

EE 483/583 Antennas for Wireless Communications Quiz #7 (Spring 2024)

Name Key

Instructions: Open book/notes. Put answers in indicated spaces & show all work for credit. $c = 2.998 \times 10^8$ m/s.

A PEC folded dipole operates at 106.7 MHz in free space. It is 1.34 m long with 18 AWG (1.02362 mm diameter) copper wires spaced 8 mm apart. Find the characteristic impedance of transmission line mode, equivalent radius of the antenna mode (mm), and length of the antenna in wavelengths (l/λ). Then, find the phase constant and input impedance of the transmission line mode. From the table of selected NEC-2 excerpts, select the input impedance of antenna mode and calculate the estimated & exact input impedance (rectangular format) for the folded dipole.

$$Z_{0t} = \frac{\eta_0}{\pi} \cosh^{-1}\left(\frac{S}{2a}\right) = \frac{376.7303}{\pi} \cosh^{-1}\left(\frac{8}{1.02362}\right) = \underline{329.1871 \Omega}$$

$$a_e = \sqrt{as^2} = \sqrt{\frac{1.02362}{2}(8)} = \underline{2.023482 \text{ mm}}$$

$$\lambda = \frac{2.998 \times 10^8}{106.7 \times 10^6} = 2.80975 \text{ m} \quad K = \frac{2\pi}{\lambda} = \frac{2\pi}{2.80975} = \underline{2.23621 \frac{\text{rad}}{\text{m}}}$$

$$\frac{l}{\lambda} = \frac{1.34}{2.80975} = \underline{0.47691}$$

NEC-2 I/O excerpts for antenna mode input impedance (circle one selected)

GW 1 51 0 0 -0.67 0 0 0.67 0.00102362 70.787 -j5.376 Ω	GW 1 51 0 0 -0.67 0 0 0.67 0.008 78.176 + j15.305 Ω
GW 1 51 0 0 -0.67 0 0 0.67 0.002023482 72.3204 + j1.708 Ω	GW 1 51 0 0 -0.67 0 0 0.67 0.002861636 73.367 + j5.3696 Ω

$$Z_t = j Z_{0t} \tan\left(\frac{Kl}{2}\right) = j 329.1871 \tan\left(\frac{2.2362(1.34)}{2}\right) = \underline{j 4530.34 \Omega}$$

$$Z_{in, est} = 4 Z_a = 4(72.3204 + j1.708) = \underline{289.2816 + j6.832 \Omega}$$

$$Z_{in, ex} = \frac{4 Z_a Z_t}{2 Z_a + Z_t} = \frac{4(72.3204 + j1.708)(j4530.34)}{2(72.3204 + j1.708) + j4530.34} = \underline{288.552 + j16.033 \Omega}$$

TL mode char. imp. = 329.187 Ω ant. mode equiv. radius = 2.0235 mm $l/\lambda = \underline{0.4769}$

TL mode phase constant = 2.2362 rad/m TL mode input impedance = j 4530.34 Ω

$$Z_{in, est} \approx \underline{289.282 + j6.832 \Omega}$$

$$Z_{in, exact} = \underline{288.552 + j16.033 \Omega}$$