PHYSICS 730 **Summer 2005** **Takehome Final**

Name:____

Each problem is worth 25 points. Solutions are due by noon on Wednesday, August 24, in my mailbox. Please call 397-1031 with questions. It is easier to talk than to type. You may consult any books or notes you wish, but work alone. You trust me and I'll trust you. The main purpose of the exam is to better establish the methods in your mind. There is no spoon, but there are a couple of cylinders!

1) A capacitor C, inductor L, and resistor R are connected in series and attached to a battery with emf $\mathcal{E}$. The charge on the capacitor at $t = -\infty$ is zero, and the emf is $\mathcal{E}(t) = \mathcal{E}_0 e^{-\epsilon t^2}\sin(\omega t)$. Assume ϵ is a small positive constant and study the limit where $\epsilon \to 0$. Assume $R/2L > 1/\sqrt{LC}$ first and then assume $1/\sqrt{LC} > R/2L$. Use a fourier expansion to find the charge on the capacitor, $q(t)$. The equation governing this circuit is:

$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{q}{C} = \mathcal{E}(t)$$

2) Solve Laplace's equation $\nabla^2\Phi = 0$ assuming the potential on the top of a cylinder is $V_0\sin(2\phi)$, on the bottom is 0 and on the side is $V_1 e^{-z^2/h^2}$, where the height of the cylinder is h and the radius is a. The bottom of the cylinder lies in the $z = 0$ $x-y$ plane. Find the potential inside the cylinder and outside.

3) Solve Laplace's equation $\nabla^2\Phi = 0$ assuming the potential on the top of a cylinder is $V_0\sin(2\phi)$, on the bottom is $V_0\sin(2\phi)$ and on the side is 0, where the height of the cylinder is h and the radius is a. The bottom of the cylinder lies in the $z = 0$ $x-y$ plane. Find the potential inside the cylinder and outside.

4) Solve Laplace's equation $\nabla^2\Phi = 0$ assuming the potential on a sphere of radius a is $V_0\cos^2(\theta)\sin(2\phi)$. Find the potential both inside the sphere and outside.