**ECEG 497** **Wireless System Design** **Spring 2025**

**Homework Assignment #9 – not graded**

***Ungraded Problems:***

The following problems will not be graded. They are intended to provide you with examples, clarifications, and practice as you prepare for the final exam. Given that the Smith chart was covered only on the last two days of class this semester, some of these problems involve concepts that are more advanced than those that will appear on the final exam. Nevertheless, they should provide additional insight and experience to help you gain confidence with the more fundamental aspects of the Smith chart and how it is used.

**1.** Using the Smith chart, find the reflection coefficient that corresponds to a load impedance of 25 + $j$60 Ω located at the end of a transmission line with a characteristic impedance of 50 Ω.

**2.** Using the Smith chart, find the input impedance of an air-insulated transmission line with a length of 5.0 m, a characteristic impedance of 450 Ω, and a load of 600 – $j$200 Ω that is operating at 10 MHz.

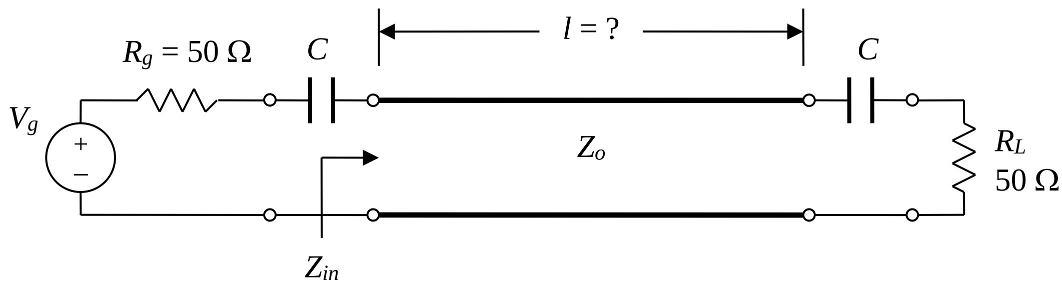
**3.** Attached to this assignment is a Smith chart that has several paths indicated on it. Sketch the matching system that the paths on the Smith chart correspond to (i.e., the physical arrangement of capacitors, inductors, and transmission lines). Assume that the reactances and/or susceptances, if any, are lumped elements. Indicate on your sketch any capacitance and/or inductance values and the lengths and characteristic impedances of any transmission line sections. The system impedance (normalizing impedance) is 75 Ω, and the operating frequency is 195 MHz (the center of the spectrum allocated to cable TV channel 10). The load is indicated by point A on the chart. The path from the load proceeds from A to B to C, clockwise from C to D, then to E and finally to the center.

**4.** Use the immittance form of the Smith chart to design a lumped element L network to match a load of 12 Ω to a source impedance of 50 Ω at an operating frequency of 1.0 MHz. Sketch and label a diagram of the resulting network. Use an inductor as the series element and a capacitor as the shunt element.

**5.** Use the Smith chart (impedance-only version is fine) to determine the maximum and minimum transformed resistances and maximum and minimum transformed reactances that would be seen along a 50 Ω transmission line having a length of at least one-half wavelength and a VSWR of 3.0, which corresponds to a load of 18.2 + $j$14.3 Ω. In other words, determine the range of impedances that would be measured along the length of the line.

(*continued on next page*)

**6.** Filters can be made from transmission line sections as well as from lumped elements. As shown in the figure below, a simple band-pass filter can be made using coupling capacitors at either end of a transmission line section. The network has an input impedance of 50 Ω at only one frequency. A mathematical analysis of the network does not provide much insight into how or why this type of filter works, but a Smith chart analysis makes it fairly clear. Use a Smith chart (impedance-only version should be sufficient) to find the line length $l$ for the transmission line-based coupled-resonator band-pass filter shown in the figure if the coupling capacitors are to have reactances of –200 Ω each at a center frequency of 432 MHz. Find the required capacitor values as well. The line section is to be made from coaxial cable with a characteristic impedance of 50 Ω and a velocity factor of 0.66 (i.e., the cable has polyethylene insulation with $\varepsilon_r = 2.25$).




(*The Smith chart referred to in Prob. 3 follows on the next page*)

NAME TITLE DWG. NO.

DATE

# NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES

A: $z_L = 0.2 + j\,1.4 = z_A$

B: $z_B = 0.2 + j\,0.675$

C: $z_C = 0.78 + j\,1.15$

D: $z_D = 0.4 - j\,0.6$

E: $z_E = 0.4 + j\,0.49$