EE 483/583 Antennas for Wireless Communications (Spring 2024)
Homework 8
Tuesday, March 19, 2024

1) Here, you will match the six-element Yagi-Uda antenna for channel 13 from the previous assignment **with the boom omitted** to a **100 Ω** twin-lead transmission line using a **T-match** so that the VSWR is less than 1.1 at the center frequency f_c. Steps:
   a) Tabulate the element lengths and spacings (in cm) for the unmatched design (make driven element length the simple average of the reflector and first director).
   b) Model **unmatched design** using NEC-2 and determine and tabulate input impedance Z_a, input reflection coefficient Γ_{in} (polar format), VSWR, maximum gain G_{max} (dBi), backlobe gain G_{back} (dBi), and front-to-back/FB ratio (dB) at f_c.
   c) Match the antenna. At each step, discuss, list, and justify design changes/choices as well as show results/work.
   d) In a **table**, summarize the original (unmatched) and final (matched)- Z_a or Z_{in}, Γ_{in}, VSWR, G_{max} (dBi), G_{back} (dBi), and FB ratio (dB) at f_c. Comment on how the final design compares with the original.
   e) Accurately sketch final antenna design with T-match (no boom).
      - Include the input NEC-2 file(s) and relevant excerpts of the output file(s). Assume $c = 2.998 \times 10^8$ m/s.

2) You have an antenna with input impedance $Z_A = 12.5 + j\,40\ \Omega$ at 200 MHz. Match it to a feeding transmission line ($Z_0 = 50\ \Omega$ & $u = 2.5 \times 10^8$ m/s) using a discrete inductor connected in series as close to the antenna as possible. Draw a fully labeled sketch of the final design.

3) An antenna has input impedance $Z_A = 80 - j\,120\ \Omega$ at 105 MHz. Match it to a feeding transmission line ($Z_0 = 80\ \Omega$ & $u = 2.1 \times 10^8$ m/s) using a stub of the same transmission line with an short-circuit termination. Place the stub as close to the antenna as possible and make the stub as short as possible. Draw a fully labeled sketch of the final design.

4) An antenna has input impedance $Z_A = 80 + j\,45\ \Omega$ at 125 MHz. Match it to a feeding transmission line ($Z_0 = 50\ \Omega$ & $u = 2.5 \times 10^8$ m/s) using a quarterwave transformer (QWT) placed as close to the antenna as possible. Assume the wavelength λ' of the QWT is 90% of λ for the feeding transmission line. Draw a fully labeled sketch of the final design.

5) **EE 583 only**: For the match of problem 2, **analytically** find the input impedance Z_{in}, reflection coefficient Γ_{in}, and VSWR at 195, 200, & 205 MHz on the feeding transmission line just past the inductor toward the generator assuming Z_A remains constant. Tabulate results- col. 1 frequency, col. 2 Z_{in} (rectangular format), col. 3 Γ (polar format), and col. 4 VSWR.

Due Tuesday, March 26, 2024

- For each problem using a Smith chart, include a *separate*, **fully labeled** chart.