Wednesday, March 2, 2022

EE 483/583 Antennas for Wireless Communications
Quiz #5 (Spring 2022)

Name Key A

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

A 12.5 cm long dipole, centered on the z-axis in free space, is driven by a phasor input current of $4.8\angle 0$ A at 1199.2 MHz. Calculate the length of the dipole as a fraction of a wavelength (ℓ/λ) and the wavenumber k. Is this dipole considered infinitesimal, finite, half-wavelength, or small? At the point ($r = 1.2$ m, $\theta = 30°$, $\phi = 20°$) are we in the near-field, intermediate, or far-zone region? Why? Find the radiation resistance, loss resistance, and efficiency (%) of the dipole if it is made of a 1.2 mm diameter graphite rod ($\sigma = 1\times10^6$ S/m).

$\lambda = c/f = \frac{2.998\times10^8}{1199.2\times10^6} = 0.25\text{ m}$, $\frac{\ell}{\lambda} = \frac{0.125}{0.25} = 0.5$

$k = 2\pi/\lambda = \frac{2\pi}{0.25} = 25.1327\ \text{rad/m}$

Per (4-47), far-zone if $r \geq \frac{2D^2}{\lambda} = \frac{2(0.125)^2}{0.25} = 0.125\text{ m}$

$\Rightarrow 1.2\text{ m} > 0.125\text{ m} \Rightarrow$ far-zone

Per (4-93), $R_r = R_{rad} = \frac{1}{4\pi} C_{in}(2\pi) = 73.079\,\Omega$

Per (2-906), $R_{hf} = \frac{\ell}{\rho}\sqrt{\frac{\omega\mu_0}{2\sigma}} = \frac{0.125}{\pi\,0.0012}\sqrt{\frac{2\pi\,1199.2\times10^6(4\pi\times10^{-7})}{2\times10^6}}$

$= 2.281416\,\Omega$

Per ex 2.13, $R_L = R_{loss} = \frac{1}{2} R_{hf} = 1.1407\,\Omega$

Per (2-90), $e_{cd} = \frac{R_r}{R_r + R_L} = \frac{73.079}{73.079 + 1.1407}\times 100\% = 98.463\%$

$\ell/\lambda =$ 0.5 $k =$ 25.133 rad/m infinitesimal, finite, (half-wavelength,) or small? (circle correct)

near-field, intermediate, or (far-zone) region? (circle correct) Why? $r = 1.2\text{ m} > \frac{2D^2}{\lambda} = 0.125\text{ m}$

$R_{rad} =$ 73.079 Ω $R_{loss} =$ 1.1407 Ω efficiency = 98.463 %