

**2.68** A 1-m long dipole antenna is driven by a 150 MHz source having a source resistance of 50 ohms and a voltage of 100 V. If the ohmic resistance of the antennas is given by  $R_L = 0.625$  ohms, find the:

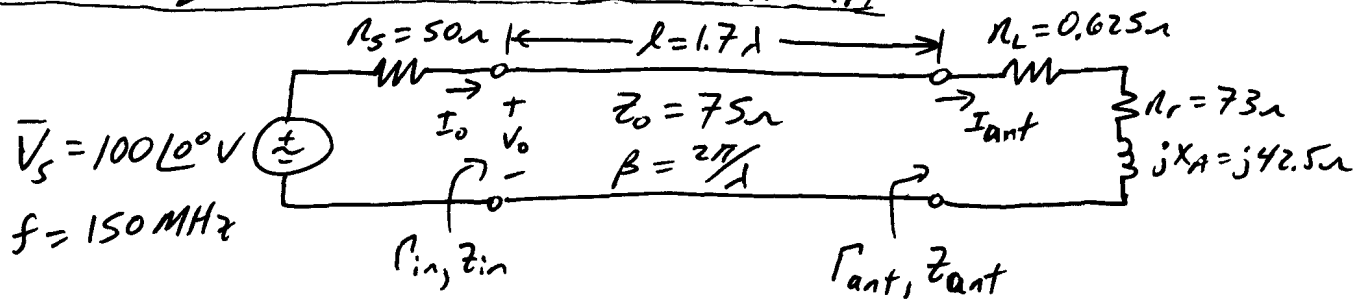
- (a) Current going into the antenna ( $I_{ant}$ ); (c) Power radiated by the antenna;  
 (b) Power dissipated by the antenna (d) Radiation efficiency of the antenna

- Assume a lossless  $75 \Omega$  transmission line of length  $1.7\lambda$  connects source and dipole (Hint: look at Chapter 4 section on  $\lambda/2$  dipoles.)

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{150 \times 10^6} = 2 \text{ m} \Rightarrow 1 \text{ m dipole is } \frac{1}{2} \text{ long!}$$

From Chap. 4 (4-93a),  $Z_{\lambda/2} = 73 + j42.5 \Omega$   
 $\uparrow R_r \quad \uparrow X_A$

Draw equivalent microwave circuit

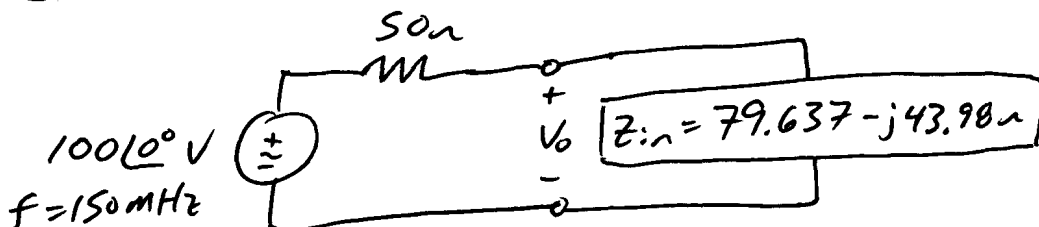


$$\Gamma_{ant} = \frac{Z_{ant} - Z_0}{Z_{ant} + Z_0} = \frac{(73.625 + j42.5) - 75}{(73.625 + j42.5) + 75} = 0.27508 \angle 75.895^\circ$$

$$\Gamma_{in} = \Gamma_{ant} e^{-j2\beta l} = (0.275 \angle 75.9^\circ) e^{-j2 \frac{2\pi}{\lambda} 1.7\lambda} = 0.27508 \angle -68.105^\circ$$

$$Z_{in} = Z_0 \frac{1 + \Gamma_{in}}{1 - \Gamma_{in}} = 75 \frac{1 + 0.275 \angle -68.1^\circ}{1 - 0.275 \angle -68.1^\circ} = 79.637 - j43.9805 \Omega$$

Reduced equivalent circuit



$$V_0 = 100 \angle 0^\circ \frac{79.637 - j43.98}{50 + (79.637 - j43.98)} = 66.456 \angle -10.17^\circ \text{ V}$$

Find forward propagating voltage wave amplitude

$$V_o^+ = \frac{V_o}{1 + \Gamma_{in}} = \frac{66.456 \angle -10.17^\circ}{1 + 0.275 \angle -68.1^\circ} = 58.7204 \angle 2.8636^\circ \text{ V}$$

a) Now, we can calculate the current going into the antenna.

$$I_{ant} = \frac{V_o^+}{Z_o} e^{-j\beta l} (1 - \Gamma_{ant}) = \frac{58.72 \angle 2.86^\circ}{75} e^{-j\frac{2\pi}{\lambda} 1.71} (1 - 0.275 \angle 75.9^\circ)$$

$$\underline{\underline{I_{ant} = 0.75973 \angle 94.9055^\circ \text{ A}}}$$

b) Per (2-77),  $P_L = \frac{1}{2} |I_{ant}|^2 R_L = \frac{1}{2} (0.7597)^2 (0.625)$

$$\underline{\underline{P_L = 0.18037 \text{ W} = 180.37 \text{ mW}}}$$

c) Per (2-76),  $P_{rad} = \frac{1}{2} |I_{ant}|^2 R_r = \frac{1}{2} (0.7597)^2 (73)$

$$\underline{\underline{P_{rad} = 21.06745 \text{ W}}}$$

d) radiation efficiency (2-90)

$$e_{cd} = \frac{P_{rad}}{P_{rad} + P_L} = \frac{R_r}{R_r + R_L} = \frac{73}{73 + 0.625}$$

$$\underline{\underline{e_{cd} = 0.99151 = 99.151\%}}$$