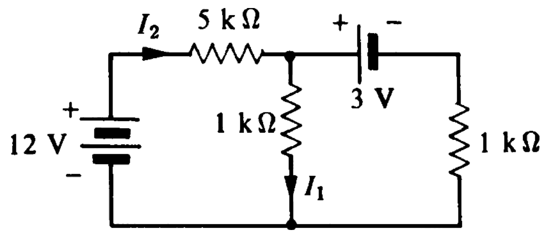
Physics 4700 HOMEWORK 2

Due February 1

Hint: Use Kirchhoff's voltage or current law to solve this problem.

1. Calculate I_1 and I_2.



2. This is a review problem on complex numbers. Manipulating complex numbers will become important when we discuss AC circuits.

Let $A = 2 + 4j$

$B = -1 + 3j$

$C = 3 - 2j$

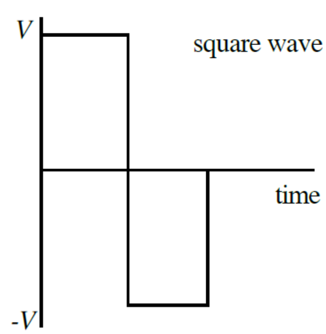
Find the magnitude and phase of,

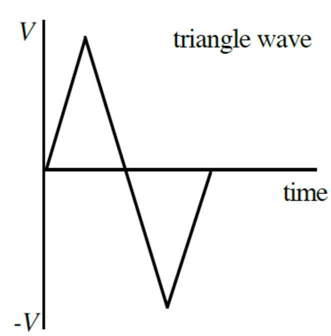
a. $A, B\ and\ C$
b. $(A + B)/C$
c. $(2A - 3B^*)/(A - C^*)$, * = complex conjugate

3. A current of 1 mA charges a capacitor of 1 μF capacitor. How long does it take for the capacitor to reach 10 V?

Hint: V_{rms} for each waveform is not zero.

4. Calculate the V_{RMS} for the following waveforms:





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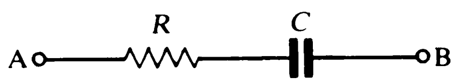
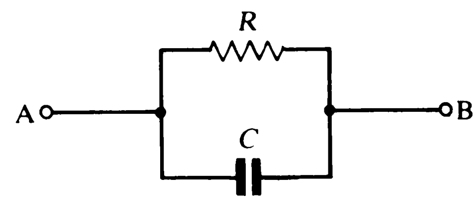
Hint: Simplify the equation to solve for magnitude and phase of impedance

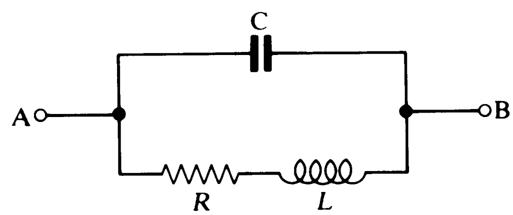
5. Calculate the impedance Z_{AB} in the form $a + jb$ and $|Z|e^{j\theta:}$.





Hint: Simplify the equation to solve for magnitude and phase of impedance

6. Calculate the impedance Z_{AB} in the form $a + jb$ and $|Z|e^{9:}$.



Hint: Remember ω is angular frequency

7. Design a low pass RC filter that will attenuate a 60 Hz sinusoidal voltage by 12 dB relative to the DC gain. Use a 100 Ω resistance. Explain in words why the low pass RC filter attenuates the high frequencies.

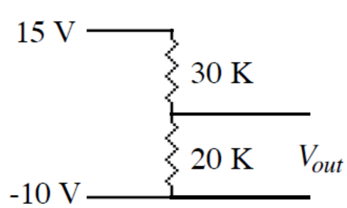
8. For a low pass RC filter prove that

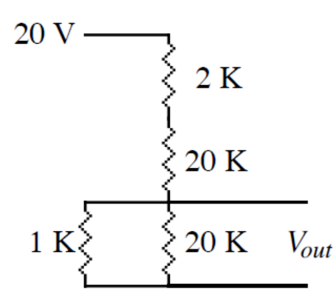
a. at the frequency $\omega = 1/RC$ the voltage gain equals $0.707 = \frac{1}{\sqrt{2}}$

b. the rise time of the output pulse equals 2.2RC for a zero rise time input pulse (Rise time is the time for a pulse to rise from 10% to 90% of the maximum value.)

Hint: Read about Thevenin's theorem before solving the problem

9. Draw the Thevenin equivalent circuit for the following two circuits:
(note: the load resistor has already been taken out of the circuit, if it were in the circuit, it be across the V_{out} terminals).





Hint: Solve for ω_0 and $\Delta\omega$. Don't just state their final answers from a book

10. For a high Q parallel RLC circuit prove that $Q = \omega_0/\Delta\omega$, where ω_0 is the (angular) resonant frequency and $\Delta\omega$ is the width at the half power points.