EE 483L/583L Antennas for Wireless Communications (Spring 2026)
Laboratory 6- Yagi-Uda Antenna Design

Background

For this project, design a Yagi-Uda antenna for a **locally available** ***over-the-air*** UHF television (TV) channel with a gain of 10 dBi or greater. Other specifications (implemented later) are that the antenna shall be fed, using a 50 Ω coaxial transmission line, such that the antenna has a VSWR < 1.1 at the center frequency and VSWR < 1.75 across the frequency band of the TV station. You will be building this antenna later using a 1/2" (I.D.) copper pipe boom.

Think practical! For matching, the first three elements need to be length-adjustable, i.e., have telescoping tips that are slightly larger/smaller in diameter. Are brass elements in your diameter available? Are brass telescoping pieces that *tightly* your element diameter available? Can you reasonably drill holes in a 1/2" copper pipe for elements?

Project

1) **Tabulate** specifications (e.g., UHF TV channel, frequency band, center frequency, etcetera).
2) Design a Yagi-Uda antenna, **without** a matching network or boom, to the specifications described above. Assume elements are made of commercially-**available** brass ($\sigma_{brass} = 1.1 \times 10^7$ S/m) pipes. All work, including design figures and/or tables, should be included in a logbook and report, and chronicled in a fashion that another engineer can easily follow. As an initial estimate, let the length l_2 of the driven element be a simple average of the lengths of the reflector l_1 and first director l_3. Describe/justify all design choices. **Tabulate** diameters, spacing(s), and then lengths of all elements. Format- col. 1 description, col. 2 0.xxxλ, and col. 3 (cm).
3) Write and run a NEC-2 input file to find the input impedance and maximum gain G_{max} of your Yagi-Uda antenna at f_l, f_c, & f_h (low, center, & high frequencies of UHF TV channel). Put antenna on the *y*-*z* plane ($x = 0$) with the elements parallel to the *y*-axis, reflector centered on origin, and driven & director elements spaced along the positive *z*-axis (i.e., antenna points up). Model the driven element as being center-fed. Iteratively adjust length l_2 of driven element until resonance is achieved (i.e., $|X_A| < 0.1$ Ω) at f_c. **Tabulate** before/start (col. 2) and final (col. 3) results. Format- col.1 descriptions, row 1 l_2 (cm), row 2 l_2/λ_c, row 3 $Z_A(f_l)$, row 4 $Z_A(f_c)$, row 5 $Z_A(f_h)$, row 6 $G_{max}(f_l)$, row 7 $G_{max}(f_c)$, and row 8 $G_{max}(f_h)$.

   Note: After adjusting to resonance, l_2 may be less than l_3. For steps 4-7, use adjusted value of l_2 if $G_{max} \geq 10$ dBi. If not, use the initial estimate.

4) Accurately draw resulting Yagi-Uda antenna with all relevant dimensions (in cm) included.
5) Write and run a NEC-2 input file to find the input impedance of the antenna over $f_c \pm 5$ MHz. Plot the input resistance R_A and reactance X_A versus frequency (MHz) on a single graph. Indicate f_l, f_c, & f_h. Also, find and **tabulate** the input impedance, radiation resistance, loss resistance, and efficiency at f_c.

6) At f_c, write and run a NEC-2 input file to determine the current distribution along each of the elements. On a single graph, plot the **normalized magnitude** of the currents versus element y-axis position (in cm). Normalize all currents by the maximum current magnitude (include in caption) on the **driven** element. **Clearly** label each curve by element, e.g., l_1 (reflector), l_2 (driven), l_3 (director 1), etcetera.

7) At f_c, write and run NEC-2 input file(s) to determine the far-zone E-plane (y-z plane) and H-plane (x-z plane) power **gain** radiation patterns (in dBi). On **two** polar graphs, plot the <u>normalized/relative</u> radiation patterns for the E-plane and H-plane scaled so that the center of each plot is at –40 dB and outer ring is at 0 dB with $\theta = 0°$ at the top. In a **table**, list the maximum power gain (in dBi), E-plane & H-plane HPBWs, maximum relative sidelobe levels (in dB), and front-to-back ratio/FB (in dB).

8) Summarize and comment on design and modeling results.

<u>Report and Logbook</u> (You may work in groups of two.)

- Show initial work in logbook.
- Following syllabus guidelines, compose a short report on this lab.

Report and logbook due by Tuesday, March 24, 2026 by 4 pm at office or EECS mailbox.