

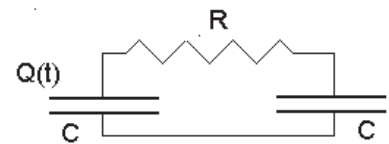
Answer **three (3)** of the following **four (4)** questions. Please give a complete description of your method of solution since *partial credit* will be given.

1. A long straight wire of radius R carries a total current I . Assume that the current I is distributed uniformly over the crosssection of the wire.



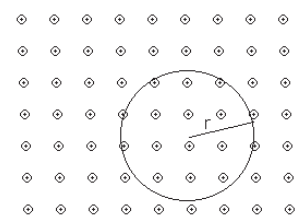
- (a) What is the current density \vec{j} within the wire? [5 points]
 (b) Find the magnetic field \vec{B} outside the wire, $r \geq R$. [14 points]
 (c) Find the magnetic field \vec{B} inside the wire, $r \leq R$. [14 points]

2. Two identical capacitors and a resistor are connected together as shown at the right. Assume that at $t = 0$ the left capacitor has a charge Q_0 and the right capacitor is uncharged. Find the charge $Q(t)$ on the left capacitor as a function of time. [33 points]



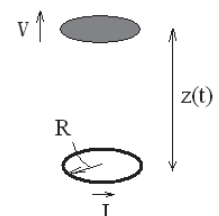
3. Consider a proton with rest energy $mc^2 = 938MeV$ and charge $e = 4.8 \cdot 10^{-10}esu$.

- (a) A proton with energy $20TeV$ ($20 \times 10^{12}eV$) moves in a region of uniform magnetic field \vec{B} of magnitude 50 KGauss. If the proton's velocity is perpendicular to \vec{B} , show that it moves in a circle and find an approximate value for that circle's radius. [18 points]



- (b) A proton with initial velocity \vec{v}_0 enters a region with a uniform electric and magnetic field \vec{E} and \vec{B} . If the vectors \vec{E} and \vec{B} are orthogonal, what condition must \vec{v} satisfy if the proton is to move through the region without being deflected? [15 points]

4. A fixed, horizontal, conducting loop of radius R carries a constant current I . A uniformly charged, non-conducting disk, also horizontal and of radius R , is a distance $z(t)$ directly above the first. You may assume that $z(t) \gg R$. The disk carries a uniform charge density σ .



- (a) Find the magnetic field due to the current in the fixed loop at the height $z(t)$. [15 points]
 (b) Find the torque $\vec{\tau}$ (both its magnitude and direction) exerted on the charged disk if it is moving upward with velocity $v = \dot{z}(t)$. [18 points]