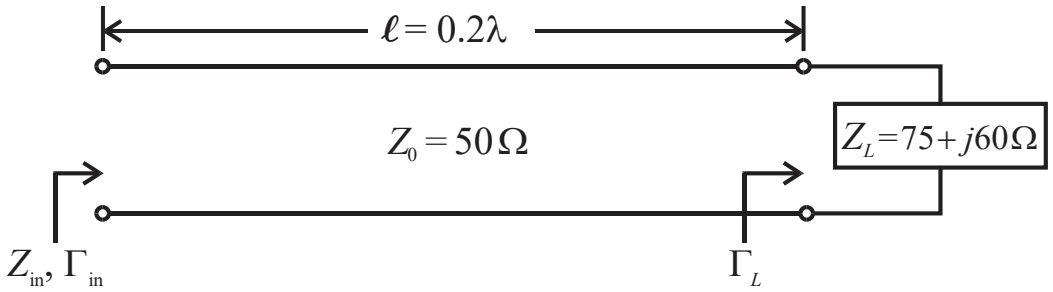
11.43 A lossless 50 Ω line is terminated by a load $Z_L = 75 + j60\ \Omega$. Using a Smith chart, determine (a) the reflection coefficient Γ, (b) the standing wave ratio *s*, (c) the input impedance at 0.2λ from the load, (d) the location of the first minimum voltage from the load, (e) the shortest distance from the load at which the input impedance is purely resistive.

- Use Smith chart. Also, determine the maximum and minimum impedances along the transmission line. Put locations in terms of wavelength λ.



a)

- Normalize Z_L & plot on Smith chart. $z_L = Z_L/Z_0 = (75 + j60)/50 \Rightarrow z_L = 1.5 + j1.2\ \Omega/\Omega$.
- Set compass to distance between center of Smith chart and z_L. Use compass to draw circle, centered on Smith chart, through z_L.
- Next, use compass to mark the "REFL. COEFF. V or I" scale below Smith chart on right side to find $|\Gamma| = |\Gamma_L| = 0.47$.
- Use a straight edge to draw radial line from center of Smith chart through z_L and outer rings of Smith chart. Use the "ANGLE OF REFLECTION COEFFICIENT IN DEGREES" scale to read $\angle\,\Gamma_L = 41.8°$.
- Put magnitude & angle of the load reflection coefficient together **$\Gamma_L = 0.47\angle 41.8°$**.

b)

- Use compass to mark SWR (VSWR) scale below Smith chart on left side.
- Read standing wave ratio to be **$s = SWR = 2.76$**.

c)

- For radial line through z_L read 0.192 on "WAVELENGTHS TOWARD GENERATOR" scale. Given $\ell = 0.2\,\lambda$. Go to 0.192 + 0.2 = 0.392 on the "WAVELENGTHS TOWARD GENERATOR" scale and draw a radial from the center of Smith chart.
- At intersection of this radial line and the $|\Gamma| = 0.47$ circle, read normalized input impedance to be $z_{in} = 0.55 - j0.65\ \Omega/\Omega$.
- Calculate input impedance $Z_{in} = z_{in} Z_0 = (0.55 - j0.65)50 \Rightarrow$ **$Z_{in} = 27.5 - j32.5\ \Omega$**.

d) V_{min} occurs at r_{min}. Using the "WAVELENGTHS TOWARD LOAD" scale, read the distance from the load to r_{min} as $\ell_{min} = 0.308\lambda$.

e) Going in "WAVELENGTHS TOWARD GENERATOR" direction, r_{max} is the first purely resistive impedance. It is 0.25 - 0.192 $\Rightarrow$ $\ell_{max} = 0.058\lambda$ from the load.

- At intersection of $|\Gamma|$ = 0.47 circle w/ real axis to right of origin read, r_{max} = 2.76. Calculate maximum impedance $Z_{max} = r_{max} Z_0 = (2.76)50 \Rightarrow$ **$Z_{max} = 138\ \Omega$**.
- At intersection of $|\Gamma|$ = 0.47 circle w/ real axis to left of origin read, r_{min} = 0.362. Calculate minimum impedance $Z_{min} = r_{min} Z_0 = (0.362)50 \Rightarrow$ **$Z_{min} = 18.1\ \Omega$**.