# EE 483L/583L Antennas for Wireless Communications (Spring 2025)
# 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. The first three elements need to be length-adjustable, i.e., have telescoping tips that are slightly larger/smaller in diameter. Think practical!

## 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. For design purposes, 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** spacing(s) and lengths of all elements (0.xxxλ & 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 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., $|X_A| < 0.1\ \Omega$) at $f_c$. **Tabulate** results. Format- col. 1 $l_2$ (cm), col. 2 $l_2/\lambda_c$, col. 3 $Z_A(f_l)$ , col. 4 $Z_A(f_c)$ , col. 5 $Z_A(f_h)$, and col. 6 $G_{max}$.

   **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 normalized/relative 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.

**Report** (You may work independently or in pairs.)

- Following syllabus guidelines, compose a short report on this lab.

**Report & logbook due Thursday, March 20, 2025 at my office of EECS mail box.**