EE 483L/583L Antennas for Wireless Communications (Spring 2025)
Laboratory 7- Yagi-Uda Match Design

Background

For this project, design a modified Gamma match for your Yagi-Uda antenna design of Laboratory 6 **after** any necessary corrections. The goal is for the antenna to have a VSWR < 1.1 at the center frequency and VSWR < 1.75 across the frequency band of the UHF television (TV) station when fed using a **50 Ω** coaxial transmission line.

Project

1) Before matching, **tabulate** a summary of your *no boom* antenna design (channel, center frequency, # elements, lengths, spacings, etc.) with driven element length set for *resonance* at f_c. At the low f_l, center f_c, and high f_h frequencies (columns) of the selected UHF TV channel, find & **tabulate** (rows) input impedance $Z_{in} = Z_a$ (rectangular format) & reflection coefficient Γ_{in} (polar format), VSWR, mainbeam G_{max} & backlobe G_{back} gains (dBi), and front-to-back ratio/FB (dB).

2) At f_c, design a **modified Gamma match** for your Yagi-Uda antenna **without the boom**, i.e., NO boom length compensation & NO boom in NEC-2 model. At each step, detail & comment on design choices, e.g., what are you changing/selecting, values, and why. **SHOW ALL WORK*. Tabulate** a summary of your starting and final designs (similar to step 1 with addition of match). (* For brevity, you can omit obviously wrong steps in report.)
   - For design/modeling purposes, assume the elements and modified Gamma match are made of commercially-available brass ($\sigma_{brass} = 1.1 \times 10^7$ S/m) pipes.
   - In the NEC-2 model(s), place the antenna on the *y*-*z* plane w/ elements parallel to *y*-axis.
   - Let the modified Gamma match portion of the driven element (modeled as wire of equivalent radius a_e) start at $y = 0$ and go to $y = l'/2$. To attempt to partially account for the use of a boom on a physical antenna, place the feed at the **second segment** out from $y = 0$ on the modified Gamma match portion of the driven element, make $\Delta \leq 1$ cm and use the EK 0 command in NEC-2 model.
   - Input NEC-2 file(s) and relevant excerpts of output file(s) should be included in logbook/report as used. Modeling choices should be explained and justified (e.g., selection of segment length Δ).

3) Write a NEC-2 input file to find Z_a, G_{max}, and G_{back} for your matched antenna at f_l, f_c, & f_h. Calculate the FB ratio, Z_{in}, Γ_{in} (polar format), and VSWR at each frequency. For these frequencies (columns), **tabulate** Z_{in}, Γ_{in}, VSWR, G_{max}, G_{back}, and FB ratio (rows). How they compare to the un-matched antenna? Comment on VSWR at the band edges. Does it meet the specifications?

4) Using Fig 10.26 (include in logbook/report), compute the boom compensation at f_c. Assume the boom diameter D is 5/8" (outer diameter for 1/2" copper pipe). Apply the full boom compensation to the element lengths found after steps 1 & 2. Apply half the boom compensation to the modified Gamma match length. **Tabulate** the resulting elements lengths l_i, spacings s_{ij}, & diameters $2a$, modified Gamma match length $l'/2$, spacing s, and diameter $2a'$. The table should have three columns- col. 1 is variable description/label, col. 2 is values (cm) before boom compensation, and col. 3 is values (cm) with boom compensation.

5) Accurately draw the resulting antenna with the modified Gamma match and boom. Include all relevant dimensions (cm). Offset your modified Gamma match by $D/2 + \Delta y$ to avoid overlapping the boom. Assume $\Delta y = 2$ mm (slightly larger than the center conductor to shield spacing for a typical 50 Ω coaxial transmission line). The modified Gamma match should be placed between the driven and reflector elements.
6) Summarize and comment on results.

Report (You may work independently or in pairs if jointly building antenna.)

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

Report & logbook due Wednesday, April 2, 2025 at class.