HW#5 - Selected solution

8-18. The standing-wave ratio on a lossless 300-(Ω) transmission line terminated in an unknown load impedance is 2.0, and the nearest voltage minimum is at a distance 0.3λ from the load. Determine (a) the reflection coefficient Γ of the load, and (b) the unknown load impedance Z_L.

a) From (8-91), $|\Gamma| = \frac{s-1}{s+1} = \frac{1}{3}$, $\Gamma = |\Gamma| e^{j\theta_\Gamma}$

From (7) on p.13 of the lecture note,

$$l_{\min} = \left(\frac{\theta_\Gamma}{\pi} + 1\right)\frac{\lambda}{4} \longrightarrow \theta_\Gamma = l_{\min}\left(\frac{4\pi}{\lambda}\right) - \pi = 0.2\pi$$

$$\therefore \Gamma = |\Gamma| e^{j\theta_\Gamma} = \frac{1}{3} e^{j0.2\pi} = 0.27 + j0.196$$

b) From (8-88)

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} \longrightarrow Z_L(1-\Gamma) = Z_0(1+\Gamma)$$

$$\longrightarrow Z_L = Z_0 \frac{1+\Gamma}{1-\Gamma} = 300\frac{1.27 + j0.196}{0.73 - j0.196} = 466 + j206(\Omega)$$

8-24. A dipole antenna having an input impedance of 73-(Ω) is fed by a 200-(MHz) source through a 300-(Ω) two-wire transmission line. Design a quarter-wave two-wire air line with a 2-(cm) spacing to match the antenna to the 300-(Ω) line.

For a $\frac{\lambda}{4}$ lossless air line,

(8-43): $Z_0 = R_0 + jX_0 = R_0 = \sqrt{\frac{L}{C}} = \frac{1}{\pi}\sqrt{\frac{\mu_0}{\varepsilon_0}} \cosh^{-1}\left(\frac{D}{2a}\right)$ ①

(11) on p.17: $Z_0 = \sqrt{Z_1 Z_L} = \sqrt{73 \times 300} \approx 148(\Omega)$ ②

② = ① : $148 = \frac{120\pi}{\pi}\cosh^{-1}\left(\frac{2}{2a}\right)$

$$\cosh^{-1}\left(\frac{1}{a}\right) \approx 1.233$$

$$a = \frac{1}{\cosh 1.233} \approx \frac{1}{1.861} \approx 0.54 \ \ cm$$