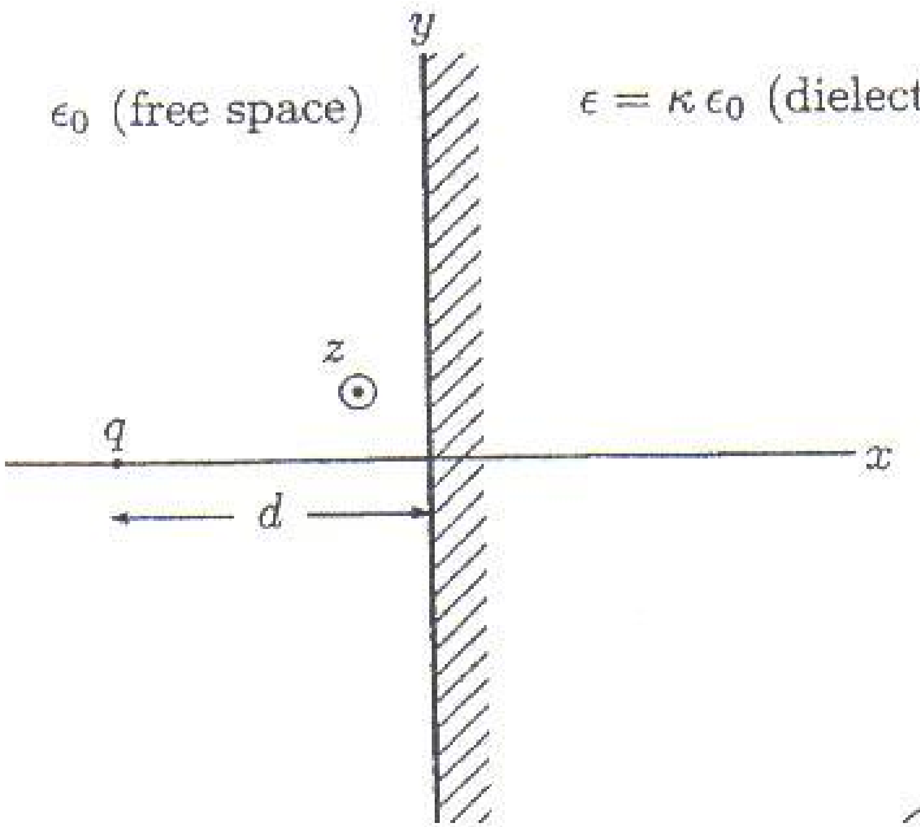
Problem 1. Electrostatics and Dielectrics.

A point charge q is located in free space a distance d from a semi-infinite block of dielectric of relative dielectric constant kappa = epsilon / epsilon0.



The electrostatic potential for this system is

((x, y, z) = q/4pi*epsilon0[1/sqrt((x+d)^2+y^2+z^2)) + (1-kappa)/(1+kappa) * 1/sqrt((x+d)^2+y^2+z^2))],

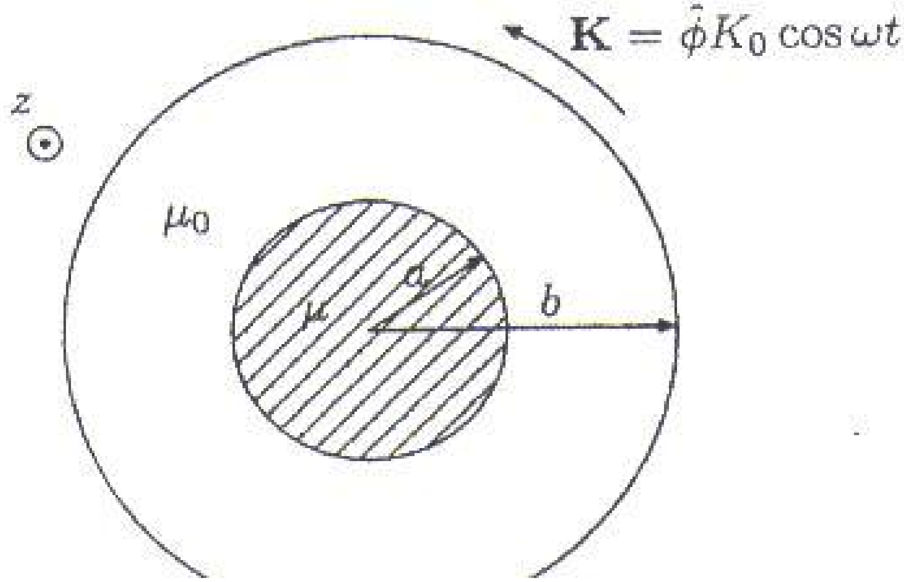
= (q/4pi*epsilon0)(2/1+kappa)1/sqrt((x+d)^2+y^2+z^2))

10 pts (a) Find the electric field E in the dielectric block region x > 0.

10 pts(b) Find the bound surface charge density sigma-b [C/m2] at the surface x = 0.

10 pts(c) Find the electrostatic force acting on the charge q (both magnitude and direction).

Problem 2. Magnetostatics Faraday's Law

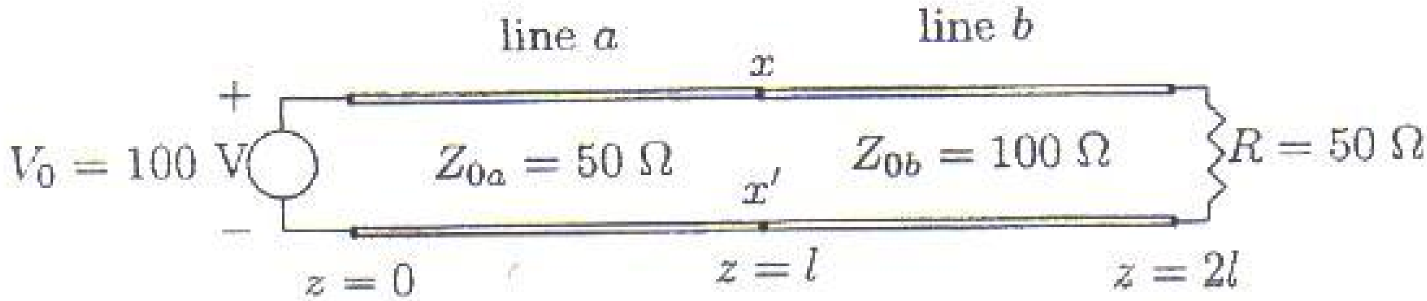


An infinite cylindrical solenoid of radius b whose axis lies along the z-axis is partially filled with a concentric ferrite (nonconducting) rod having a radius a < b and permeability u > u0. A low frequency surface current K = phi K0 cos wt [A/m] flows in the phi-direction on the surface of the solenoid at r = b.

10 pts (a) Assume that the frequency w is low enough that the laws of magnetostatics can be used to determine the time-varying magnetic fields, Find the (time-varying) magnetic field H and magnetic induction B everywhere within the solenoid (r < b).

10 pts (b) Using Faraday's law find the induced (time-varying) electric field E(r, t) everywhere within the solenoid (0 < r < b).

Problem 3. Pulsed and Sinusoidal Transmission Line Excitations.



Two ideal lossless transmission lines, a and b, having lengths l = 200m and propagation velocities v = 2 E8 m/s, are connected together. The system is excited at the left on line a by an ideal dc voltage source V_0 = 100V and terminated at the right on line b by a resistor R = 50 ohms. Lines a and b have characteristic impedances Z0a = 50ohms and Z0b = 100ohms, respectively.

10 pts (a) Assuming that the voltage source V_0 has been connected for a long time (-infinity< t < 0), what is the voltage (in volts) and the current (in amperes) at all points along lines a and b? Find (in volts) the forward and backward traveling waves (Va+, Va- and Vb+, Vb-) on lines a and b at time t = 0.

10 pts (b) Now assume that the dc voltage source is replaced by an ideal rf voltage source V(t) = V0 cos wt, where w = pi/2 E6 ^{rad}/s. Find the impedance $Z_{xx'}$ (real and imaginary parts in ohms) looking to the right at the junction x-x' joining lines a and b. You may used the Smith chart to do the calculation if you wish.

10 pts (c) For what values of w will the voltage source of part (b) be matched to its load (no backward wave on line a; i.e., Va- =0)?
