Electromagnetics (I) Final Examination

June 25, 2010

1. In Fig. 1, media 1 and 3 extend to infinity, and medium 2 is a dispersive (i.e., the material parameters depend on frequency) slab. For an infinite planar sheet current, lying in z=0 plane,
$\vec{J}_s(t) = -2J_{s0}\cos^2(1.5\times10^8\pi t)\hat{a}_x$ A/m,
there will be electric and magnetic fields in the three media. The frequency dependency of material parameters of medium 2 are listed in the following Table 1

	$\varepsilon(\omega)$	$\mu(\omega)$
$\omega = 0$	$2\varepsilon_0$	$2\mu_0$
$\omega = 1.5\times10^8\pi$	$2.5\varepsilon_0$	$2.5\mu_0$
$\omega = 3\times10^8\pi$	$3\varepsilon_0$	$3\mu_0$

(1) Can you solve the problem by using integral form Maxwell equations? Why? (10%)
(2) Can you solve the problem by using time-dependent and differential form Maxwell equations? Why? (10%)
(3) Please find the time-dependent form electric- and magnetic fields in all three media. (15%)
(4) Please find the time-dependent form surface current on the surface of media 3. (5%)
(5) Please find the time-average Poynting vectors in media 1 and 2 and explain the physical meaning of the results briefly. (10%)

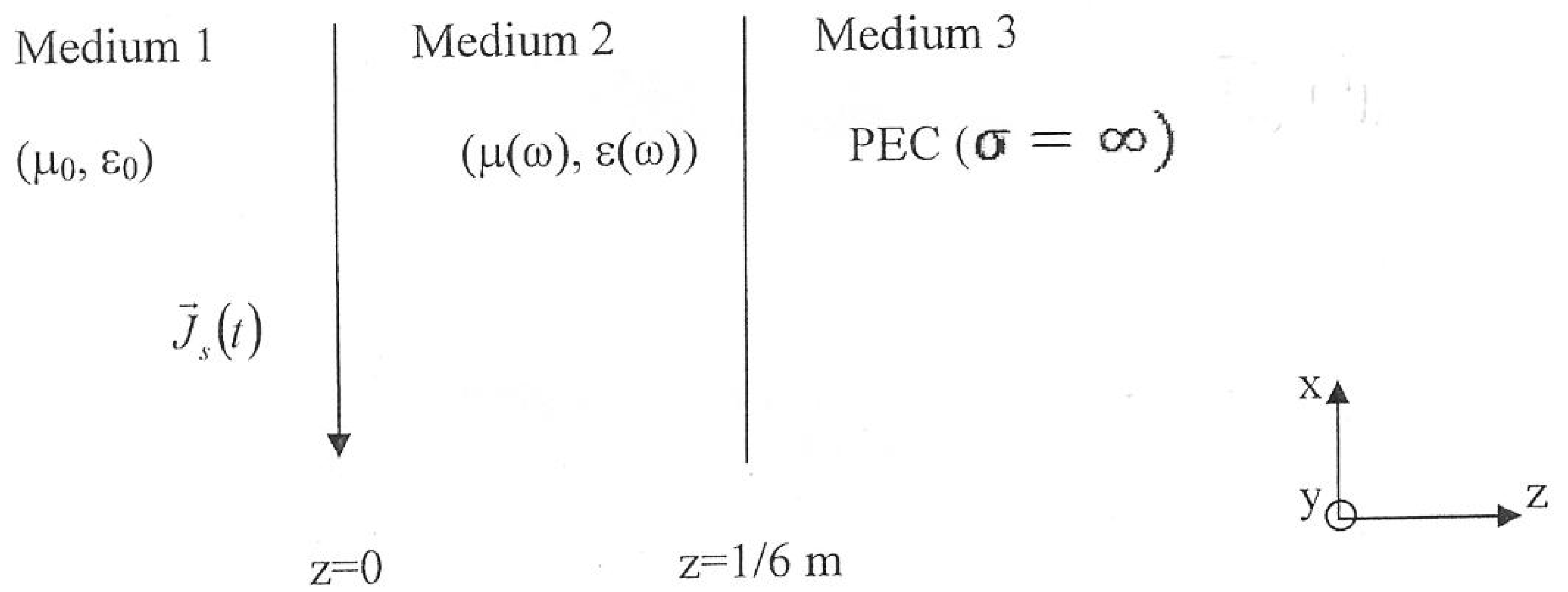

Fig. 1 for Problem 1

2. The space between two parallel conducting plates each having an area S is filled with two different lossy dielectrics as shown in Fig. 2, where the thicknesses d_1, d_2 << $S^{1/2}$=L (the length) so that the fringe effect can be neglected. A battery of dc voltage V is applied across the plates. Please determine
(1) The steady current densities in both dielectrics (10%)
(2) The electric field intensities in both dielectrics. (10%)
(3) The surface charge densities on the plates and the interface. Please explain briefly the reason of the existence of the surface charge density on the interface. (10%)
(4) If the steady magnetic field is neglected, please draw the equivalent circuit of this system and show the circuit parameters. (10%)
(5) The power dissipation in this structure. (10%)

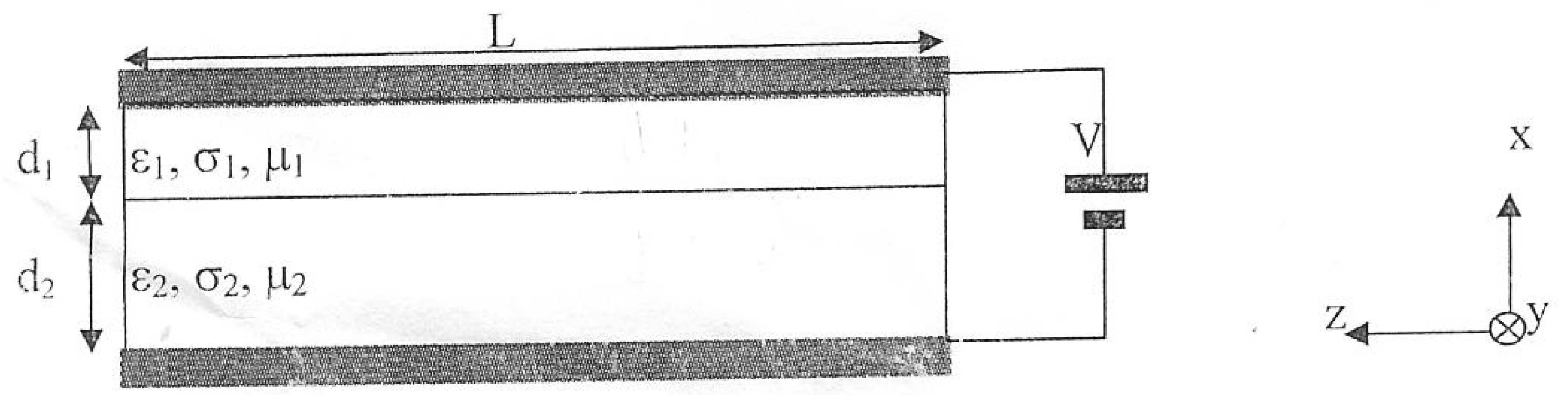

Fig. 2 for Problem 2