EE 483/583 Antennas for Wireless Communications
Quiz #5 (Spring 2026)

Name **KEY**

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A 20 cm long dipole, oriented and centered on the z-axis, is driven by a phasor input current of $3.6\angle 30^\circ$ A at 749.5 MHz. Calculate length of this antenna as a fraction of a wavelength ℓ/λ and the wavenumber k. Is this antenna infinitesimal, small, finite, or half-wavelength? At the point $(r = 1\,\text{m}, \theta = 60^\circ, \phi = 45^\circ)$ are we in the near-field, intermediate, or far-field region? Why? Find the radiation resistance and loss resistance of the dipole if it is made with a 2 mm diameter lead-alloy wire ($\sigma = 2\times10^6$ S/m). Calculate the radiated power, loss power, and total input power as well as the antenna efficiency. Assume $c = 2.998\times10^8$ m/s.

$\lambda = c/f = 2.998\times10^8 / 749.5\times10^6 \Rightarrow$ **$\lambda = 0.4$ m = 40 cm**

The dipole length in wavelengths is $\ell/\lambda = 20/40 \Rightarrow$ **$\ell/\lambda = 0.5$**.

The wave number is $2\pi/\lambda = 2\pi/0.4 \Rightarrow$ **$k = 15.708$ rad/m**.

Is (4-47) $r = 1$ m $> 2D^2/\lambda = 2\,(0.2^2)/0.4 = 0.2$ m? $\Rightarrow$ The point is in the **far-field**!

Per (4-93), $R_r = 73\ \Omega$. More accurately, using (4-88) & (4-93),

$$R_r = \frac{\eta}{2\pi}\int_0^{\pi}\frac{\cos^2(0.5\pi\cos\theta)}{\sin\theta}\,d\theta = \frac{376.73}{2\pi}\int_0^{\pi}\frac{\cos^2(0.5\pi\cos\theta)}{\sin\theta}\,d\theta \Rightarrow \mathbf{R_r = 73.07901\ \Omega}.$$

Per (2-90b), $$R_{hf} = \frac{\ell}{2\pi a}\sqrt{\frac{\omega\mu_0}{2\sigma}} = \frac{0.2}{2\pi(1\times10^{-3})}\sqrt{\frac{2\pi(749.5\times10^6)\,4\pi\times10^{-7}}{2\,(2\times10^6)}} = \mathbf{1.22433655\ \Omega}.$$

For the current distribution on a $\lambda/2$ dipole, $R_{\text{loss}} = R_{hf}/2 = 1.224/2 \Rightarrow$ **$R_{\text{loss}} = 0.612168\ \Omega$**.

Per (2-90), the efficiency is $$e_{cd} = \frac{R_r}{R_r + R_{\text{loss}}} = \frac{73.07901}{73.07901 + 0.612168} \Rightarrow \mathbf{e_{cd} = 0.99169}.$$

Per (2-76), the radiated power $P_{\text{rad}} = 0.5\,|I_g|^2 R_r = 0.5(3.6)^2\,73.079 \Rightarrow$ **$P_{\text{rad}} = 473.552$ W**.

Per (2-77), the loss power $P_{\text{loss}} = 0.5\,|I_g|^2 R_{\text{loss}} = 0.5(3.6)^2\,0.612 \Rightarrow$ **$P_{\text{loss}} = 3.96685$ W**.

Per conservation of power, $P_{\text{in}} = P_{\text{rad}} + P_{\text{loss}} = 473.552 + 3.967 \Rightarrow$ **$P_{\text{in}} = 477.519$ W**.

$\ell/\lambda =$ **0.5** $k =$ **15.708 rad/m** infinitesimal, small, finite, or **half-wavelength**? (circle correct)

near-field, intermediate, or **far-field** region? (circle correct) Why? **$r = 1$ m $> 2D^2/\lambda = 0.2$ m**

$R_{\text{rad}} =$ **73.079 Ω** $R_{\text{loss}} =$ **0.61217 Ω** efficiency = **99.17%**

$P_{\text{rad}} =$ **473.552 W** $P_{\text{loss}} =$ **3.967 W** $P_{\text{in}} =$ **477.519 W**