

SOLVE ALL OF THE FOLLOWING PROBLEMS.

1. What is the power dissipated over 5 feet of 22-gauge Nichrome wire at 240 V?
2. For an RC-circuit of time constant  $\tau = 0.8$ , after how many seconds will the capacitor be charged to 80% capacity by a 30 V battery? What is the current through the resistor at that moment in terms of the capacitance  $C$ ?
3. An electron has a velocity of  $3.0 \times 10^6$  m/s in the positive  $z$  direction at a point where the magnetic field is given by  $\mathbf{B} = (3\mathbf{i} + 2\mathbf{j} + 1\mathbf{k})$  T. What is the magnitude of the acceleration of the electron at this point?
4. A current of 6.0 A is maintained in a circular loop having a circumference of 50 cm. An external magnetic field of 3.3 T is directed so that the angle between the field and the plane of the loop is  $36^\circ$ . How much torque does the loop experience?
5. A proton is accelerated from rest through a 15-kV potential difference and then moves perpendicularly through a uniform magnetic field of magnitude  $B = 2.0$  T. What is the radius of the resulting circular path?
6. An infinitely long wire of radius  $R$  has a current non-uniformly distributed over its cross section. The current density  $J$  varies with radius  $r$  according to

$$J = J_0 \left( \frac{r}{R} \right)^2.$$

What is the magnetic field inside ( $r < R$ ) and outside ( $r > R$ ) the wire? *Hint: use cylindrical coordinates to integrate over the cross sectional area of the wire...this is an Ampere's Law problem where the right hand side is complicated!*

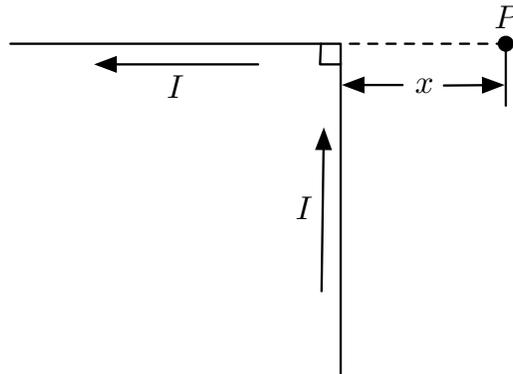
7. What is the magnitude of the magnetic field inside a long solenoid of 150 turns per meter carrying a current of 1.5 A?
8. A long solenoid of radius  $R$  has  $n$  turns of wire per unit length and carries a time varying current given by

$$I(t) = I_{\max} \cos \omega t,$$

where  $I_{\max}$  is the maximum current and  $\omega$  is the angular frequency of the alternating current source. What is the magnitude of the induced electric field outside the solenoid at a distance  $r > R$  from its long central axis?

9. Two protons in a molecule are  $3.80 \times 10^{-10}$  m apart. What is the electrical force exerted on one proton by the other?

10. Determine the magnetic field at a point  $P$  located a distance  $x$  from the corner of an infinitely long wire bent at a right angle as shown in the figure. The wire carries a current  $I$ .



BONUS (3 POINTS)

Assume the magnitude of the magnetic field outside a sphere of radius  $R$  is  $B = B_0(R/r)^2$ , where  $B_0$  is a constant. Find an expression for the total energy stored in the magnetic field outside the sphere.