Fundamentals of Electromagnetic Fields – Prof. C. Riva
July 7, 2014

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SURNAME AND NAME _____

MATRICULATION _____

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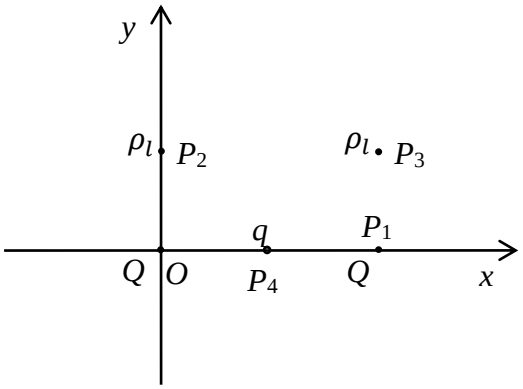
Exercise 1

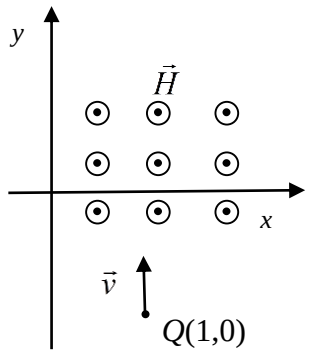
Consider two point charges $Q = 10^{-4}$ C, placed (in vacuum) in O(0 m, 0 m) and P_1(2 m, 0 m), as shown in the figure, and two linear charge distributions $\rho_l = 10^{-4}$ C/m, oriented orthogonally to the page in P_2(0 m, 1 m) e P_3(2 m, 1 m). Calculate the total force vector acting on the point charge $q = 2 \cdot 10^{-6}$ C in P_4(1 m, 0 m).



Solution:

Exercise 2

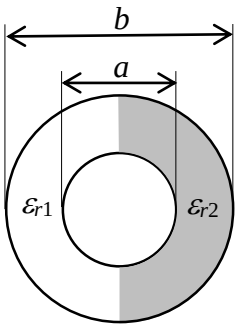
A point charge $Q = 4$ C enters, with velocity $\vec{v} = 5\,\vec{a}_y\ (\mathrm{m/s})$, a uniform magnetic field $\vec{H} = 1\,\overrightarrow{a_z}$ (A/m). Calculate the electric field vector, such that it preserves the linear uniform motion of the charge in *y* direction.
Note: the electric force must balance the Lorentz's force.



Solution:

Exercise 3

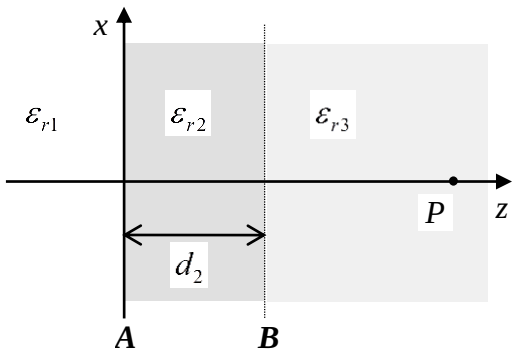
The coaxial cable in the figure (a=4 mm, b = 8 mm) is half filled with a dielectric ε_{r1}=1 and half with a dielectric ε_{r2}=4. Calculate the phase velocity and the attenuation in dB/m at 3 GHz frequency, assuming lossy conductors with $\sigma = 5.7 \cdot 10^7$ S/m.



Solution:

Exercise 4

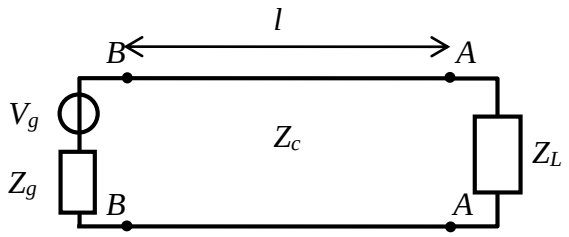
A uniform plane wave propagates (frequency 150 MHz, incident electric field in the origin $\vec{E}_i(0,0,0) = 20\vec{a}_x$ V/m) in a multi-slab structure ($\varepsilon_{r1} = 1$, $\varepsilon_{r2} = 4$, $\varepsilon_{r3} = 1$, $\mu = \mu_0$ everywhere, $d_2 = 50$ cm), as shown in the figure. Calculate the phasor vector of the electric and magnetic fields in $P(0, 0, 1.5\text{ m})$.



Solution:

Exercise 5

A generator (impedance Z_g = 50 Ω, maximum available power P_d = 12 W, frequency 200 MHz) is connected to the load $Z_L = 50 - j\,50\ \Omega$ by means of a lossy transmission line (characteristic impedance Z_c=50 Ω, attenuation constant 20 dB/km, length l = 20 m), as shown in the figure. Calculate the power dissipated in the load and in the line.



f = 200 MHz
Z_g = 50 Ω
P_d = 12 W
Z_L = 50 - j 50 Ω
Z_c = 50 Ω
α = 20 dB/km
l = 20 m

Solution: