Fundamentals of Electromagnetic Fields – Prof. C. Riva
September 4, 2014

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SURNAME AND

NAME ____

MATRICULATION ____

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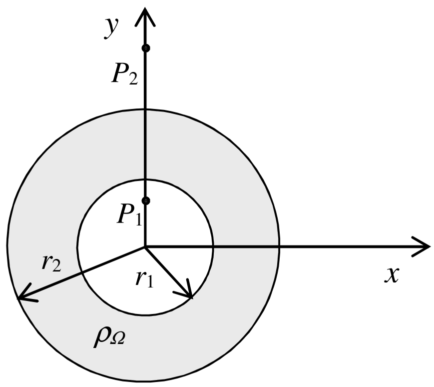
Exercise 1

Consider a volumetric charge distribution in vacuum with constant density, $\rho_\Omega = 10^{-9}\ \mathrm{C/m^3}$, distributed in an hollow cylinder (see Figure) with $r_1 \le r \le r_2$ (r_1=20 cm e r_2=40 cm).
Calculate the force vector acting on the point charge q=1 C in P_1(0, 15 cm). Calculate the force when q is in P_2(0, 80 cm).



Solution:

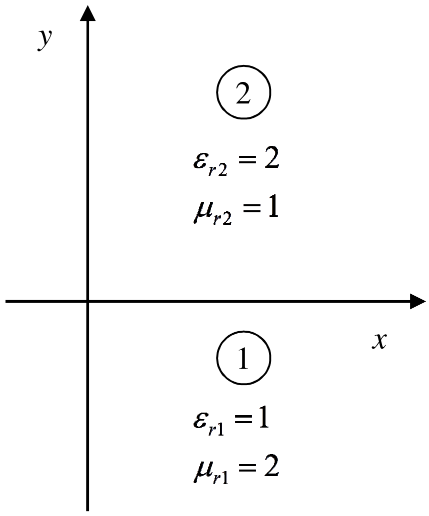
Exercise 2

Consider the two media in the figure (medium 1 for $y < 0$, medium 2 for $y > 0$) and the following static (independent) electric and magnetic fields in medium 1:

$\overrightarrow{E_1} = \overrightarrow{a_x} + \overrightarrow{a_y}$ (V/m)

$\overrightarrow{H_1} = 2\overrightarrow{a_x} - 3\overrightarrow{a_y}$ (A/m)

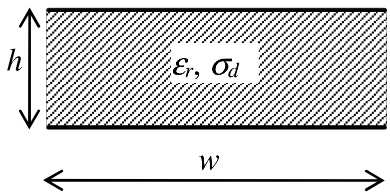
Calculate the electric and magnetic fields in medium 2 ($\overrightarrow{E_2}$, $\overrightarrow{H_2}$), assuming that between the two media (for $y = 0$) there is a surface charge density $\rho_s = 4.4 \cdot 10^{-12}$ (C/m^2) and a surface current density $\vec{J}_s = -4\,\vec{a}_z$ (A/m).



Solution:

Exercise 3

Given the microstrip in figure ($\mu = \mu_0$ everywhere, h=1 mm, w=3 mm), filled with a lossy dielectric material with ε_r=4 e $\sigma_d = 4 \cdot 10^{-4}$ S/m, calculate the attenuation constant α expressed in dB/km at the frequency f=300 MHz, due to only dielectric losses (conductors must be considered as perfect conductors).

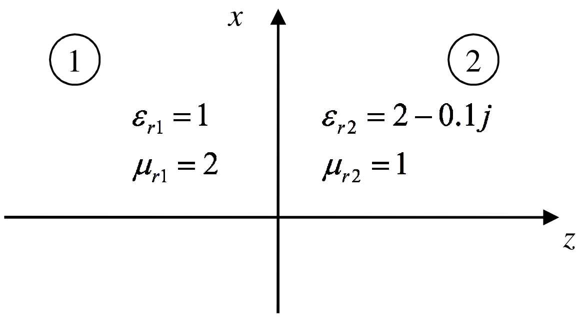


Solution:

Exercise 4

A uniform plane wave, at 150 MHz frequency, is propagating in +*z* direction in the dielectric 1 $(\varepsilon_{r1} = 1, \mu_{r1} = 2)$ and orthogonally incident on the dielectric 2 $(\varepsilon_{r2} = 2 - j0.2, \mu_{r2} = 1)$ (see figure). Assuming that the phasor of the incident electric field in the axis origin is $\vec{E}_i(0,0,0) = 2\,\vec{a}_x$ (V/m), calculate the power density transported by the transmitted wave in dielectric 2 for z = 2 λ_2.

Note: the approximation for good dielectrics can be used..

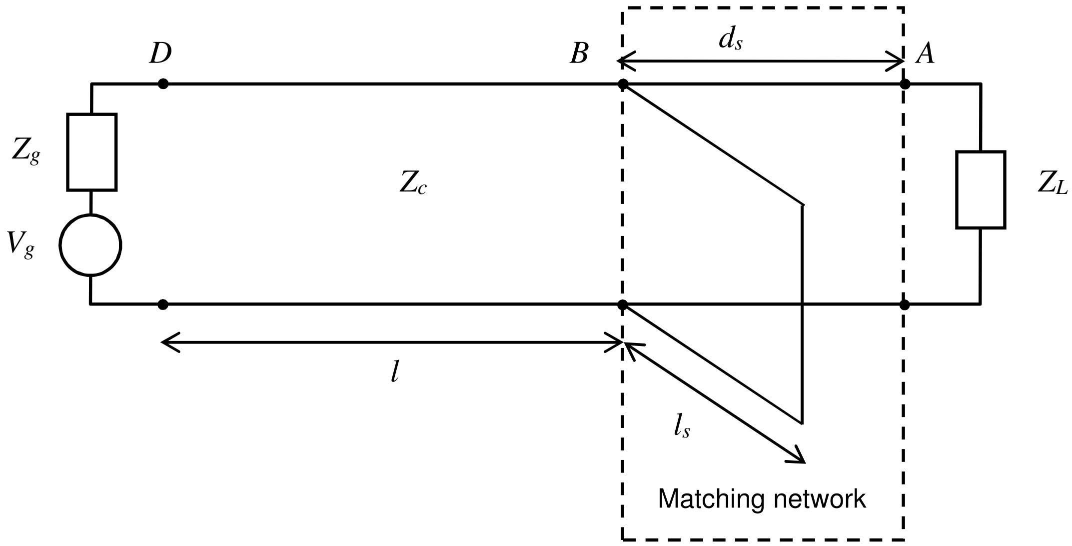


Solution:

Exercise 5

A generator (impedance Z_g = 100 Ω, V_g = 50 V, frequency 150 MHz) is connected to the load Z_L = 120-j40 Ω by means of a transmission line without losses (ε_r=1), with characteristic impedance Z_c = 80 Ω, and length l (see figure without matching network).

1. Design the shunt short circuit stub network between sections A and B to match the load to the line (specify the characteristics impedance of the transmission lines used).
2. Calculate the power dissipated in the load with the matching network with con l = 1 m e l = 1.5 m.



Solution: