**Jimma University CNS, Physics Department**

**Assignment I on the Course "Electrodynamics II (Phys 3082)'' for third year students**

## Part I: conceptual questions

1. In your own words write an explanation of each Maxwell's equation and Lorentz force (describe what each equation is saying)
2. Suppose you had a sphere has radius *a* above its critical temperature, and you held it in a uniform magnetic field *B*0 ˆ**z** while cooling it below $T_C$ (critical temperature). What do you say about induced surface current density?
3. Differentiate Maxwell's equation and force law.
4. Suppose the fields;$E(r,t) = {}^{kq}/_{r^2}\,\theta(vt-r)\hat{r}$) and magnetic field is $B(r,t) = 0$; is this fields satisfy all Maxwell's equation? If yes show and determine $\rho$ *and* $J$. Describe the physical situation that give rise these fields

## Part II: Workout Problems

5. Two long straight copper pipes, each of the plane *a*, are held a distance 2d apart as fig. below. One is at potential $V_o$, the other at $-V_o$. The space surrounding the pipes is filled with weakly conducting material of conductivity $\sigma$. Find the current, per unit length, which follows from one pipe to the other.

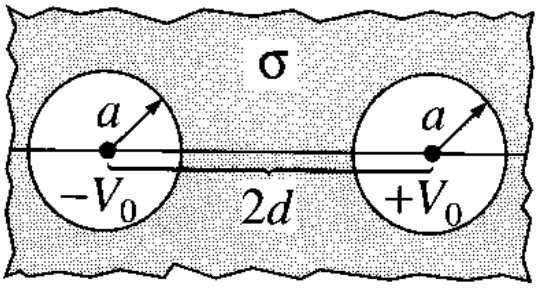


Figure 1

6. Imagine an infinitely long cylindrical sheet, of uniform resistivity and radius *a*. A slot (corresponding to the battery) is maintained at $\pm V_o/2$ at $\phi = \pm\pi$ and a steady current flows over the surface, as indicated in fig. 2. According to Ohm's law, then

$$V(a,\phi) = \frac{V_o\phi}{2\pi}, \qquad (-\pi < \phi < +\pi)$$

a) Find $V(s,\phi)$ inside and outside the cylinder

b) Find the surface charge density on the cylinder

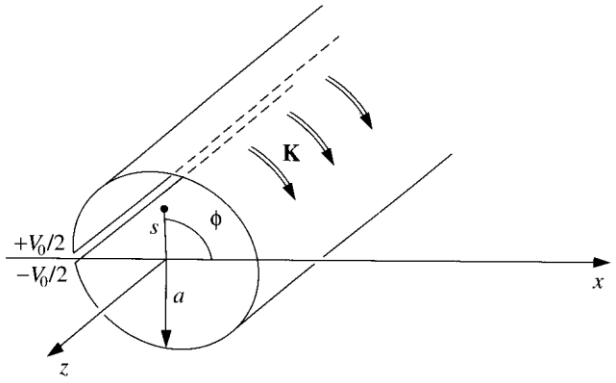


Figure 2

7. Consider two equal point charges *q*, separated by a distance 2*a*. Construct the plane equidistant from the two charges. By integrating Maxwell's stress tensor over this plane, determine the force of one charge on the other.
8. Suppose you have a perfect conductor material.

**a)** Show that the magnetic field is constant inside a perfect conductor

**b)** Show that the magnetic flux through a perfectly conducting loop is constant.

**c)** Show that the current in a superconductor is confined to the surface.