1. Construct a phasor diagram showing I_s, V, I_R, and I_L. What is the phase relationship between V and I_s?

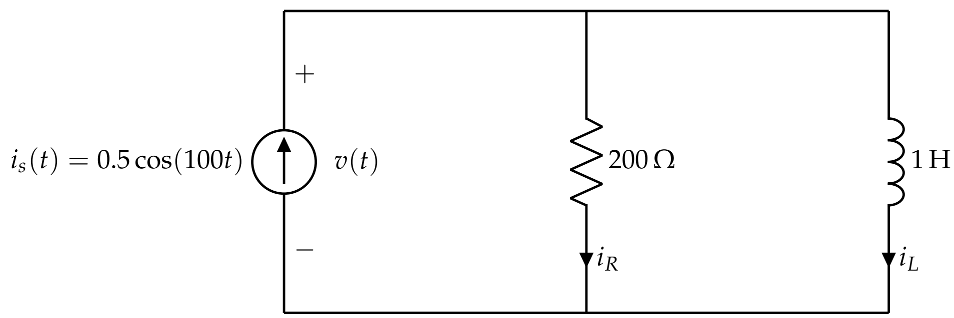

Figure 1: P5.46

2. Hambley P5.65

Consider a load that has an impedance given by $Z = 100 - j50\Omega$. The current flowing through the load is $I = 15\sqrt{2}\angle 30^\circ$A. Is the load inductive or capacitive? Determine the power factor, power, reactive power, and apparent power delivered to the load.

3. Hambley P5.83

(a) Find the Thevenin and Norton equivalent circuits for the circuit shown in Figure 2.

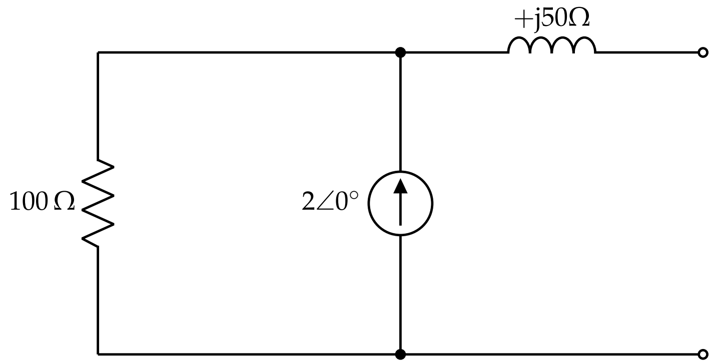

Figure 2: P5.83

(b) Find the maximum power that this cicuit can deliver to a load if the load can have any complex impedance.

(c) Repeat the previous part, but this time the load is purely resistive.

4. Hambley P6.27

The input signal of a first-order lowpass filter with the transfer function given by Equation 6.9 on page 288 of the text and a half-power frequency of 400 Hz is

$$v_{\text{in}}(t) = 1 + 2\cos(800\pi t + 30^\circ) + 3\cos\left(20 \times 10^3 \pi t\right) \tag{1}$$

Find an expression for the output voltage.

5. Hambley P6.30

Sketch the magnitude of the transfer function $H(f) = \frac{V_{\text{out}}}{V_{\text{in}}}$ to scale versus frequency for the circuit shown in Figure 3. What is the value of the half-power frequency? *(HINT: Start by finding the Thevenin equivalent circuit seen by the capacitance.)*

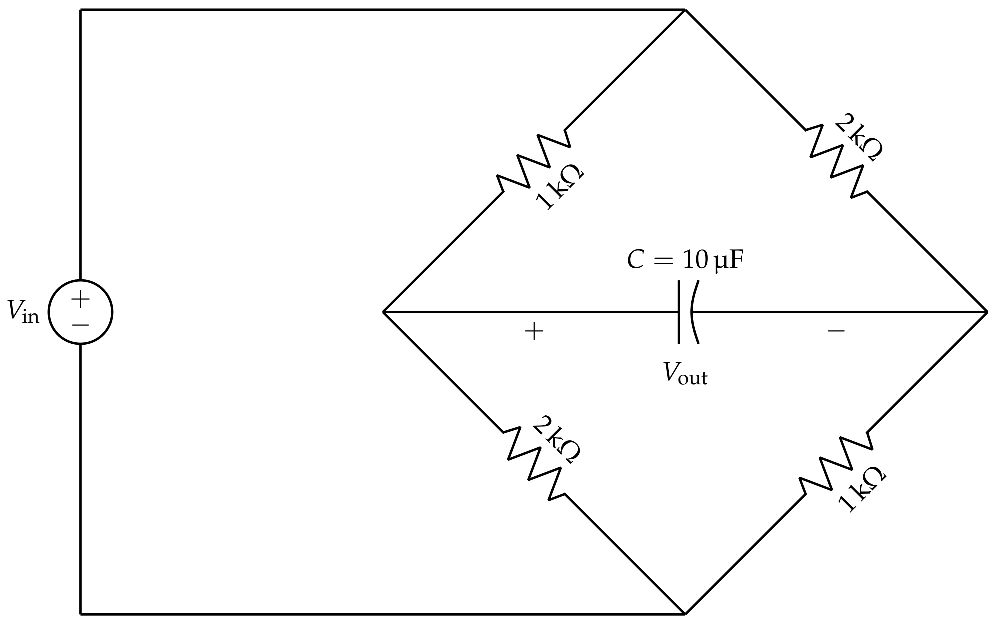

Figure 3: P6.30

6. Hambley P6.33

Consider the circuit shown in Figure 4. This circuit consists of a source having an internal resistance of R_s, an RC lowpass filter, and a load resistance of R_l.

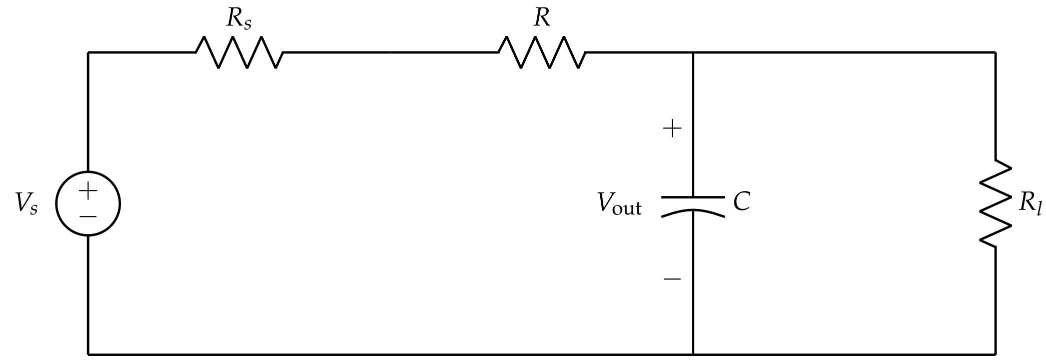

Figure 4: P6.33(a)

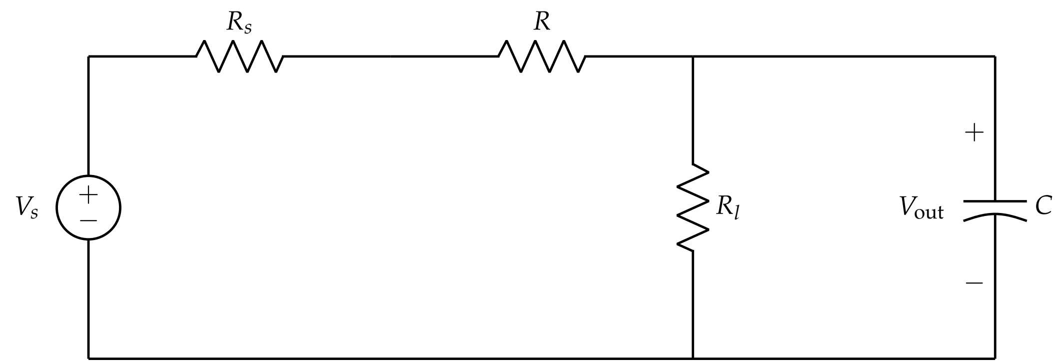

Figure 5: P6.33(b)

(a) Show that the transfer function of this circuit is given by

$$H(f) = \frac{V_{\text{out}}}{V_s} = \frac{R_l}{R_s + R + R_l} \times \frac{1}{1 + \mathrm{j}\frac{f}{f_B}} \tag{2}$$

in which the half-power frequency f_B is given by $f_B = \frac{1}{2\pi R_t C}$ where $R_t = \frac{R_L(R_s+R)}{R_l+R_s+R}$. Notice that R_t is the parallel combination of R_l and $(R_s + R)$. *(HINT: One way to make this problem easier is to rearrange the circuit as shown in Figure 5 and then to find the Thevenin equivalent for the source and resistances.)*

(b) Given that $C = 0.2\,\mu\text{F}$, $R_s = 2\,\text{k}\Omega$, $R = 47\,\text{k}\Omega$, and $R_l = 1\,\text{k}\Omega$, sketch the magnitude of $H(f)$ to scale versus $\frac{f}{f_B}$ from 0 to 3.

7. Hambley P6.53

A transfer function is given by

$$H(f) = \frac{100}{1 + \mathrm{j}\frac{f}{1000}} \tag{3}$$

Sketch the asymptotic magnitude and phase Bode plots to scale. What is the value of the half-power frequency?

8. Hambley P6.55

Sketch the asymptotic magnitude and phase Bode plots to scale for the transfer function

$$H(f) = 10\frac{1 - \mathrm{j}\frac{f}{100}}{1 + \mathrm{j}\frac{f}{100}} \tag{4}$$