15.10. A 70-Ω high-frequency lossless line is used at a frequency where $\lambda = 80$ cm with a load at $x = 0$ of $(140 + j91)$ Ω. Use the Smith Chart to find: Γ_R, VSWR, distance to the first voltage maximum from the load, distance to the first voltage minimum from the load, the impedance at V_{max}, the impedance at V_{min}, the input impedance for a section of line that is 54 cm long, and the input admittance.

Mathcad

On the Smith Chart plot the normalized load $Z_R/R_0 = 2 + j1.3$, as shown in Fig. 15-21. Draw a radial line from the center through this point to the outer λ-circle. Read the angle of Γ_R on the angle scale: $\phi_R = 29°$. Measure the distance from the center to the z-point and determine the magnitudes of Γ_R and VSWR from the scales at the bottom of the chart.

$$|\Gamma_R| = 0.50 \qquad \text{VSWR} = 3.0 \qquad \text{and} \qquad \Gamma_R = 0.5\,\underline{/29°}$$

Draw a circle at the center passing through the plotted normalized impedance. Note that this circle intersects the horizontal line at $3 + j0$. This point of intersection could be used to determine the VSWR instead of the bottom scale, because the circle represents a constant VSWR. Locate the intersection of the VSWR circle and the radial line from the center to the open-circuit point at the right of the z-chart. This intersection is the point where the voltage is a maximum (the current is a

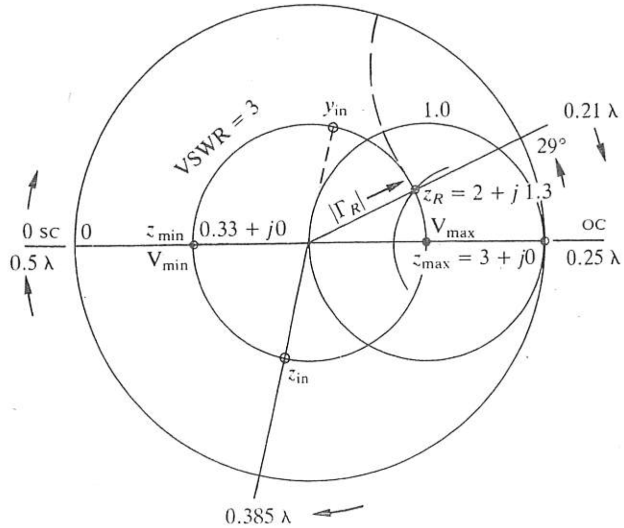

Fig. 15-21

minimum) and the impedance is a maximum. The normalized impedance at this point is $3 + j0$, whence $Z_{max} = 210 + j0$ Ω. To find the distance from the load to the first V_{max} use the outer scale (*wavelengths toward the generator*). The reference position is at 0.21λ and the max. line is at $0.25\,\lambda$; so the distance is 0.04λ toward the generator, or 3.2 cm from the load.

From the V_{max} point move 0.25λ toward the generator and locate the V_{min} point. The normalized impedance is $0.33 + j0$, and $Z_{min} = 23.1 + \text{j}0$ Ω. The distance from the load to the first minimum is

$$0.25\lambda + 0.04\lambda = 0.29\lambda = 23.2 \text{ cm}$$

To find the input impedance, move $\frac{54}{80} = 0.675$ wavelengths from the load toward the generator, and read the normalized impedance. Once around the circle is 0.5λ, so locate the point that is 0.175λ from the load on the outer scale. The point is at $0.21\lambda + 0.175\lambda = 0.385\lambda$. Through this point draw a radial line and locate the intersection with the VSWR circle. The normal impedance is $0.56 - j0.71$ and $Z_{in} = 39.2 - j49.7$ Ω..

The normalized input admittance is located a diameter across on the chart, which corresponds to the inversion of a complex number. For $z = 0.56 - j0.71$, $y = 0.68 + j0.87$; therefore,

$$Y_{in} = \frac{y}{R_0} = (9.71 + j12.4) \text{ mS}$$

SOURCE: <u>*Schaum's Outlines – Electromagnetics*</u>, 2nd ed., J. A. Edminister, McGraw-Hill