Electromagnetics (I) Final Examination

June 20, 2014

1. In Fig. 1, media 1 and 3 extend to infinity, and medium 2 is a dielectric slab with finite width l. For a uniform plane wave having the electric field

$$\vec{E}_i = E_0 \cos\left(3\times10^8 \pi t - \pi z\right)\hat{a}_x \ \text{V/m},$$

incident from medium 1 onto the interface $z=0$.

(1) Please write down the phasor form electric- and magnetic-fields in all three media. (15%)

(2) Please write down the boundary conditions at $z=0$ and $z=l$. (5%)

(3) To reduce the reflection (-) wave in medium 1 to zero, please find the suitable ε_r and l for medium 2. (10%)

(4) Please find the time-average Poynting vectors in all the three media and explain the physical meaning of the results briefly. (10%)

(5) Please calculate the wavelengths in media 1 and 2 and compare them with l obtained in (3). Please briefly explain the physical reason of antireflection (i.e. reflection=0) at the boundary based on the interference of waves and the power density flow. (10%)

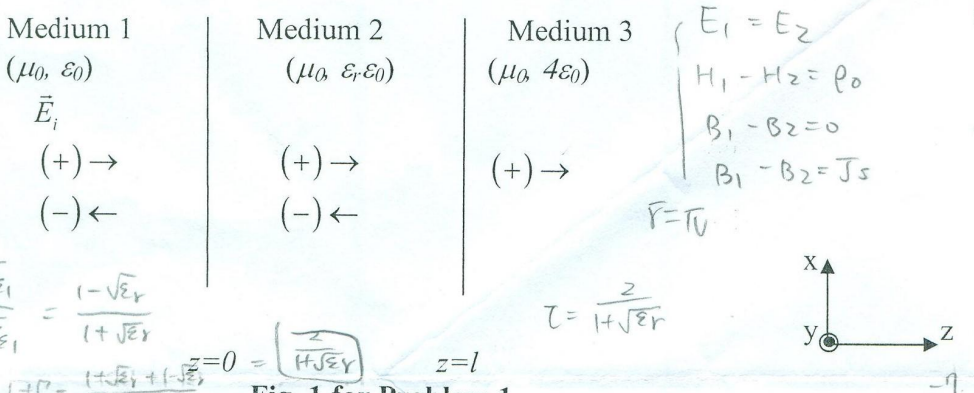

Fig. 1 for Problem 1

2. The space between two parallel square 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 (5%)

(2) The surface charge densities on the interfaces. Please explain briefly their origin. (5%)

(3) If $\sigma_1=0$, please find the potential on the interface $x=d_2$. (8%)

(4) If $\sigma_1=0$, please find the electric force $\boldsymbol{F}_e$ for the (ε_1, μ_1) dielectric in the situation shown as the dashed square in Fig. 2. (8%)

(5) If $\sigma_1=\sigma_2=0$, please find the capacitance of the system. (8%)

(6) If $\sigma_1=\sigma_2=0$ and the voltage source V is changed to a current source I and short-circuited at the other end, please find the external inductance L_e of the system. (8%)

(7) Continued from (6), if both conductor plates are of finite (ε, σ, μ) and thickness d ($d << S^{1/2}=l$), please find the internal inductance L_i of the system. (8%)

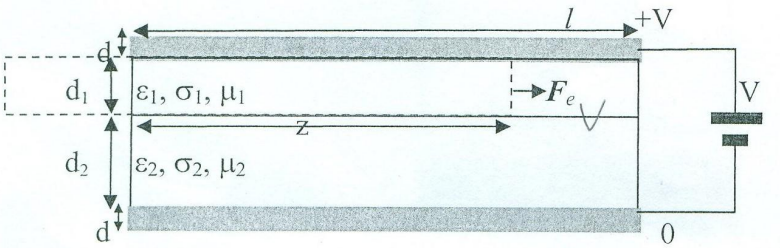

Fig. 2 for Problem 2

私は、ずっと一生懸命勉強したのに 何で 這週のテストは全然できなかった。

とても悲しい。