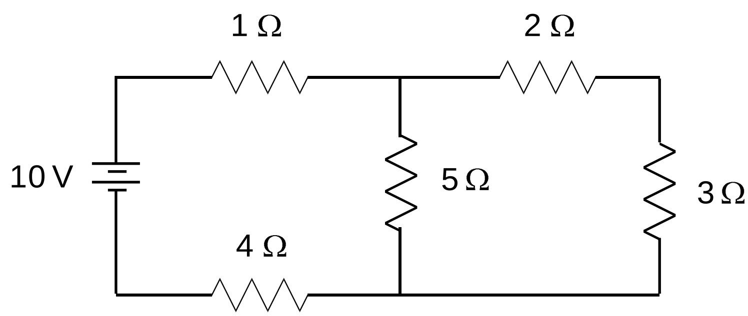
Physics 310 – Midterm Exam OLD/ Practice **Name:** ______________________

Show all of your work. *Include units where appropriate.*

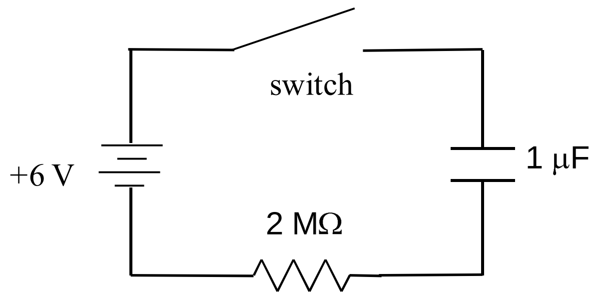
1. In the circuit shown below, the current through the 2-Ω resistor is 0.667 A to the right. (20 pts.)



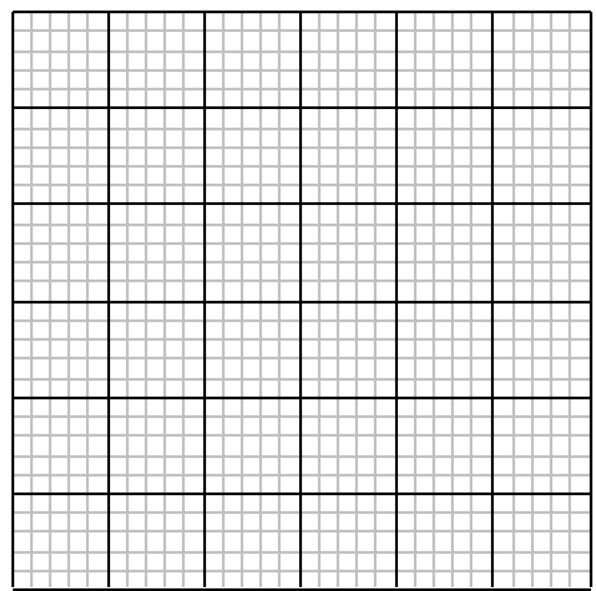
(a) Calculate the current through the 4-Ω resistor.

(b) Calculate the size of the voltage across the 5-Ω resistor.

2. The switch in the circuit below is closed at time t=0. (20 pts.)

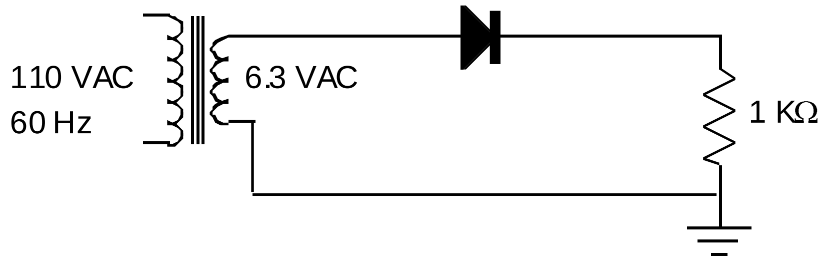


(a) Carefully sketch the voltage across the resistor vs. time. Be sure to label the axes and the scales on the graph. Also, show any calculations you make.



(b) How long after the switch closes is the voltage across the capacitor 1 Volt?

3. The voltages given in the circuit below are rms values. (20 pts.)

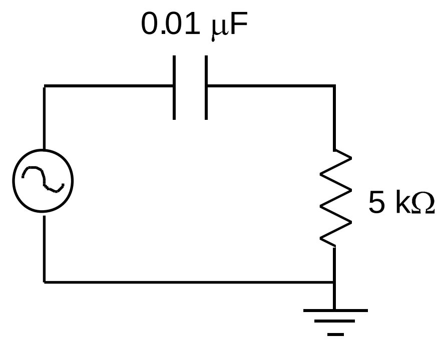


(a) Carefully sketch the voltage across the resistor (as a function of time) for the circuit above. Be sure to label the maximum and minimum values of the voltage. Also, show any calculations.

(b) What is the peak current through the resistor for the circuit above?

(c) What value (in μF) would you choose for a filter capacitor to assure that the voltage across the resistor never drops below 6 V? Also, clearly draw in the capacitor where you would place it in the circuit above.

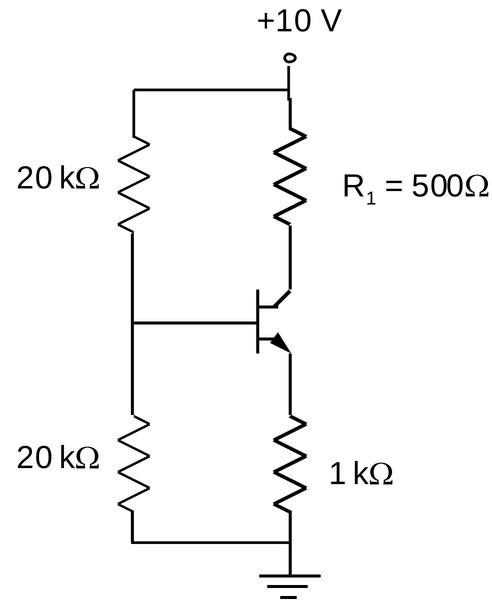
4. The function generator in the circuit below is adjusted to produce a 10 V rms sine wave with a frequency of 1 kHz. (20 pts.)



(a) Find the rms current and its phase angle relative to the input signal from the function generator (assume this has zero phase).

(b) If the circuit is used as a filter and the output voltage is measured across the resistor, what is the gain?

5. In the circuit below, the transistor has a large current gain (β). (20 pts.)



(a) What is the approximate current through the resistor R_1?

(b) Would the current change if the value of R_1 was changed to 2 kΩ? <u>Explain</u>.

Equation & Units: [units in square brackets]

$\Delta V = -IR \quad [\mathrm{V} = 1\,\mathrm{A}\cdot\Omega]$ $\qquad P = IV \quad [1\ \mathrm{W} = 1\ \mathrm{A}\cdot\mathrm{V}]$

$R_S = R_1 + R_2 + \ldots$ $\qquad \dfrac{1}{R_P} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \ldots$

$1/C_S = 1/C_1 + 1/C_2 + 1/C_3 + \ldots$ $\qquad C_p = C_1 + C_2 + C_3 + \ldots$

$\Delta V_C = -Q/C \quad [\mathrm{V} = 1\,\mathrm{C/F}]$ $\qquad \tau_{RC} = RC \quad [1\ \mathrm{s} = 1\ \Omega\cdot\mathrm{F}]$

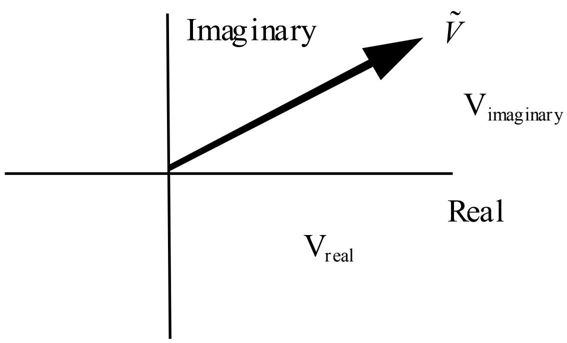
$\Delta V_L = -L(di/dt) \quad [\mathrm{V} = 1\,\mathrm{H}\cdot\mathrm{A/s}]$ $\qquad \tau_{RL} = L/R \quad [1\ \mathrm{s} = 1\ \mathrm{H}/\Omega]$

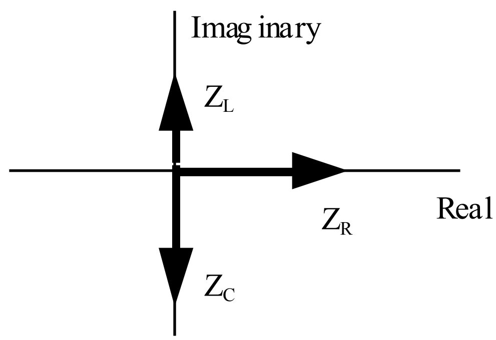
$|X_C| = 1/\omega C = 1/2\pi f C$ $\qquad Z_C = -j/\omega C = -j/2\pi f C \quad [\Omega = 1/\mathrm{Hz}\cdot\mathrm{F}]$ $\qquad j = \sqrt{-1}$

$|X_L| = \omega L = 2\pi f L$ $\qquad Z_L = j\omega L = j2\pi f L \quad [\Omega = \mathrm{Hz}\cdot\mathrm{H}]$ $\qquad \omega = 2\pi f$

$V = \sqrt{(V_{\text{real}})^2 + (V_{\text{imaginary}})^2}$ $\qquad \phi = \tan^{-1}(V_{\text{imaginary}}/V_{\text{real}})$ $\qquad \tilde{V} = Ve^{j\phi_V}$

$\tilde{A} \times \tilde{B} = (AB)e^{j(\phi_A + \phi_B)}$ $\qquad \tilde{A}/\tilde{B} = (A/B)e^{j(\phi_A - \phi_B)}$ $\qquad \tilde{V} = \tilde{i}\tilde{Z}$





$\dfrac{v_s}{v_p} = \dfrac{N_s}{N_p}$ $\qquad P_p \approx P_s$ $\qquad \dfrac{Z_s}{Z_p} = \left(\dfrac{N_s}{N_p}\right)^2$

$C \approx \dfrac{i}{\Delta V \cdot f} \quad [\mathrm{F} = \mathrm{A}/(\mathrm{V}\cdot\mathrm{Hz})]$ $\qquad r = \dfrac{\Delta V}{V_{DC}}$ $\qquad V_p = \sqrt{2}\cdot V_{rms}$

$I_B = I_E - I_C$ $\qquad I_C = \beta I_B$ $\qquad V_E = V_B - 0.6\ \mathrm{V}$