Classical Electrodynamics (Physics course 503)

Problem set #2

Due date: 6pm, Mar 13 (Tue), 2018

Submission: HW box in physics building.

***1. Transmission Lines*** Transmission lines are cables for AC or RF signal. The most common structure is two coaxial lines. (a) Calculate the capacitance of two long coaxial cylinders with radii and (. Another structure is two parallel wire lines. (b) Find the total electrostatic energy of the coaxial structure. (c) Calculate the capacitance of two parallel wire lines in the case of separation between two long cylinders , the radii of cylinders are and . For simplicity, assume .

***2. (a) Relaxation time in dielectric materials*** There are some charges in the body of a dielectric material whose permittivity is and conductivity . These charges move into the surface of the material. Calculate the relaxation time of this process.

***(b) Capacitance with Lossy Dielectrics*** Parallel plate capacitor is usually considered with perfect dielectric (zero conductance) materials between two parallel plates. However, in reality, dielectric materials also have some conductance. In the case of the parallel plate capacitor with non-zero dielectric material, proof that the relation

Where R is a resistance of the dielectric material, C is a capacitance of the system, is permittivity of the dielectric material, and is conductance of the dielectric material.

***3.*** Jackson 1.11

***4.*** Jackson 1.17

***5.*** Show that for the field, outside the source, of a dipole at the origin the scalar potential is

And the vector potential is

***6.*** A circular loop of wire of radius a lies in the XY-plane, is centered at the origin, and carries current I. (a) calculate the magnetic induction everywhere on the axis of the loop. (b) Calculate the following quantities directly from the divergence and curl properties of B:

(1) at points on the Z-axis,

(2) at points near the axis, say

(3) at points near the axis.