Lossy Transmission Lines

Reading assignment
Ulaby, 2-4

Problem 1 - resistance and attentuation 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 $\sigma = 10^{-13}$/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 μH/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 Ω load.

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