2.8 Find α, β, 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),

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

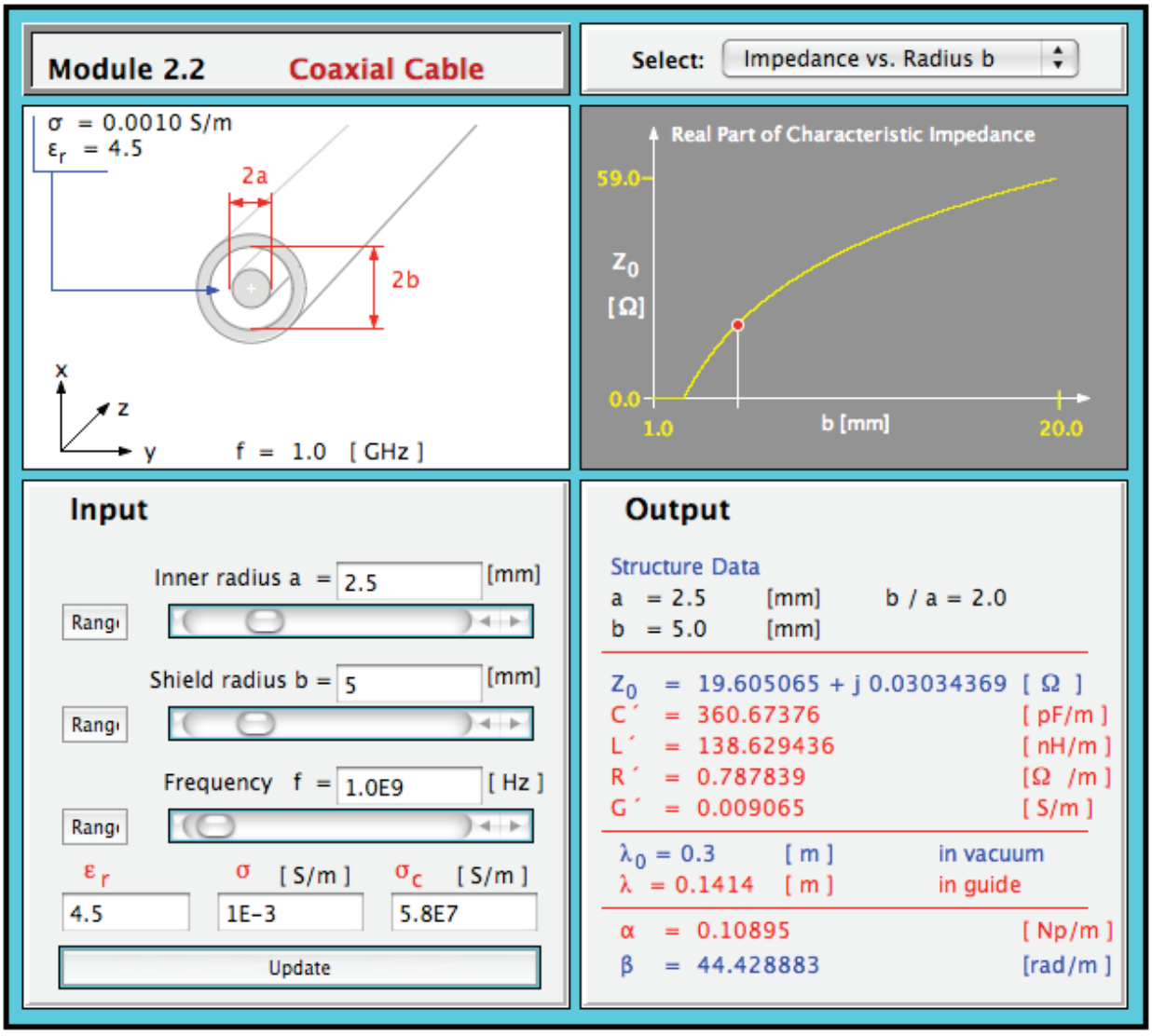
Thus, from Eqs. (2.25a) and (2.25b), $\alpha = 0.109$ Np/m and $\beta = 44.5$ rad/m.

From Eq. (2.29),

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

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
σ = 0.0010 S/m
εr = 4.5
2a
2b
x
z
y
f = 1.0 [GHz]
Real Part of Characteristic Impedance
59.0
Z0
[Ω]
0.0
1.0
b [mm]
20.0
Input
Inner radius a = 2.5 [mm]
Range
Shield radius b = 5 [mm]
Range
Frequency f = 1.0E9 [Hz]
Range
εr
σ [S/m]
σc [S/m]
4.5
1E-3
5.8E7
Update
Output
Structure Data
a = 2.5 [mm] b / a = 2.0
b = 5.0 [mm]
Z0 = 19.605065 + j 0.03034369 [Ω]
C´ = 360.67376 [pF/m]
L´ = 138.629436 [nH/m]
R´ = 0.787839 [Ω /m]
G´ = 0.009065 [S/m]
λ0 = 0.3 [m] in vacuum
λ = 0.1414 [m] in guide
α = 0.10895 [Np/m]
β = 44.428883 [rad/m]