#### Physics 4700 HOMEWORK 2

#### Due September 26

1. Simpson Page 50, #32

Calculate I<sub>1</sub> and I<sub>2</sub>.



**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. (2*A* − 3*B*\*)/(*A* − *C*\*), \* = complex conjugate
- 3. A current of 1 mA charges a capacitor of 1  $\mu$ F capacitor. How long does it take the capacitor to reach 10V?

### 4. Simpson Page 103, #2

Prove that the root mean square (RMS) value of

$$V(t) = V_0 cos \omega t$$

is equal to  $\frac{V_0}{\sqrt{2}}$ . What is the RMS value of the voltage of Problem 1? Also calculate the V<sub>RMS</sub> for the following waveforms:



## 5. Simpson Page 104, #10

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

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# 6. Simpson Page 104, #12

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

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# 7. Simpson Page 105, #14

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  $\Omega$  resistance. Explain in words why the low pass RC filter attenuates the high frequencies.

- 8. Simpson Page 105, #15. (The rise time is defined on page 107 of Simpson.) 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 time input pulse
- **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<sub>out</sub> terminals).



# 10. Simpson Page 105, #23

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