**Problem 1 - resistance and attenuation of coaxial cables**

In the waves section of the course, we will learn that waves penetrate into a material a distance known as a skin depth, $\delta = (\pi f \mu \sigma)^{-0.5}$.

a. Calculate the skin depth in copper at 1 kHz and 15 MHz.

b. An RG-58 cable has a polyethylene dielectric ($\varepsilon_r = 2.3$ and $\sigma = 10^{-13}/\text{ohm m}$) and copper conductors. The inner conductor extends from $r = 0$ to $r = a \approx 0.4$ mm and the outer conductor extends from $r = b \approx 1.4$ mm to 1.53 mm. (Note the numbers here are slightly different than in the book).

1) Calculate the resistance per unit length $r$, and conductance per unit length $g$ at 1 kHz. Use $\sigma = 10^{-13}$ for the polyethylene.

2) Repeat for 15 MHz.

c. The inductance and capacitance per unit length, $l$ and $c$ have already been calculated. They are 0.25 $\mu$H/m and 100 pF/m respectively. At 15 MHz,

1) determine the characteristic impedance, $Z_C$,

2) the propagation constant, $\gamma = \alpha + j\beta$

3) the distance a wave travels before the voltage is attenuated to $1/e$ of its original value.

4) The reflection coefficient for a 93 $\Omega$ load.

d. What parameters are essentially the same for low-loss and lossless lines? What is new?