

ECE 391: Suggested Homework Problems

Smith Chart - Stub Matching Networks

1. Consider the circuit below. A generator with $R_o = 75\Omega$ is connected to a complex load of $Z_L = 100 + j100\Omega$ through a transmission line of arbitrary length with $Z_o = 75\Omega$ and $v_p = 0.8c$. Using a Smith Chart, evaluate the line for stub tuning using shorted series stub. The generator is operating at 100Mhz. Find:
- the electrical length of λ on the transmission line
 - the normalized load impedance
 - the closest stub location as measured from the load
 - the next closest stub location as measured from the load
 - the length of the stub at the closest location.
 - the length of the stub at the next closest location.
 - the lumped load element value that could take the place of the stub at the nearest location
 - the lumped load element value that could take the place of the stub at the second nearest location

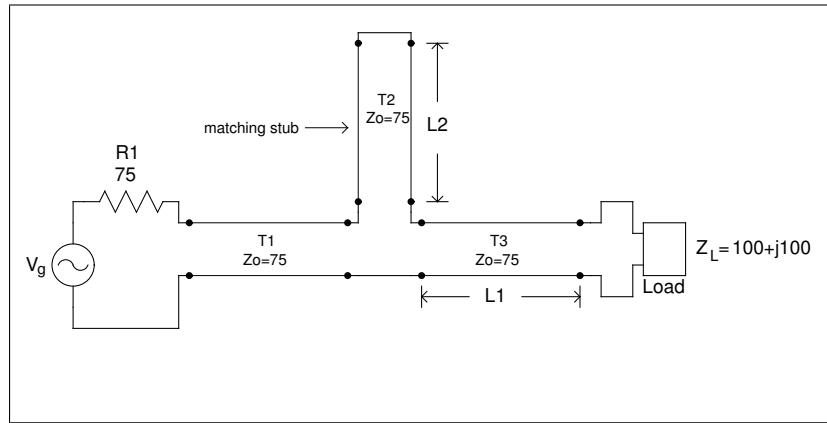


Figure 1: Problem 1

2. For the following system parameters:

Frequency of operation: 300 Mhz

Impedance of Load: $100 + j156\Omega$

Feedline $Z_o = 50\Omega$, $v_p = 0.89c$

Feedline length from generator to stub is 50ft

Design the following matching networks:

- (a) Series stub matching network with short circuit stub at nearest position
- (b) Shunt stub matching network with short circuit stub at nearest position
- (c) Series stub matching network with open circuit stub at second nearest position
- (d) Shunt stub matching network with open circuit stub at second nearest position

For each of the networks:

- (i) determine the position of the stub
- (ii) the length of the stub
- (iii) the equivalent inductance or capacitance that the stub represents at 300Mhz

3. A Vector Network Analyzer (VNA) is attached to the end of a lossless, 15m long transmission line (50Ω , $\epsilon_r = 2.3$) operating at 220Mhz. The VNA shows an input impedance of $Z_{in} = 75 - j35$. Use shunt stub matching to match the load to the input end of the coax.

- a) Using Smith Chart #1, find the SWR on the line as it is presently.
- b) Using Smith Chart #1, find the normalized, denormalized, and equivalent circuit of the load impedance Z_L at the far end of the line. Your equivalent circuit must show the correct schematic symbols (L and/or R and/or C) and the values of each symbol.
- c) Using Smith Chart #1, find the normalized load admittance Y_L at the far end of the line.
- d) Using Smith Chart #1, find the distance in both λ and meters from the load to the first matching point.
- e) What is the normalized admittance at the first match point?
- f) Using Smith Chart #2, find the shortest stub to match the susceptance found at the first match point. Give the length of the stub in both λ and meters.

State if your stub is an open or short circuit.

- g) If fabrication of a coaxial stub was not feasible but a lumped matching element was necessary, draw the component schematic symbol and give its value.
- h) After the matching network is connected, where do standing waves exist and where do they not exist in this system? In your answer include the lengths (i) from input to stub, (ii) along the stub, and (ii) between stub and load.

- i) After applying the matching network, what is the SWR at the input to the line?