Homework 3
EE 381 Electric & Magnetic Fields (Fall 2024)
Wednesday, September 18, 2024

1) A lossless transmission line ($Z_0 = 50\ \Omega$, $u = 2.08 \times 10^8$ m/s) of length $28.8\,\lambda$ is terminated with an unknown load. Using a vector network analyzer (VNA), an input reflection coefficient of $\Gamma_{in} = 0.50\angle 60°$ is measured. The transmission line (TL) is then connected to a generator with a voltage $36\angle 0°$ V and impedance $50\,\Omega$ operating at 2 GHz. Draw the TL circuit. Then, determine the (a) propagation constant & wavelength, (b) input impedance, (c) phasor current & voltage and time-average power at the input, (d) phasor forward voltage wave amplitude, (e) phasor current & voltage and time-average power at the load.
2) Repeat the previous problem if the transmission line is now assumed to be lossy with a measured attenuation of 18 dB/100 ft.
3) For a matching network, a radar engineer needs a capacitive reactance of $-j40\,\Omega$ at a frequency of 4 GHz. To achieve this goal, they are required to use stubs made from $50\,\Omega$ coaxial transmission line with a phase velocity of 2.5×10^8 m/s. To allow connectors to be attached, the stubs must have a minimum length of 2 cm. Find the length of the shortest possible stubs with (a) open-circuit and (b) short-circuit terminations and sketch the resulting equivalent circuits.
4) 11.40 Use Smith chart. Also, determine input reflection coefficient.
5) 11.43 Use Smith chart. Also, determine the maximum and minimum impedances along the transmission line. Put locations in terms of wavelength λ.
6) 11.49 Use Smith chart. First, calculate wavelength λ.

Due Wednesday, September 25, 2024.

Notes:

- Express all currents, voltages, & reflection coefficients in the polar/phasor format with angles in degrees (e.g., $10\angle 30°\,\text{V}$). Express impedances in rectangular format (e.g., $10 + j30\,\Omega$).
- Where relevant, use **one** Smith chart per problem inserted immediately after the corresponding problem. **Clearly label** all work and relevant quantities on each Smith chart (e.g., Z_0, f or λ, all points, arcs, distances, …).