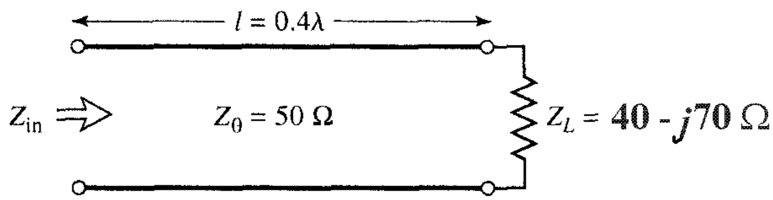
2.20 Use the Smith chart to find the following quantities for the transmission line circuit shown in the accompanying figure:

(a) The SWR on the line.
(b) The reflection coefficient at the load.
(c) The load admittance.
(d) The input impedance of the line.
(e) The distance from the load to the first voltage minimum.
(f) The distance from the load to the first voltage maximum.



Normalize and plot load impedance

- $z_L = Z_L / Z_0 = (40 - j70) / 50 \Rightarrow z_L = 0.8 - j\,1.4\ \Omega/\Omega$.
- Plot z_L on Smith chart by finding intersection of $r = 0.8$ circle with $x = -1.4$ arc.

a) Find SWR

- Use compass to draw $|\Gamma|$ circle centered on Smith chart through z_L.
- Then, go to 'SWR (VSWR)' scale below Smith chart on left side and make mark using compass. Read $\Rightarrow$ **SWR = 4.25**.

b) Find load reflection coefficient

- Use compass to mark the "RFL COEFF, E or I" scale below Smith chart on right side to determine $|\Gamma_L| = 0.62$.
- 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 $\angle\,\Gamma_L = -60.2°$.
- Put magnitude and angle together to get $\Rightarrow$ $\mathbf{\Gamma_L = 0.62\angle{-60.2°}}$.

c) Find load admittance

- Use a straight edge to extend radial line from center of Smith chart through z_L to other side of Smith chart.
- Read normalized input admittance at intersection of $|\Gamma|$ circle and radial line at 180° opposite to z_L as $y_L = 0.31 + j\,0.54$ S/S.
- Find input admittance by dividing y_L by Z_0. $Y_L = y_L / Z_0 = (0.31 + j\,0.54\text{ S/S}) / 50\ \Omega$

$\Rightarrow$ $\mathbf{Y_L = 6.2 + j\,10.8\ mS}$.

d) Find input impedance

- Move ℓ/λ = 0.4 on circle of constant $|\Gamma|$ from z_L point at 0.166λ on 'WAVELENGTHS TOWARD LOAD' scale to 0.234λ on 'WAVELENGTHS TOWARD GENERATOR' scale (0.166λ + 0.234λ = 0.4λ). Draw radial line from center to outer edge of Smith chart. Intersection of line and circle is z_{in} point.
- At z_{in} point, read-off the normalized input resistance $r_{in} = 3.6$ and input reactance $x_{in} = 1.5$, giving $z_{in} = 3.6 + j\,1.5$ Ω/Ω.
- Find input impedance by multiplying z_{in} with Z_0 to get $Z_{in} = Z_0 z_{in} = 50(3.6 + j\,1.5)$

$\Rightarrow$ **$Z_{in} = 180 + j\,75\ \Omega$**.

e) Find distance from load to V_{min}

- The z_L point is at 0.166λ on the 'WAVELENGTHS TOWARD LOAD' scale. If we move 0.166λ in the 'WAVELENGTHS TOWARD GENERATOR' direction, we arrive at the V_{min} (and r_{min}) point. $\Rightarrow$ **$d_{min} = 0.166\lambda$**.

f) Find distance from load to V_{max}

- The z_L point is at 0.166λ on the 'WAVELENGTHS TOWARD LOAD' scale. If we move 0.166λ + 0.25λ in the 'WAVELENGTHS TOWARD GENERATOR' direction, we arrive at the V_{max} (and r_{max}) point. $\Rightarrow$ **$d_{max} = 0.416\lambda$**.

****

Bonus:

For comparison, the exact values are-

SWR = 4.2656

$\Gamma_L = 0.6202\angle{-60.255°}$

$Y_L = 6.154 + j\,10.769$ mS

$\Gamma = 0.6022\angle 109.8°$

$Z_{in} = 180.744 + j\,74.155\ \Omega$

$d_{min} = 0.16631\lambda$

$d_{max} = 0.41631\lambda$

2.20 mod1

Simple
Smith Chart

$Z_0 = 50\Omega$
λ unspecified