2.7 Find α, β, u_p, and Z_0 for the two-wire line of Problem 2.2. Compare results with those based on CD Module 2.1. Include a printout of the screen display.

Solution: From Problem 2.2:

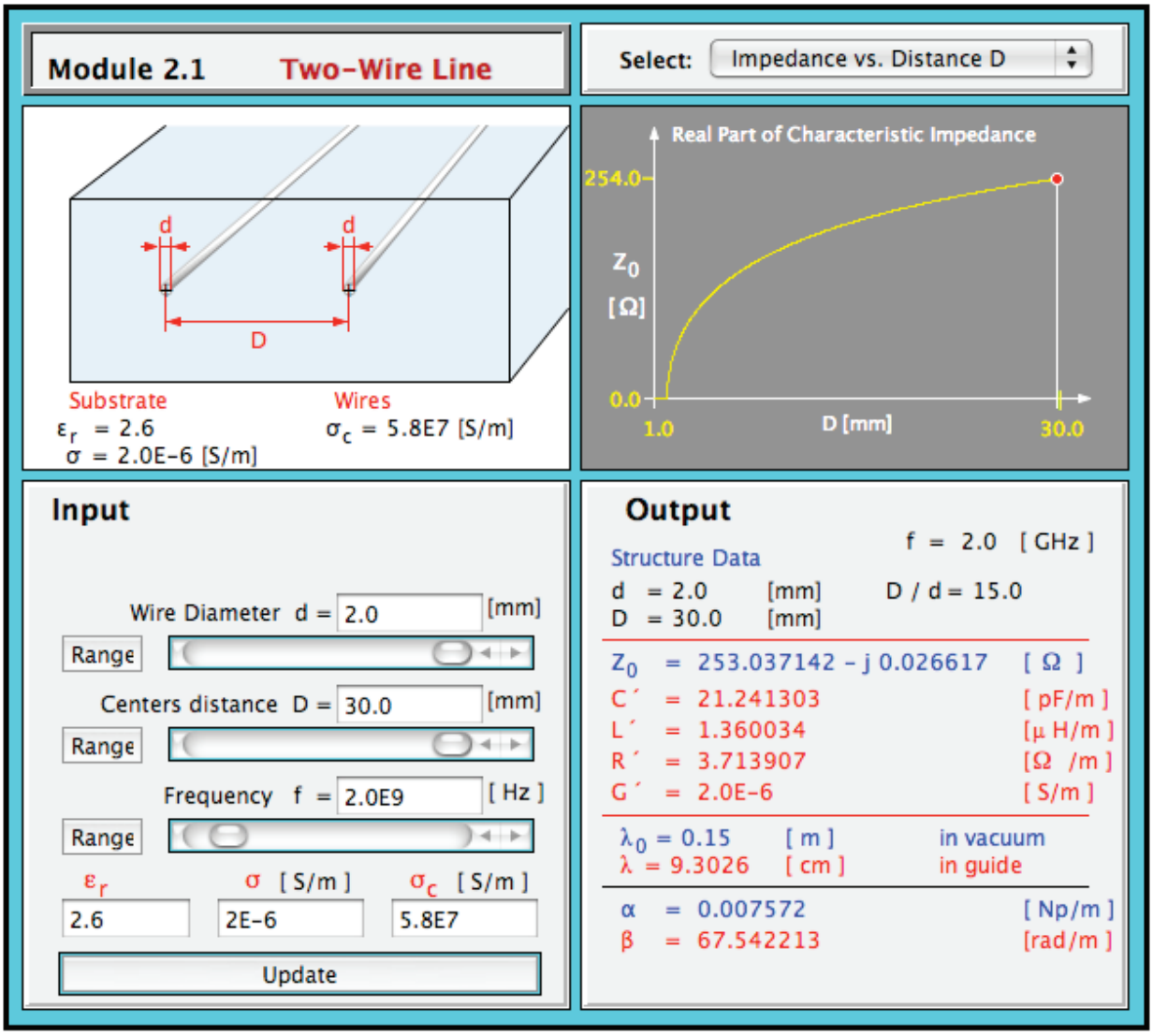
$$\begin{aligned} R' &= 3.71\ \Omega/\text{m}, \\ L' &= 1.36 \times 10^{-6}\ \text{H/m}, \\ G' &= 1.85 \times 10^{-6}\ \text{S/m}, \\ C' &= 2.13 \times 10^{-11}\ \text{F/m}. \end{aligned}$$

At 2 GHz:

$$\begin{aligned} \gamma &= \sqrt{(R' + j\omega L')(G' + j\omega C')} \\ &= 0.0076 + j67.54. \end{aligned}$$

Hence

$$\begin{aligned} \alpha &= 0.0076\ \text{Np/m}, \\ \beta &= 67.54\ \text{rad/m}. \\ u_p &= \frac{\omega}{\beta} = \frac{2\pi \times 2 \times 10^9}{67.54} = 1.86 \times 10^8\ \text{m/s}, \\ Z_0 &= \sqrt{\frac{R' + j\omega L'}{G' + j\omega C'}} = 253\ \Omega. \end{aligned}$$


Module 2.1
Two-Wire Line
Select:
Impedance vs. Distance D
d
d
D
Substrate
Wires
εr = 2.6
σ = 2.0E-6 [S/m]
σc = 5.8E7 [S/m]
Real Part of Characteristic Impedance
254.0
Z0
[Ω]
0.0
1.0
D [mm]
30.0
Input
Wire Diameter d = 2.0 [mm]
Range
Centers distance D = 30.0 [mm]
Range
Frequency f = 2.0E9 [Hz]
Range
εr
σ [S/m]
σc [S/m]
2.6
2E-6
5.8E7
Update
Output
f = 2.0 [GHz]
Structure Data
d = 2.0 [mm]
D = 30.0 [mm]
D / d = 15.0
Z0 = 253.037142 - j 0.026617 [Ω]
C´ = 21.241303 [pF/m]
L´ = 1.360034 [μ H/m]
R´ = 3.713907 [Ω /m]
G´ = 2.0E-6 [S/m]
λ0 = 0.15 [m] in vacuum
λ = 9.3026 [cm] in guide
α = 0.007572 [Np/m]
β = 67.542213 [rad/m]