EE 483/583 Antennas for Wireless Communications
Quiz #4 (Spring 2025)

Name Key

Instructions: Open book & notes. Place answers in indicated spaces & show all work for credit. $c = 2.998\times10^8$ m/s.

A center-fed 30 cm long dipole, oriented and centered on the z-axis in free space, is driven by a phasor input current of $16\angle0°$ A at 14.99 MHz. Calculate the length ℓ of the dipole in terms of wavelengths, i.e., ℓ/λ. Is this dipole considered infinitesimal, finite, half-wavelength, or small? Find the radiation resistance, loss resistance, and efficiency (%) of the dipole if it is made with 1.6 mm diameter tungsten wire ($\sigma = 1.7\times10^7$ S/m). Then, calculate the time-average power input, radiated, and lost.

$\lambda = c/f = \frac{2.998\times10^8}{14.99\times10^6} = 20\text{ m} \rightarrow \ell/\lambda = \frac{0.3}{20} = 0.015 = \frac{1}{66.6}$

Per p. 155 of text $\ell/\lambda = \frac{1}{66.6} < \frac{1}{50} \Rightarrow$ infinitesimal

(4-19) $R_r = \eta\left(\frac{2\pi}{3}\right)\left(\frac{\ell}{\lambda}\right)^2 = 376.7303\left(\frac{2\pi}{3}\right)(0.015)^2 = 0.17753\,\Omega$

Inf. dipole → constant current → $R_{loss} = R_{hf} = \frac{\ell}{\rho}\sqrt{\frac{\omega\mu_0}{2\sigma}}$ (2-906)

$R_{loss} = \frac{0.3}{\pi(1.6\times10^{-3})}\sqrt{\frac{2\pi\,14.99\times10^6(4\pi\times10^{-7})}{2(1.7\times10^7)}} = 0.1113545\,\Omega$

(2-90) $e_{cd} = \frac{R_{rad}}{R_{rad}+R_{loss}} = \frac{0.17753}{0.17753+0.11135} = 0.61454 = 61.454\%$

(4-18) $P_{rad} = \frac{1}{2}|I_0|^2 R_{rad} = \frac{1}{2}(16)^2\,0.17753 = 22.7238\text{ W}$

(2-77) $P_{loss} = \frac{1}{2}|I_0|^2 R_{loss} = \frac{1}{2}(16)^2\,0.1113545 = 14.2534\text{ W}$

$P_{in} = P_{rad} + P_{loss} = 22.7238 + 14.2534 = 36.977\text{ W}$

$\ell/\lambda =$ 0.015 (infinitesimal,) ~~finite, half-wavelength, or small~~? (circle correct)

$R_{rad} =$ 0.17753 Ω $R_{loss} =$ 0.11135 Ω efficiency = 61.454 %

$P_{in} =$ 36.977 W $P_{rad} =$ 22.724 W $P_{loss} =$ 14.253 W