THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering

ELEC 311 – Electromagnetic Fields and Waves

Smith Chart Practice

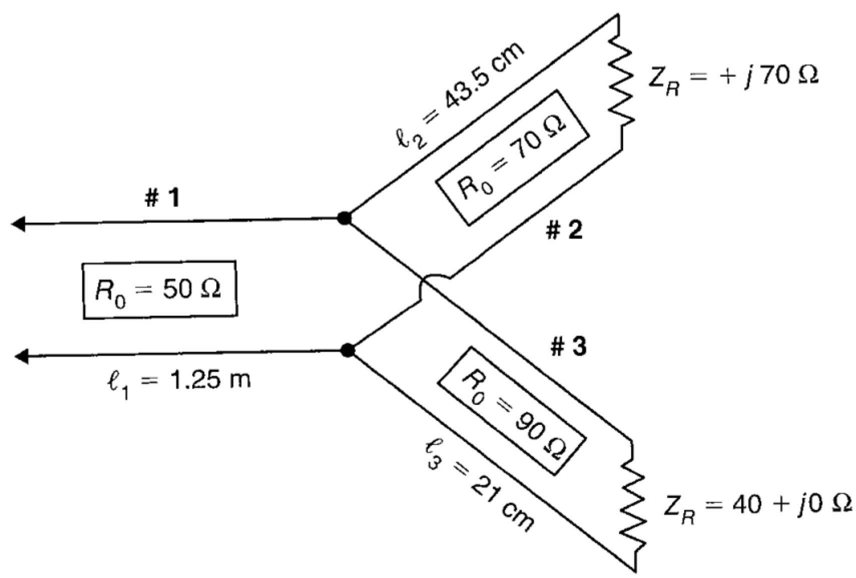
The high-frequency lossless transmission system shown below operates at 700 MHz with a phase velocity in each line section of 2.1 x 10^8 m/s. Use the Smith Chart to find the VSWR on each section of line and the input impedance to line #1 at the drive point.

There are three distinct transmission line problems to be solved. In the figure below, R_0 is equivalent to Z_0.

a. VSWR of Line #2 [10]

b. VSWR of Line #3 [10]

c. VSWR of Line #1 and the input impedance [10]



Solution

For the three lines the wavelength is $\lambda = (2.1 \times 10^8)/(7 \times 10^8) = 30$ cm. For line #2 the length is $(43.5/30)\lambda = 1.45\lambda$ and the normalized load is $(0 + j70)/70 = j1$. Plot this value as point **1** in Fig. 15-23. Note the reference position, 0.125λ and VSWR $= \infty$. Move on the VSWR circle 1.45λ *toward the generator* to point **2** and read the value $z_{in} = 0 + j0.51$. The input impedance to line #2,

$$Z_{in2} = z_{in} R_{02} = 0 + j35.7\ \Omega$$

is one part of the load on line #1.

For line #3 the length is $\frac{21}{30} = 0.7\lambda$ and the normalized load is $(40 + j0)/90 = 0.44 + j0$. Plot this value as point **3** and note the reference position of 0λ and the VSWR $= 2.25$. Move on the VSWR circle 0.7λ *toward the generator* to point **4**, and read off

$$z_{in} = 1.62 + j0.86 \qquad \text{or} \qquad Z_{in3} = z_{in} R_{03} = 145.8 + j77.4\ \Omega$$

This is the second part of the load on line #1.

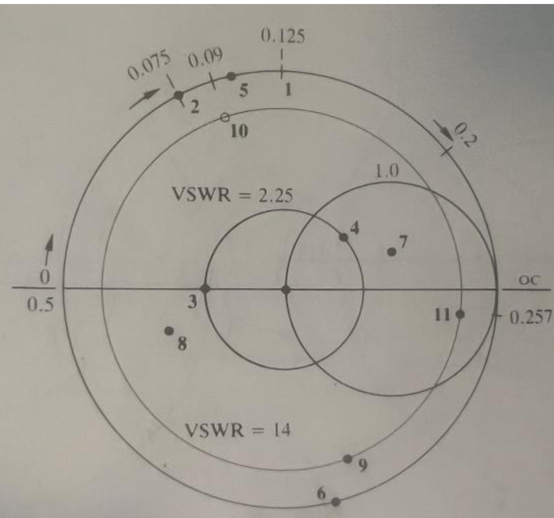


Fig. 15-23

For line #1: the length is $1.25/0.30 = 4.167\lambda$ and the load is the parallel combination of Z_{in2} and Z_{in3}. Normalize each impedance to the 50-Ω line, find each admittance, add the admittances for y_R, and then find z_R.

$$z_2 = j\left(\frac{35.7}{50}\right) = 0 + j0.714 \quad \text{(point 5)} \qquad \text{and} \qquad y_2 = 0 - j1.41 \quad \text{(point 6)}$$

$$z_3 = \frac{145.8 + j77.4}{50} = 2.92 + j1.55 \quad \text{(point 7)} \qquad \text{and} \qquad y_3 = 0.27 - j0.14 \quad \text{(point 8)}$$

$$y_R = 0.27 - j1.55 \quad \text{(point 9)} \qquad \text{with} \qquad \text{VSWR} = 14$$

Invert by moving a diameter across to point **10** for $z_R = 0.1 + j0.63$ at the reference position 0.09λ. Now move 4.167λ *toward the generator* from z_R on the VSWR $= 14$ circle to point **11**, and read $z_{in} = 9.5 - j6.3$. The input impedance to line #1 is

$$50(9.5 - j6.3) = 475 - j315\ \ \Omega$$