Monday, March 28, 2022

EE 483/583 Antennas for Wireless Communications
Spring 2022 Laboratory 3- Yagi-Uda Antenna Matching Design

Background

For this project, design a modified Gamma match for your Yagi-Uda antenna design of Laboratory 2. The goal is for the antenna to have a VSWR < 1.1 at the center frequency and VSWR < 1.8 across the frequency band of the UHF television (TV) station when fed using a 50 Ω coaxial transmission line.

Project

1) Before matching, summarize *no boom* antenna design (channel, lengths, spacings, etc.) with driven element length at **resonance** at center frequency. At the low f_l, center f_c, and high f_h frequencies of the selected UHF TV channel, find & tabulate input impedance, and mainbeam & backlobe gains.

2) At f_c, design a **modified Gamma match** for your Yagi-Uda antenna of Laboratory 2 **without the boom**, i.e., NO boom length compensation & NO boom in NEC model. At each step, detail & comment on design choices, e.g., what are you changing/selecting, values, and why. Summarize final design. **SHOW ALL WORK*.** (* For brevity, you can omit obviously wrong steps.)
   - 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.
   - Input NEC 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 determine the input impedance, gain, and front-to-back (FB) ratio of your matched antenna at f_l, f_c, & f_h. Calculate the input reflection coefficient (polar format) and VSWR at each frequency. For these frequencies (rows), **tabulate** the input impedance, input reflection coefficient, VSWR, gain (dBi), and FB ratio (dB). Comment on how they compare to the un-matched antenna. Comment on the VSWR at the band edges. Does it meet the specifications?

4) Using Fig 10.26 (include figure in logbook), compute the boom compensation at f_c. Assume the boom diameter is D = 1.5 cm, a value between the typical 9/16" and 5/8" outer diameters of common 1/2" copper pipe. Apply the full boom compensation to the element lengths found after steps 1 & 2, and apply half the boom compensation to the modified Gamma match length. Tabulate the resulting elements lengths l_i and diameters $2a$, modified Gamma match length $l'/2$, spacing *s*, and diameter $2a'$. The table should have three columns- column 1 is variable description/label, column 2 is values without boom compensation, and column 3 values 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 of a 50 Ω coaxial transmission line). It should be placed between the driven and reflector elements.

6) Summarize and comment on results.

Due Friday, April 1, 2022 by 4 pm at my office (MDT).