EE 483/583 Antennas for Wireless Communications
Spring 2022 Laboratory 4- Yagi-Uda Antenna Construction & Matching

Background

For this project, you or your team (2 students max) will construct and impedance match the Yagi-Uda antenna designed in previous labs for a local UHF television (TV) station. It should have a gain ≥ 10 dBi, and VSWR < 1.1 at center frequency and VSWR < 1.8 across the frequency band of the selected UHF TV station when fed using a 50 Ω coaxial transmission line (supplied by instructor).

Project

After consulting with instructor, buy parts, and build the antenna, including the matching network, per your design to meet the specifications listed above. See instructor for tools & help. Comment on and describe all work, especially any changes from original design. Some items to consider are:

- Start with a tabulated summary of the initial (after Lab #3) matched & boom-compensated design.
- Will the diameters, lengths, centering, spacing, and alignment of boom & elements as well as matching network of the antenna actually built conform to exactly to this initial design? If not, detail adjustments/changes being made? (e.g., telescoping pieces, changes in *s*, …)
- Is the boom long enough to attach antenna to an antenna mast without interference?
- Is antenna mechanically sturdy? I.e., Can it withstand the *fingernail* & '**FAT PIGEON**' tests?
- Is the antenna presentable to a customer? (consider cleanliness, sharp edges, …)
- Tabulate **estimated costs and parts list**. The table should have columns listing: description of item(s), purchased quantity, overall cost (exclude taxes), estimated quantity used, estimated pro-rated cost (i.e., cost of materials actually used), and supplier(s) with addresses. E.g., if you need 18 inches of 1/8 inch pipe, but the minimum length available is 36 inches costing $3, itemize the 36-inch pipe & cost ($3), amount used (18 inches) & pro-rated cost (18/36*$3 = $1.50). The boom, coaxial cable, and BNC connector will be supplied by the instructor (SDSM&T EE department is the supplier). Go on-line to estimate the costs (e.g., Menards, Amazon). You do not need to list lab/shop materials (e.g., solder, paste flux, …). At the bottom of the table, give total estimated cost & pro-rated cost of the antenna.

Experiment

1) **Before** making any matching adjustments to the antenna (i.e., set all lengths to design values), work with instructor to use a vector network analyzer (VNA) to collect data and/or graphs needed to plot VSWR, linear magnitude of the reflection coefficient (AKA $|s_{11}|$), and antenna input impedance Z_{ant} (both Smith chart and rectangular format) for f_c ± **10 MHz** (f_c is the center frequency of your antenna).

   Note: The names of the data/graphics files should be recorded in the logbook as taken. The actual files should be available in/with logbook (e.g., USB flash drive).

2) Then, match the antenna using a VNA with instructor assistance. Collect the data and/or graphs needed to plot the VSWR, $|s_{11}|$, and Z_{ant} (both Smith chart and rectangular format) for f_c ± **10 MHz**.

3) On four consecutive pages in logbook & report generate (show applicable equations if necessary) and insert four pairs of plots showing the: 1) VSWR, 2) $|s_{11}|$, 3) Z_{ant} in Smith chart format, and 4) Z_{ant} in rectangular format before (top) and after (bottom) matching for f_c ± **10 MHz**. On the plots, indicate the lower f_l, center f_c, and high f_h frequencies of the selected UHF TV channel.

4) Accurately draw the actual Yagi-Uda antenna after construction **and** matching, include all relevant dimensions. Compare and contrast with the actual antenna with the preliminary design.

5) Summarize/comment on results.

Logbook, report, and antenna due Thursday, April 21, 2022 at my office by 4 pm.