# *Final Exam Review Questions and Problems*

**Question 1**
If the electric field *E* equals zero at a given point, must the potential difference *V* also equal zero at that point? Give an example to prove your answer.

**Question 2**
Two incandescent lamps are connected in series across a battery. The lamps are not identical: lamp A has a filament (i.e. the wire through which current flows) that is shorter and has a larger cross-sectional area than the filament in lamp B. Both filaments are made of tungsten.

For each of the following variables, indicate whether the value for lamp A is greater than, less than, or the same as the value for lamp B.

**(a)** resistance

**(b)** current

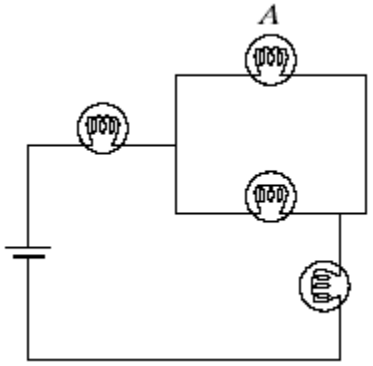
**(c)** voltage drop

**(d)** power

**Question 3**
You are given a small box equipped with two electrical terminals. Upon applying an alternating current to the two terminals, you notice that the instantaneous potential difference across them and the instantaneous current through the box are in phase. **(a)** What conclusions can you make about the resistance and/or the capacitive and inductive reactance of the box? **(b)** If you lower the frequency, will the potential difference and the current remain in phase?

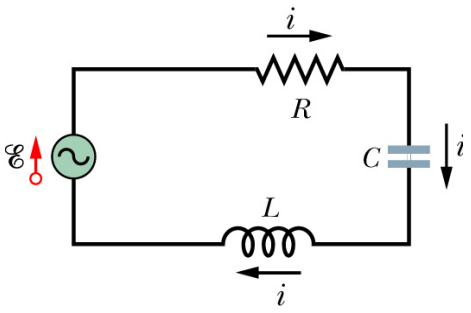
**Question 4**
Suppose a resistor and a capacitor are connected in series to a battery and the capacitor is allowed to fully charge. Does the value of the resistor affect how much charge the capacitor stores? If yes, explain how. If no, what is the effect of the resistor?

**Question 5**
Suppose bulb *A* in the circuit shown is unscrewed from its socket. How do the brightnesses of the three remaining bulbs change?



**Problem 1**

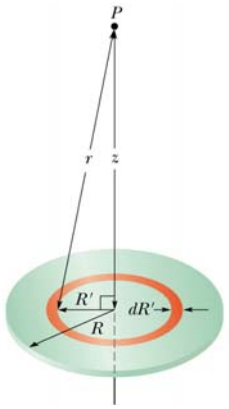
In the figure below, let $R = 100\,\Omega$, $C = 25.0\,\mu F$, L = 200 mH, $f_d$ = 60 Hz, and $\xi_m$ = 30.0 V. When the voltage across the generator is a maximum, what is the voltage across the resistor, across the inductor, and across the capacitor?




**Problem 2**

The potential at a point P a distance z above the center of a uniformly charged disk of radius R is given by:

$$\frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+R^2}-z\right).$$

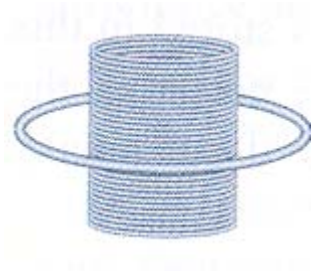



**a)** Use this expression to find the electric field a distance z above the center of the disk.

**b)** Show that the equation for the electric field reduces to the expected results for R >> z and z >> R.

**Problem 3**

In the figure below, a circular loop of wire is concentric with a solenoid and lies in a plane that is perpendicular to the solenoid's central axis. The circular loop had a radius of 6.00 cm and a resistance of 1.0 mΩ. The solenoid has a radius 2.00 cm, consists of 8000 turns per meter, and carries a current that varies with time according to $i$ = (0.50 A/s) t. What is the induced current in the circular loop?



**Problem 4**

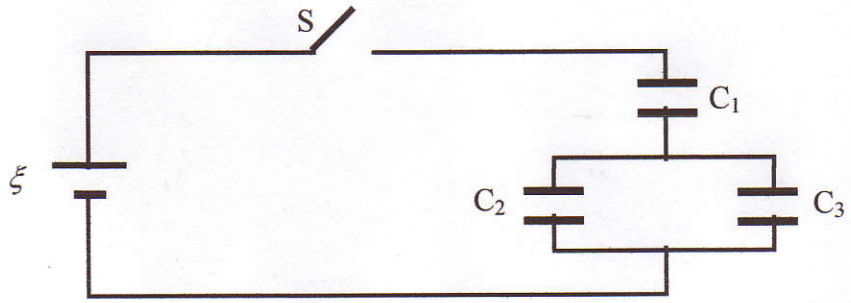
A hollow spherical conductor, carrying a net charge +1.0 μC, has inner radius $R_1$ and outer radius $R_2 = 2R_1$. At the center of the sphere is a point charge of charge +0.50 μC.

**a)** Use Gauss' law to find the **electric field** strength E (as a function of r) for the three regions: $0 < r < R_1$; $R_1 < r < R_2$; and $r > R_2$.

**b)** Roughly **plot** the potential function for this conductor. Explain your plot in detail using short concise sentences. Note that I have not asked for the electric potential function!

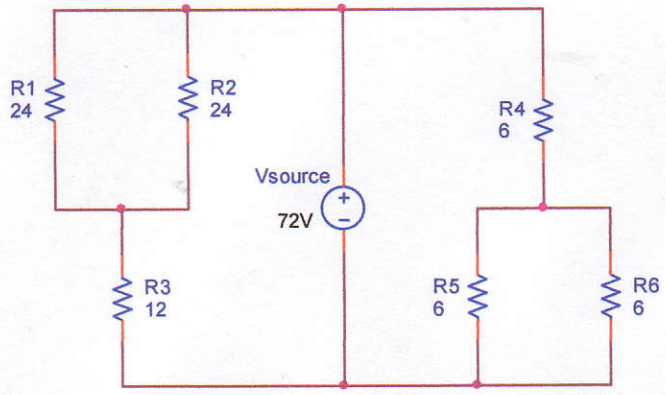
**Problem 5**

Three uncharged capacitors with capacitances $C_1 = 2\mu F$, $C_2 = 1\mu F$, and $C_3 = 4\mu F$ are connected in a circuit as shown below. When the switch S is closed, the capacitors become fully charged. Determine the values of $Q_1$, $Q_3$, and $\xi$ if the charge on capacitor 2 is $Q_2 = 10\mu C$.




**Problem 6**

Consider the circuit shown below:




What is the **current** through and the **voltage** drop across each resistor?