804 Final Exam (40 points).

Problem 1.

A long cylindrical metal wire of radius a carries a uniform current of density J in the axial direction. The conductivity of the metal is σ. Calculate the magnitude and the direction of Poynting vector at the surface of the wire.

Problem 2.

In a certain gauge the magnetic vector potenial has the form

$$\vec{A}(t, \vec{r}) = -t\vec{E}$$

($\vec{E}$ is constant) and the scalar electic potential vanishes. Find the gauge transformation $\Lambda(t, \vec{r})$ to another gauge where the magnetic vector potential is zero and write down the corresponding electric potential.

Problem 3.

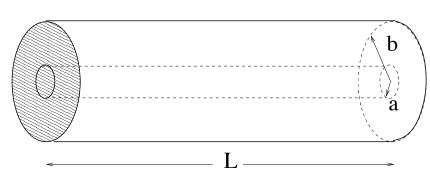
A linearly polarized electromagnetic plane wave is incident at angle θ on an infinitely large plane made from a perfect conductor. The electric field is orthogonal to the plane of incidence. Find charge and current densities induced on the conducting plane.

Problem 4.

The co-axial wave guide is closed at both ends by metal lids so the space between two cylinders makes a resonant cavity. Show that this cavity can support a TEM wave ($E_z = B_z = 0$) and find:

(a) Allowed frequencies

(b) Electric and magnetic fields in the TEM wave



Problem 5.

An insulated circular ring of radius b lies in the x, y plane centered at the origin. It carries a linear charge density $\lambda = \lambda_0 \sin\phi$ where ϕ is an azimuthal angle. The ring is set spinning at a constant angular velocity $\vec{\omega} = \omega\hat{z}$. Find the power radiated by the ring.

Problem 6.

Is it possible for $\vec{E}$ and $\vec{B}$ at some point to be parallel in one frame and antiparallel in some other frame?