3^{rd} HOMEWORK
Due April 10, 2008

1. What deviations from Ohm's Law do you expect if the current is very large?

2. The resistivity of semiconductors and insulators decreases with temperature. Can you think of a likely explanation.

3. A circular loop of superconducting material has a radius of 2.0 cm. It carries a current of 4.0 A. What is the orbital angular momentum of the moving electrons in the wire? Take the center of loop as the origin.

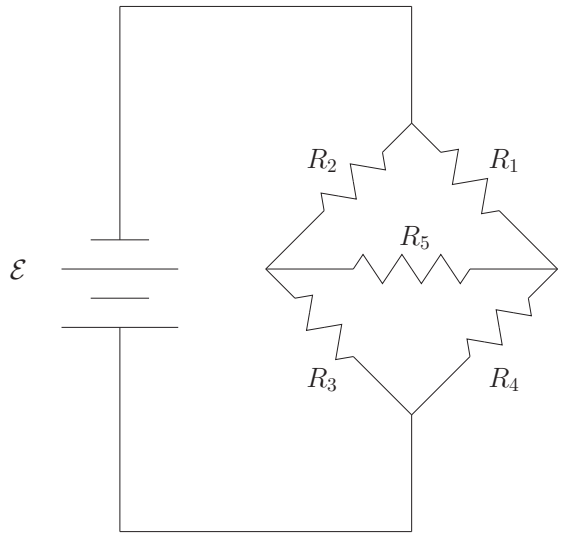

Figure 1:

4. Calculate the currents flowing though each of the resistors in the circuit shown in Fig 1

5. The banks of batteries in a submarine store an electric energy of $5 \times 10^3\ kW \cdot h$. If the submarine has an electric motor developing $1000hp$, how long can it run on batteries?

6. A capacitor with $C = 0.25\mu F$ is initially charged to a potential of 6.0 V The capacitor is then connected across a resistor and allowed to discharge. After a time of 5.0×10^{-3} s, the potential across the capacitor has dropped to 1.2 V. What value of resistance can you deduce from this?

7. Prove that the magnetic force can be expressed as

$$\vec{F} = \frac{\mu_0}{4\pi}\frac{qq'}{r^2}\left(\vec{v}'\hat{r}\cdot\vec{v} - \hat{r}\vec{v}\cdot\vec{v}'\right)$$

8. Show that the magnetic field of a point charge q' moving with a velocity $\vec{v}'$ can be written in terms of the electric field of this point charge as $\vec{B} = \mu_0\epsilon_0\vec{v}'\times\vec{E}$.

9. A very long wire carrying a current I is bent at a right angle near the midpoint. One branch of it lies along the positive x-axis and the other along the positive $y$axis. Find the magnetic field at a point (x, y), $x, y > 0$.

10. A very long strip of copper of width b carries a current I uniformly distributed over the strip. What is the magnetic field at a distance z above the midline of this strip?

11. A sphere of radius R and mass M has a uniform charge density σ over its surface. If the sphere is rotating with an angular velocity ω around the z axis, find the magnetic moment created at a point on the z axis. Express your result in terms of the angular momentum of the sphere by expressing ω in terms of the angular momenta.