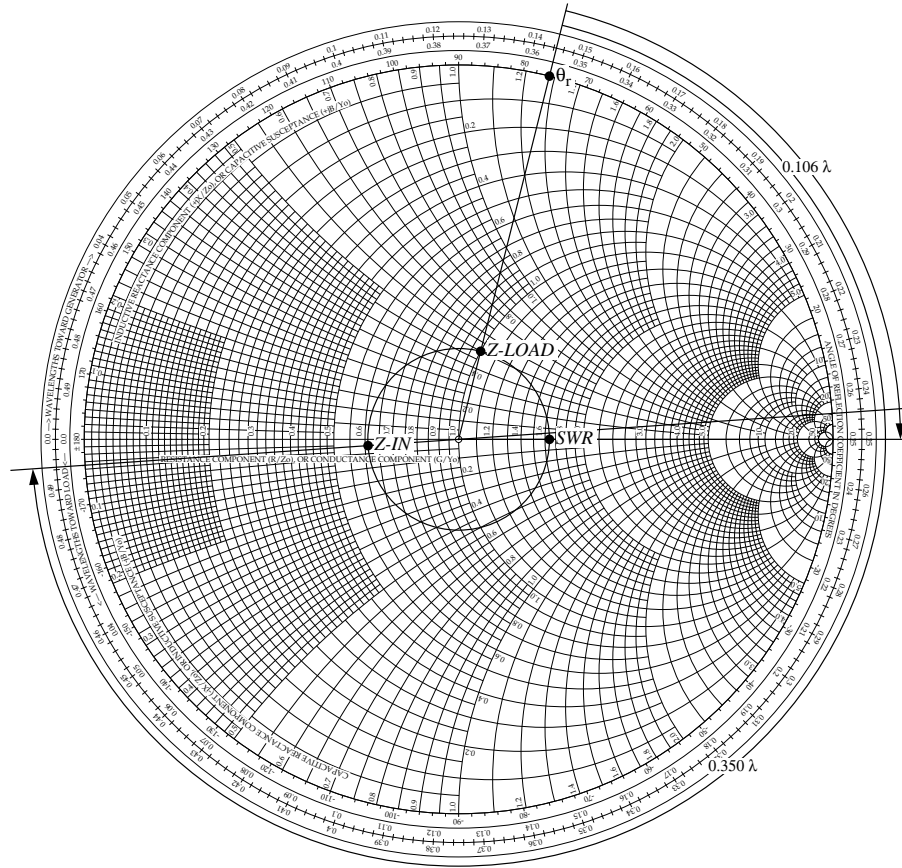


**Problem 2.53** A lossless  $50\text{-}\Omega$  transmission line is terminated in a load with  $Z_L = (50 + j25)\text{ }\Omega$ . Use the Smith chart to find the following:

- (a) The reflection coefficient  $\Gamma$ .
- (b) The standing-wave ratio.
- (c) The input impedance at  $0.35\lambda$  from the load.
- (d) The input admittance at  $0.35\lambda$  from the load.
- (e) The shortest line length for which the input impedance is purely resistive.
- (f) The position of the first voltage maximum from the load.



**Figure P2.53:** Solution of Problem 2.53.

**Solution:** Refer to Fig. P2.53. The normalized impedance

$$z_L = \frac{(50 + j25) \Omega}{50 \Omega} = 1 + j0.5$$

is at point *Z-LOAD*.

(a)  $\Gamma = 0.24e^{j76.0^\circ}$  The angle of the reflection coefficient is read of that scale at the point  $\theta_r$ .

(b) At the point *SWR*:  $S = 1.64$ .

(c)  $Z_{in}$  is  $0.350\lambda$  from the load, which is at  $0.144\lambda$  on the wavelengths to generator scale. So point *Z-IN* is at  $0.144\lambda + 0.350\lambda = 0.494\lambda$  on the WTG scale. At point *Z-IN*:

$$Z_{in} = z_{in}Z_0 = (0.61 - j0.022) \times 50 \Omega = (30.5 - j1.09) \Omega.$$

(d) At the point on the SWR circle opposite  $Z\text{-IN}$ ,

$$Y_{\text{in}} = \frac{y_{\text{in}}}{Z_0} = \frac{(1.64 + j0.06)}{50 \, \Omega} = (32.7 + j1.17) \, \text{mS}.$$

(e) Traveling from the point  $Z\text{-LOAD}$  in the direction of the generator (clockwise), the SWR circle crosses the  $x_L = 0$  line first at the point  $SWR$ . To travel from  $Z\text{-LOAD}$  to  $SWR$  one must travel  $0.250\lambda - 0.144\lambda = 0.106\lambda$ . (Readings are on the wavelengths to generator scale.) So the shortest line length would be  $0.106\lambda$ .

(f) The voltage max occurs at point  $SWR$ . From the previous part, this occurs at  $z = -0.106\lambda$ .

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