Problem 1 (20%)

A dielectric material of permittivity ε sliding freely in a cylindrical capacitor experiences a mechanical force $\mathbf{F}_e$ of electric origin in the axial direction, as shown in Figure Problem-1. (assuming the fringing effects at the edges negligible)

(a) find the expression of electric field in the region of $a < r < b$

(b) calculate the capacitance of such configuration in terms of the intrusion x

(c) find the expression for $\mathbf{F}_e$

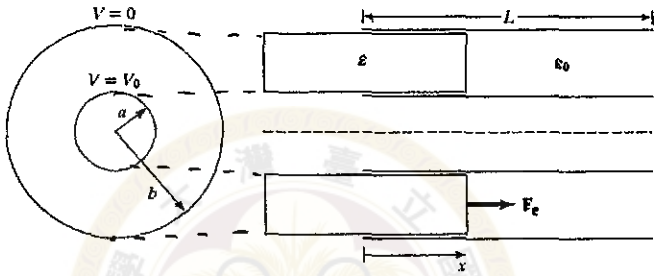

Figure Problem-1

Problem 2 (30%)

In Figure Problem-2, the region $z < 0$ is a perfect dielectric, whereas the region $z > 0$ is a perfect conductor. For an incident uniform plane wave having the electric field $\overline{E}_i = E_0[\cos(wt - \beta z)\hat{x} - \sin(wt - \beta z)\hat{y}]$ where $\beta = w\sqrt{\mu\varepsilon}$,

(a) obtain the magnetic field of the incident wave (hint: using the wave impedance η)

(b) determine the polarization sense of the incident wave (linear/circular? right/left handed?)

(c) write down the boundary condition at z=0 and find the expressions for the electric and magnetic fields of the reflected waves

(d) determine the polarization sense of the reflected wave (linear/circular? right/left handed?)

(e) find the expressions of the total (incident + reflected) electric and magnetic fields; Are they standing waves?

(f) find the induced current density on the surface of the perfect conductor

(g) find the Poynting vector of the incident wave

(h) find the Poynting vector of the total fields in the perfect dielectric

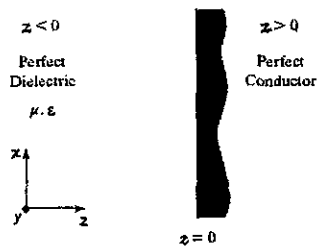

Figure Problem-2

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Problem 3. (30%)

(a) Please define and explain the Brewster Angle. (5%)

(b) What is the polarization of the reflected wave for an elliptically polarized wave incident on a dielectric interface at the Brewster Angle? Please explain why? (10%)

(c) Oblique incident from air onto a lossless, nonmagnetic dielectric at a certain incidence angle is observed to result in 80% power transmission when TE polarization is used and in 100% power transmission when TM polarization is tried. What are the index of refraction n of the dielectric and the angle of incidence θ? (15%)

Problem 4. (20%)

A 2950m-long, lossless telephone line is subjected to a 24V u(t) (step) source having an internal resistance of $100\,\Omega$. The per-unit-length inductance and capacitance of the line are $1.15\,\mu$H/m and 10 pF/m, respectively. The transmission line is terminated into a load resistance of $500\,\Omega$.

(a) What is the lattice diagram (or bounce diagram) for calculating the transient behavior on transmission line? Please briefly describe. (5%)

(b) Sketch the voltage and current waveforms as a function of time at the midpoint using the lattice diagram. (15%)

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