Physics 323, Spring Quarter 2015
Electrodynamics: Homework Assignment 3

Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)

Due 9:00 am Thursday April 23

1. RG-6/U cable is a type of TEM coaxial waveguide commonly used in cable TV from DC to around 900 MHz. Approximately, the inner-conductor diameter is 1mm, the outer-conductor diameter is 7mm, and the space between conductors is filled with solid polyethylene dielectric. (NB. sometimes the polyethylene is a foam; ignore that detail).

a. Estimate the propagation velocity (phase velocity) of TEM waves along this cable. Estimate the guided wavelength in this cable. You'll need to look up properties of the dielectric.

b. Suppose you don't want any reflections from the end of the cable. What value of termination resistor do you need?

c. Suppose you left the resistor off and you're interested in cable TV channel 48 (KING TV, frequency band around 370 MHz). At what positions from the open end of the cable are the voltage maxima and minima? At what positions are current maxima and minima?

2. A point charge q moves at a constant velocity V in the z-direction. Suppose at time t=0 the charge is at the origin. At a later time t' at a field point $x=x_0$, y=z=0:

a. Find the scalar and vector potential.

b. What coordinate components does the electric field have?

c. What coordinate components does the magnetic field have?

d. Find the component E_x.

3. Consider again the rectangular resonator with sides of length 1 cm, 2 cm and 3 cm.
a. How many modes are there in the wavelength interval $4/\sqrt{5}$ cm to $8/\sqrt{13}$ cm? Hint: each mode index has two modes. Find those wavelengths.
b. How many unique resonant frequencies are there?
** c. Make a crude estimate for the number of modes in the wavelength interval 100 μm to 110 μm.

** 4. Consider the retarded-time charge density $\rho(\mathbf{r}',t_r)$ appearing in the retarded potential Griffiths 10.26. Does the volume integral $\iiint \rho(\mathbf{r}',t_r)d^3x$ represent the total charge of the system? If not, explain why.

Note: Problems I consider subtle or challenging have a **.

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