Wednesday, February 5, 2025 A

EE 483/583 Antennas for Wireless Communications
Quiz #1 (Spring 2025)

Name Key A

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

For an antenna embedded in ice cream, the maximum radiation intensity is 12 W/sr. Find the intrinsic impedance of the ice cream ($\mu = \mu_0 = 4\pi \times 10^{-7}$ H/m, $\varepsilon = 3.2 \times 10^{-10}$ F/m). Then, calculate the power density and magnitude of the total electric field at a far-field point 92 m from the antenna in the direction of maximum radiation intensity. If the total power radiated by the antenna is 22 W, determine the maximum directivity (dimensionless and dBi).

intrinsic impedance $\eta = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{4\pi \times 10^{-7}}{3.2 \times 10^{-10}}} = \underline{62.6657\,\Omega}$

(2-12), $U = r^2 W_{rad} \Rightarrow W_{rad} = \frac{U}{r^2} = \frac{12}{92^2}$

$\underline{W_{rad} = 0.00141777\ \text{W/m}^2}$

(2-12a) $U = \frac{r^2}{2\eta}|\bar{E}|^2$

$\hookrightarrow |\bar{E}| = \sqrt{\frac{2\eta U}{r^2}} = \sqrt{\frac{2(62.6657)12}{92^2}} = \underline{0.421534\ \text{V/m}}$

(2-16a) $D_{max} = \frac{4\pi U_{max}}{P_{rad}} = \frac{4\pi(12)}{22} = \underline{6.8544}$

$= 10\log_{10} 6.8544 = \underline{8.3597\ \text{dBi}}$

intrinsic impedance = $62.666\,\Omega$ power density at 92 m = $1.4178\ \text{mW/m}^2$

$|\bar{E}|$ at 92 m = $0.4215\ \text{V/m}$ maximum directivity = 6.854 = $8.36\ \text{dBi}$

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Name Key B

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

For an antenna embedded in gelato, the maximum radiation intensity is 16 W/sr. Find the intrinsic impedance of the gelato ($\mu = \mu_0 = 4\pi \times 10^{-7}$ H/m, $\varepsilon = 3.5 \times 10^{-10}$ F/m $\approx 40\varepsilon_0$). Then, calculate the power density and magnitude of the total electric field at a far-field point 86 m from the antenna in the direction of maximum radiation intensity. If the total power radiated by the antenna is 24 W, determine the maximum directivity (dimensionless and dBi).

intrinsic impedance $\eta = \sqrt{\frac{\mu}{\epsilon}} = \sqrt{\frac{4\pi \times 10^{-7}}{3.5 \times 10^{-10}}} = \underline{59.9199\,\Omega}$

(2-12) $U = r^2 W_{rad} \Rightarrow W_{rad} = U/r^2 = \frac{16}{86^2}$

$\underline{W_{rad} = 0.00216333\ \text{W/m}^2}$

(2-12a) $U = \frac{r^2}{2\eta}|\bar{E}|^2$

$\hookrightarrow |\bar{E}| = \sqrt{\frac{2\eta U}{r^2}} = \sqrt{\frac{2(59.9199)16}{86^2}} = \underline{0.509169\ \text{V/m}}$

(2-16a), $D_{max} = \frac{4\pi U_{max}}{P_{rad}} = \frac{4\pi(16)}{24} = \underline{8.37758}$

$= 10\log_{10} 8.37758 = \underline{9.23119\,\text{dBi}}$

intrinsic impedance = 59.92 Ω

power density at 86 m = 2.1633 mW/m²

$|\bar{E}|$ at 86 m = 0.5092 V/m

maximum directivity = 8.378 = 9.23 dBi