

**Problem 2.7** Find  $\alpha$ ,  $\beta$ ,  $u_p$ , and  $Z_0$  for the coaxial line of Problem 2.6. Verify your results by applying CD Module 2.2. Include a printout of the screen display.

**Solution:** From Eq. (2.22),

$$\begin{aligned}\gamma &= \sqrt{(R' + j\omega L')(G' + j\omega C')} \\ &= \sqrt{(0.788 \, \Omega/\text{m}) + j(2\pi \times 10^9 \, \text{s}^{-1})(139 \times 10^{-9} \, \text{H/m})} \\ &\quad \times \sqrt{(9.1 \times 10^{-3} \, \text{S/m}) + j(2\pi \times 10^9 \, \text{s}^{-1})(362 \times 10^{-12} \, \text{F/m})} \\ &= (109 \times 10^{-3} + j44.5) \, \text{m}^{-1}.\end{aligned}$$

Thus, from Eqs. (2.25a) and (2.25b),  $\alpha = 0.109 \, \text{Np/m}$  and  $\beta = 44.5 \, \text{rad/m}$ .

From Eq. (2.29),

$$\begin{aligned}Z_0 &= \sqrt{\frac{R' + j\omega L'}{G' + j\omega C'}} = \sqrt{\frac{(0.788 \, \Omega/\text{m}) + j(2\pi \times 10^9 \, \text{s}^{-1})(139 \times 10^{-9} \, \text{H/m})}{(9.1 \times 10^{-3} \, \text{S/m}) + j(2\pi \times 10^9 \, \text{s}^{-1})(362 \times 10^{-12} \, \text{F/m})}} \\ &= (19.6 + j0.030) \, \Omega.\end{aligned}$$

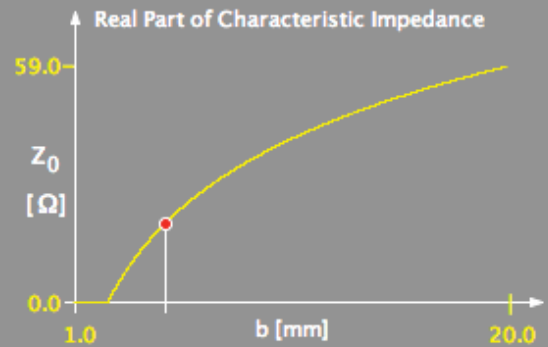
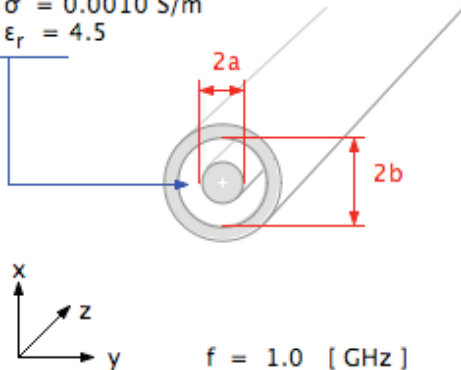
From Eq. (2.33),

$$u_p = \frac{\omega}{\beta} = \frac{2\pi \times 10^9}{44.5} = 1.41 \times 10^8 \, \text{m/s}.$$

## Module 2.2 Coaxial Cable

Select: Impedance vs. Radius b

$\sigma = 0.0010 \text{ S/m}$   
 $\epsilon_r = 4.5$



### Input

Inner radius a = 2.5 [mm]

Range:

Shield radius b = 5 [mm]

Range:

Frequency f = 1.0E9 [Hz]

Range:

$\epsilon_r$   $\sigma \text{ [S/m]}$   $\sigma_c \text{ [S/m]}$

4.5 1E-3 5.8E7

Update

### Output

#### Structure Data

a = 2.5 [mm] b / a = 2.0

b = 5.0 [mm]

$Z_0 = 19.605065 + j 0.03034369 \text{ [}\Omega\text{]}$

$C' = 360.67376 \text{ [pF/m]}$

$L' = 138.629436 \text{ [nH/m]}$

$R' = 0.787839 \text{ [}\Omega\text{/m]}$

$G' = 0.009065 \text{ [S/m]}$

$\lambda_0 = 0.3 \text{ [m]}$  in vacuum

$\lambda = 0.1414 \text{ [m]}$  in guide

$\alpha = 0.10895 \text{ [Np/m]}$

$\beta = 44.428883 \text{ [rad/m]}$