Problem 2.4 A 1-GHz parallel-plate transmission line consists of 1.2-cm-wide copper strips separated by a 0.15-cm-thick layer of polystyrene. Appendix B gives \( \mu_c = \mu_0 \approx 4\pi \times 10^{-7} \) (H/m) and \( \sigma_c = 5.8 \times 10^7 \) (S/m) for copper, and \( \varepsilon_r = 2.6 \) for polystyrene. Use Table 2-1 to determine the line parameters of the transmission line. Assume \( \mu = \mu_0 \) and \( \sigma \approx 0 \) for polystyrene.

Problem 2.6 A coaxial line with inner and outer conductor diameters of 0.5 cm and 1 cm, respectively, is filled with an insulating material with \( \varepsilon_r = 4.5 \) and \( \sigma = 10^{-3} \) S/m. The conductors are made of copper.

(a) Calculate the line parameters at 1 GHz.

(b) Compare your results with those based on CD Module 2.2. Include a printout of the screen display.

Problem 2.7 Find \( \alpha, \beta, \nu_p, \) 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.

This problem requires the knowledge about problem 2.2

Problem 2.2 A two-wire copper transmission line is embedded in a dielectric material with \( \varepsilon_r = 2.6 \) and \( \sigma = 2 \times 10^{-6} \) S/m. Its wires are separated by 3 cm and their radii are 1 mm each.

(a) Calculate the line parameters \( R', L', G', \) and \( C' \) at 2 GHz.

(b) Compare your results with those based on CD Module 2.1. Include a printout of the screen display.

You don’t need to solve problem 2.2
Problem 2.13  In addition to not dissipating power, a lossless line has two important features: (1) it is dispersionless \((\mu_p\text{ is independent of frequency})\) and (2) its characteristic impedance \(Z_0\) is purely real. Sometimes, it is not possible to design a transmission line such that \(R' \ll \omega L'\) and \(G' \ll \omega C'\), but it is possible to choose the dimensions of the line and its material properties so as to satisfy the condition

\[ R'C' = L'G' \quad \text{(distortionless line).} \]

Such a line is called a distortionless line because despite the fact that it is not lossless, it does nonetheless possess the previously mentioned features of the loss line. Show that for a distortionless line,

\[ \alpha = R' \sqrt{\frac{C'}{L'}} = \sqrt{R'G'}, \quad \beta = \omega \sqrt{L'C'}, \quad Z_0 = \sqrt{\frac{L'}{C'}}. \]

Problem 2.16  A transmission line operating at 125 MHz has \(Z_0 = 40 \, \Omega\), \(\alpha = 0.02 \, \text{(Np/m)}\), and \(\beta = 0.75 \, \text{rad/m}\). Find the line parameters \(R'\), \(L'\), \(G'\), and \(C'\).

Problem 2.21  On a 150-\(\Omega\) lossless transmission line, the following observations were noted: distance of first voltage minimum from the load = 3 cm; distance of first voltage maximum from the load = 9 cm; \(S = 3\). Find \(Z_L\).

Problem 2.22  Using a slotted line, the following results were obtained: distance of first minimum from the load = 4 cm; distance of second minimum from the load = 14 cm; voltage standing-wave ratio = 1.5. If the line is lossless and \(Z_0 = 50 \, \Omega\), find the load impedance.
Problem 2.26  A 50-Ω lossless transmission line is connected to a load composed of a 75-Ω resistor in series with a capacitor of unknown capacitance (Fig. P2.26). If at 10 MHz the voltage standing wave ratio on the line was measured to be 3, determine the capacitance C.

![Figure P2.26: Circuit for Problem 2.26.](image)

Problem 2.28  A lossless transmission line of electrical length \( l = 0.35\lambda \) is terminated in a load impedance as shown in Fig. P2.28. Find \( \Gamma \), \( S \), and \( Z_{in} \). Verify your results using CD Modules 2.4 or 2.5. Include a printout of the screen’s output display.

![Figure P2.28: Circuit for Problem 2.28.](image)

Problem 2.29  Show that the input impedance of a quarter-wavelength–long lossless line terminated in a short circuit appears as an open circuit.