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

Homework 11

Wednesday, April 16, 2025

1) 5.3 Hint: Read section 5.2.7 to find reactance.
2) 5.11 As part of (a), find the loss and radiation resistances.
3) 5.13 Change 300 Ω to **50** Ω for transmission line. For part (c), first calculate the maximum effective area (refer to Chap. 2). Add part (d)- If the antenna is made of aluminum wire (20 AWG, 3.5×10^7 S/m) with a turn spacing of 1.14 mm, compute the loss resistance and efficiency. [‘Resonant’ means assume reactance is zero.]
4) For a single, 18.5 cm diameter, circular loop of wire (16 AWG, $\sigma = 5 \times 10^7$ S/m) in free space, centered on *x-y* plane and fed where it crosses the positive *x*-axis, use NEC-2 to:
   a) Determine the input impedance over normalized frequency range $0.1 \le ka \le 2$. On a single graph, plot R_A and X_A versus ka. Use vertical scale of -1000 Ω to 1500 Ω for both R_A and X_A. [Hint: $k = \omega/c = 2\pi/\lambda$.]
   b) **EE 483 only**: In a table, list ka equal to 0.1 as well as for the anti-resonant & resonant frequencies within the range $0.1 \le ka \le 2$, frequency f (MHz), R_A, X_A, and antenna efficiency η. Format: col. 1 ka, col. 2 f (MHz), col. 3 R_A, col. 4 X_A, col. 5 η, and col. 6 description (e.g., small loop, resonance #1 …) **EE 583 only**: In a table, list ka equal to 0.1 as well as for the anti-resonant & resonant frequencies within the range $0.1 \le ka \le 2$, frequency f (MHz), R_A, X_A, R_r, R_l, and η. Format: Col. 1 ka, col. 2 f (MHz), col. 3 R_A, col. 4 X_A, col. 5 $R_{\text{rad,}}$, col. 6 R_{loss}, col. 7 η, and col. 8 description (e.g., small loop, resonance #1 …)
   c) Determine the current distributions at $ka = 0.1$ and the first resonant frequency. On a <u>single</u> graph, plot the <u>normalized</u> current **magnitudes** versus the fractional circumference (e.g., 0 ≤ distance/circumference < 1) starting at the positive *x*-axis. Normalize each current magnitude independently so that its maximum is 1.
   d) **Extra credit:** At $ka = 0.1$ and the first resonant frequency, determine the far-zone E-plane (*x-y* plane) and H-plane (*x-z* plane) power gain radiation patterns (in dBi). On two polar graphs, plot the <u>relative</u> power radiation patterns for the E-plane and H-plane scaled so that the center of each plot is at –30 dB and the outer ring is at 0 dB. Tabulate the maximum and minimum gain in each plane at each frequency.

   Hints: Use GA command to ‘make’ a loop with 60 or more segments. Start first segment at a <u>negative</u> angle so its **center** will be on the positive *x*-axis. Use GM command to rotate loop onto *x-y* plane. I do check!

Due Wednesday, April 23, 2025