

EE 483/583 Antennas for Wireless Communications (Spring 2024)
Homework 5
Tuesday, February 13, 2024

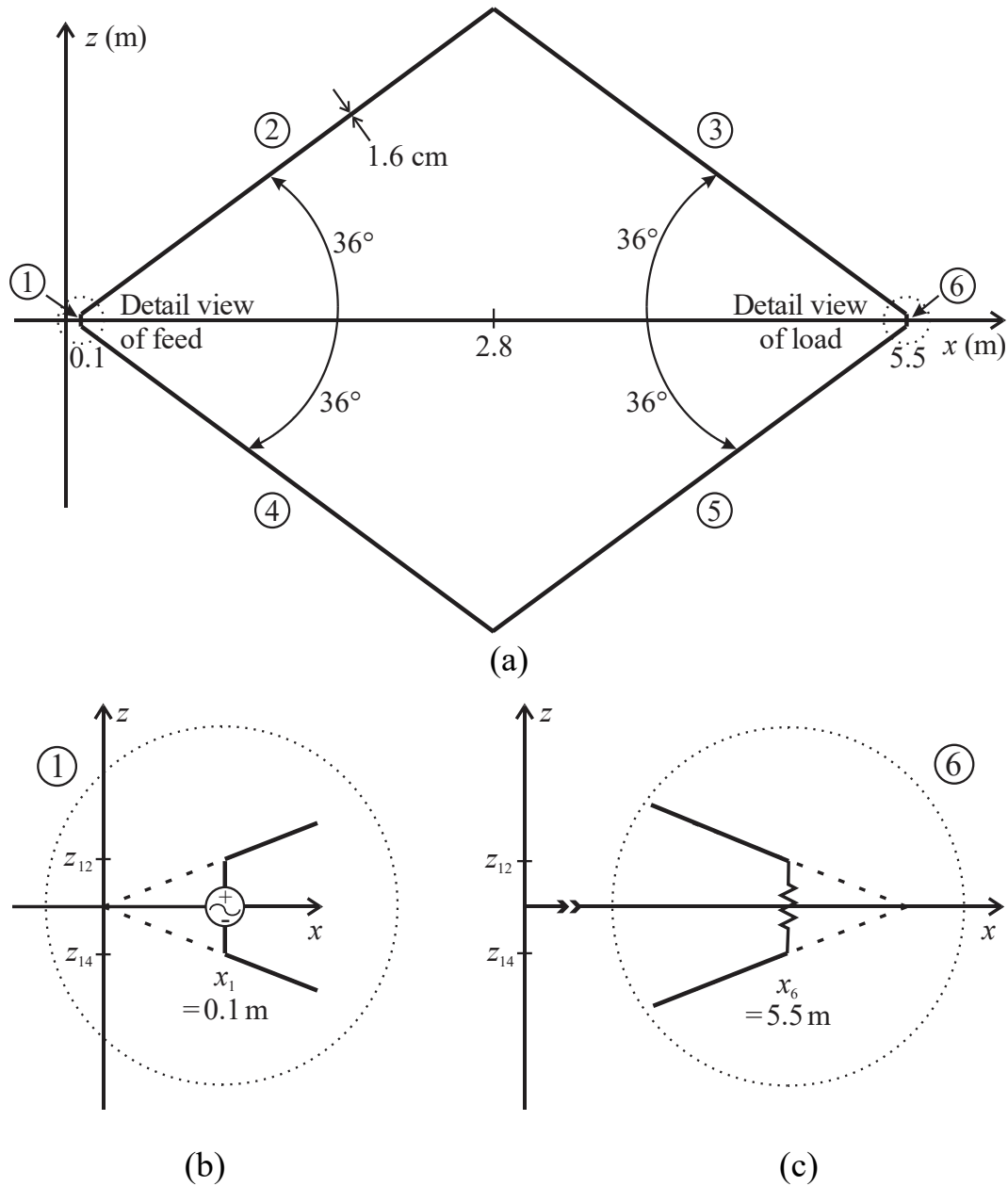


Figure 1 (a) Rhombic Antenna, (b) detail view of feed, and (c) detail view of load.

For this assignment, you will write the NEC-2 commands needed to model and obtain data for/about the rhombic antenna, located on x - z plane symmetrically about $z = 0$, shown in Figure 1. The antenna is meant to operate from 100 - 300 MHz. To drive the antenna, place a voltage source centered on section 1. The antenna is terminated with a resistive load centered on section 6. As shown, lines through sections 2 & 4 converge at origin. Let $c = 2.998 \times 10^8$ m/s to agree with NEC-2.

- 1) Using geometry & trigonometry, find the points P_{ij} where the sections connect as well as the lengths l_i of sections 1 - 6. Clearly shown work in appendix titled 'Geometry Calculations'. Keep up to 6-7 significant figures. Use units of **meters**.

$P_{12} =$ _____ $P_{14} =$ _____

$P_{23} =$ _____ $P_{45} =$ _____

$P_{36} =$ _____ $P_{56} =$ _____

$l_1 =$ _____ $l_2 =$ _____ $l_3 =$ _____

$l_4 =$ _____ $l_5 =$ _____ $l_6 =$ _____

- 2) All sections are made with the same wire. Select segment sizes Δ_{16} and Δ_{25} (**in cm**) for sections 1 & 6 as well as sections 2 - 5. Note: Δ_{16} and Δ_{25} may or may not be equal. Restrictions: Each section must have an integer number of segments and do NOT exceed **250 segments** in total. Justify your design decisions in appendix titled 'Segment Selection'. List the number of segments used for each section as well as the total number of segments N_{Δ} . Is the extended thin-wire kernel necessary? Why?

$\Delta_{16} =$ _____ $\Delta_{25} =$ _____

$N_1 =$ _____ $N_2 =$ _____ $N_3 =$ _____ $N_4 =$ _____

$N_5 =$ _____ $N_6 =$ _____ $N_{\Delta} =$ _____

EK? _____

- 3) Write the geometry commands necessary to model the wires for the rhombic antenna for the segment sizes selected. Assume the antenna is in free space. Assign TAG numbers to wires based on the section numbering shown in Figure 1. Use up to 6-7 significant figures for dimensions.

- 4) Write the program control commands needed to either use the standard or extended thin-wire kernel, model the antenna as being made with wires with a conductivity of $3 \times 10^7 \text{ S/m}$, and place a 750Ω resistive load centered on antenna section 6.

- 5) Write the program control commands necessary to simulate the antenna from 100 to 300 MHz in 10 MHz steps (generate an impedance table) and to place a voltage source of $100 \angle 0^\circ \text{ V}$ centered on antenna section 1.

- 6) Write the program control command(s) necessary to output **only** the currents for the segments on antenna sections 2 and 3.

- 7) Write the program control commands necessary to output the far-field radiation patterns for **only** the x - z plane (elevation) for $-179^\circ \leq \theta \leq 180^\circ$ in 1° increments and **only** the x - y plane (azimuthal) for $0 \leq \phi \leq 359^\circ$ in 1° increments. Output the unnormalized gain with no averaging.

- 8) Write the program control command(s) to mark the end of the input file.

- 9) **EE 483 only:** Use work in prior steps as the basis for a NEC-2 input file to simulate this rhombic antenna **only** at 200 MHz to determine the input impedance, efficiency (%), maximum gain (dBi), corresponding angle(s) θ & ϕ (deg) where the maximum gain occurs (check both azimuthal and elevation planes), and the half-power beamwidths (deg) in the elevation and azimuthal planes. Add comment lines at the beginning of the input file(s) (e.g., filename, course, *your name*, date, etcetera) as well as at the end of each line to describe what you are doing. Include a listing of your NEC-2 input file and excerpts from output file(s) with desired quantities in **bold**. Consolidate answers in a table (put table before output file excerpts).
- 10) **EE 583 only:** Use work in prior steps as the basis for a NEC-2 input file to simulate this rhombic antenna **only** at 200 MHz to determine the input impedance, efficiency (%), maximum gain (dBi), corresponding angle(s) θ & ϕ (deg) where the maximum gain occurs (check both azimuthal and elevation planes), and the half-power beamwidths (deg) in the elevation and azimuthal planes. In addition, plot the azimuthal and elevation radiation patterns (clearly labeled, in dB, normalized, & with center at -30 dB). Add comment lines at the beginning of the input file(s) (e.g., filename, course, *your name*, date, etcetera) as well as at the end of each line to describe what you are doing. Include a listing of your NEC-2 input file(s) and excerpts from output file with desired quantities in **bold**. Consolidate answers in a table (put table before output file excerpts).

Due Thursday, February 22, 2024.