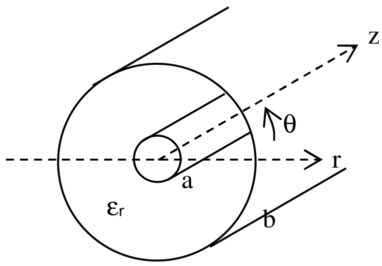
# Homework 1

We consider a coaxial line. Its inner radius is a, its outer one is b. An homogeneous lossless material is embedded between the conductors.

1) Does a TEM wave propagate in this line ?

2) The metallic conductor are considered lossless in this part.




a – A voltage V is imposed on the inner conductor, the outer conductor is grounded. Does V(r, θ) depend on both r et θ directions?

b –Solve the Poisson equation, knowing :

$$\Delta = \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} + \frac{1}{r^2}\frac{\partial^2 \theta}{\partial \theta^2}$$

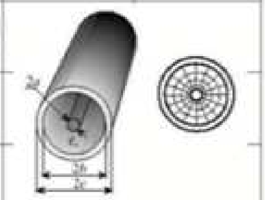
c – Compute then the electric and magnetic field, the current, the characteristic impedance, the inductor and capacitor per unit length.

3) The conductors are now lossy, and characterized by a finite conductivity. Compute the resistance per unit length of the line.

Solution :

# Common Transmission Lines

$R$, $L$, $G$, and $C$ depend on the particular transmission line structure and the material properties. $R$, $L$, $G$, and $C$ can be calculated using fundamental EMAG techniques.

| Parameter | Two-Wire Line | Coaxial Line | Parallel-Plate Line | Unit |
|---|---|---|---|---|
| $R$ | $\dfrac{1}{\pi a \sigma_{cond} \delta}$ | $\dfrac{1}{2\pi \sigma_{cond} \delta}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$ |  | |
| $L$ | $\dfrac{\mu}{\pi} a\cosh\left(\dfrac{D}{2a}\right)$ | $\dfrac{\mu}{2\pi}\ln\left(\dfrac{b}{a}\right)$ | | |
| $G$ | $\dfrac{\pi \sigma_{diel}}{a\cosh(D/(2a))}$ | $\dfrac{2\pi \sigma_{diel}}{\ln(b/a)}$ | | |
| $C$ | $\dfrac{\pi \varepsilon}{a\cosh(D/(2a))}$ | $\dfrac{2\pi \varepsilon}{\ln(b/a)}$ | $\varepsilon \dfrac{w}{d}$ | $F/m$ |

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