HW 4 Solution

Problem 2.36 Use the Smith chart to find the normalized load impedance corresponding to a reflection coefficient:

(a) $\Gamma = 0.5$,
(b) $\Gamma = 0.5\angle 60^\circ$,
(c) $\Gamma = -1$,
(d) $\Gamma = 0.3\angle -30^\circ$,
(e) $\Gamma = 0$,
(f) $\Gamma = j$.

Solution: Refer to Fig. P2.36.

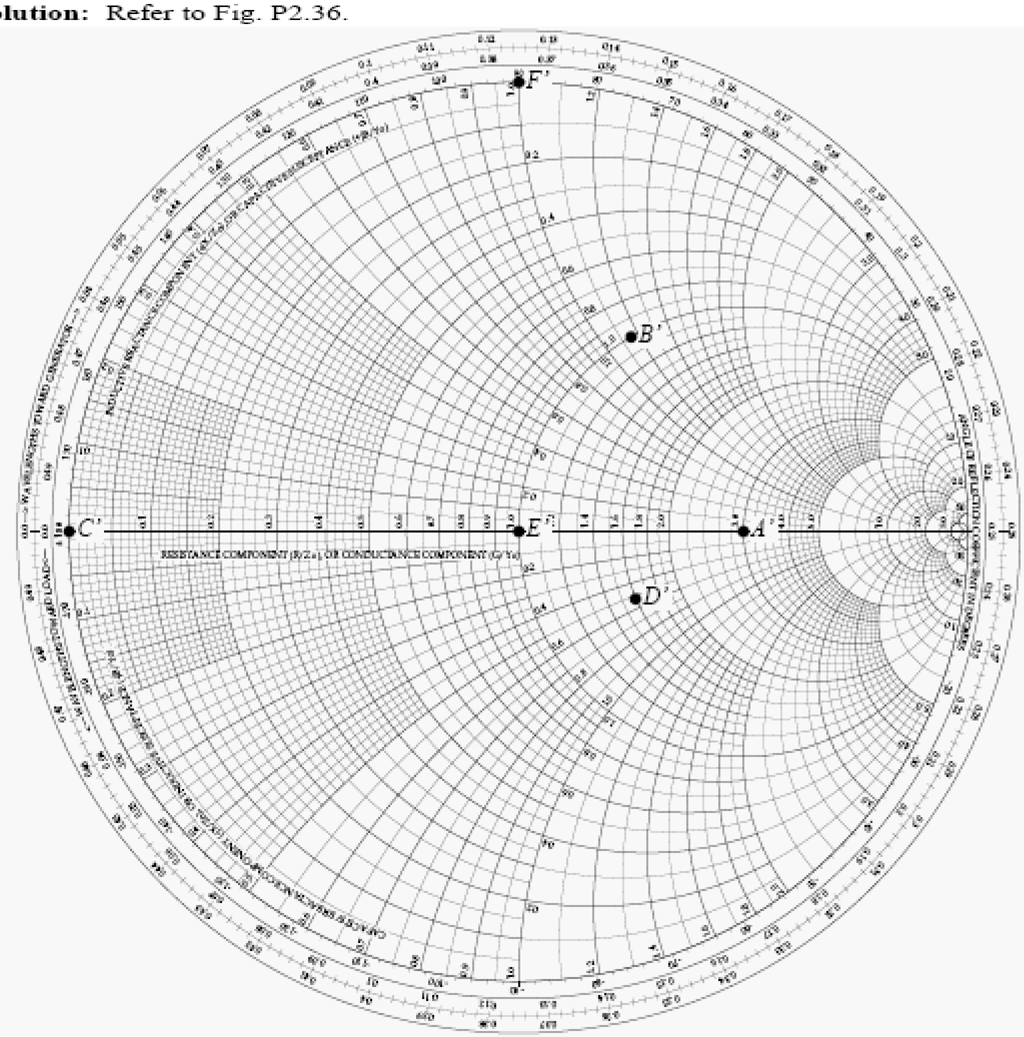


Figure P2.36: Solution of Problem 2.36.

(a) Point A' is $\Gamma = 0.5$ at $z_L = 3 + j0$.
(b) Point B' is $\Gamma = 0.5e^{j60^\circ}$ at $z_L = 1 + j1.15$.
(c) Point C' is $\Gamma = -1$ at $z_L = 0 + j0$.
(d) Point D' is $\Gamma = 0.3e^{-j30^\circ}$ at $z_L = 1.60 - j0.53$.
(e) Point E' is $\Gamma = 0$ at $z_L = 1 + j0$.
(f) Point F' is $\Gamma = j$ at $z_L = 0 + j1$.

Problem 2.38 A lossless 50-Ω transmission line is terminated in a load with $Z_L = (50 \quad j25)\ \Omega$. Use the Smith chart to find the following:

(a) the reflection coefficient Γ,

(b) the standing-wave ratio,

(c) the input impedance at 0.35λ from the load,

(d) the input admittance at 0.35λ 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.

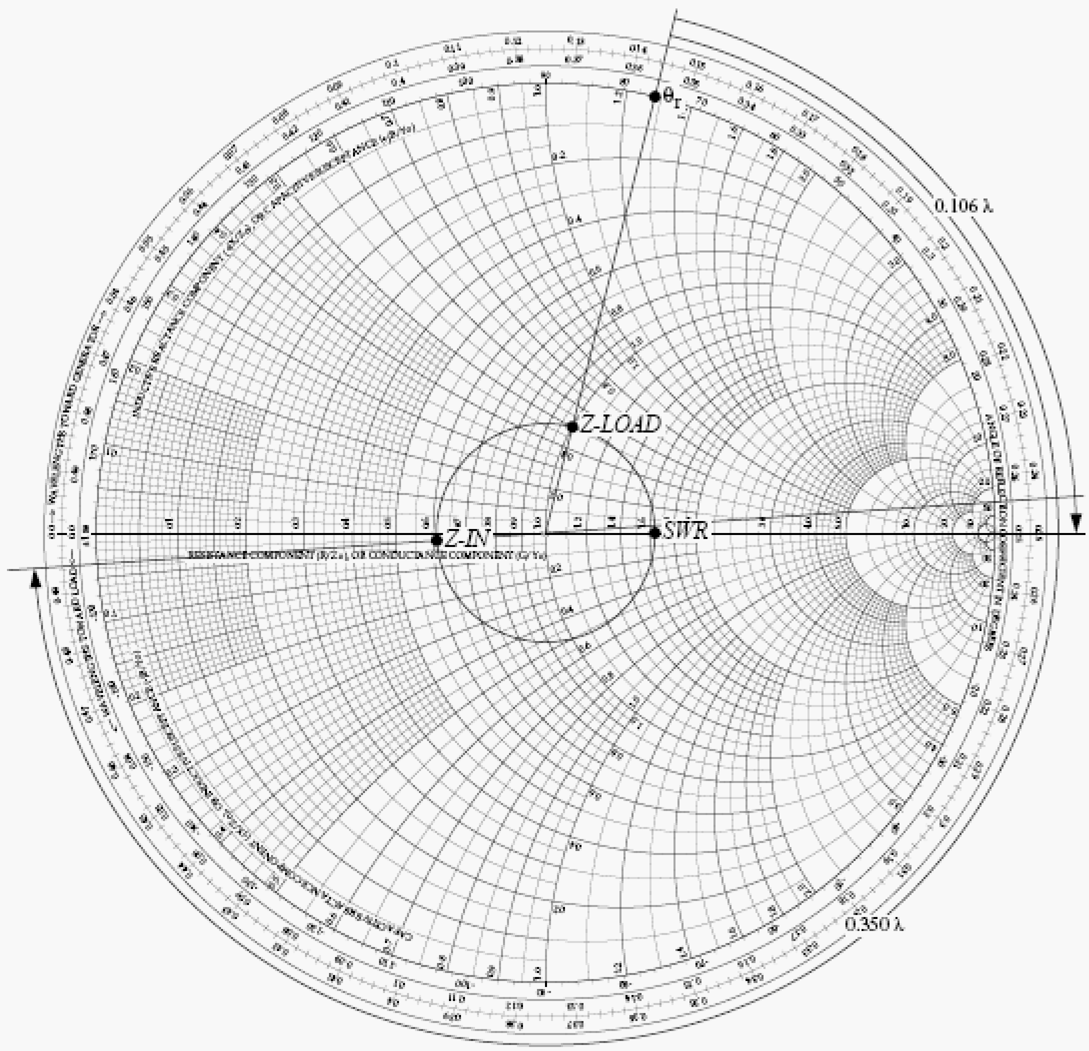


Figure P2.38: Solution of Problem 2.38.

Solution: Refer to Fig. P2.38. The normalized impedance

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

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 θ_r.

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

(c) Z_{in} is 0.350λ from the load, which is at 0.144λ 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*:

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

(d) At the point on the SWR circle opposite *Z-IN*,

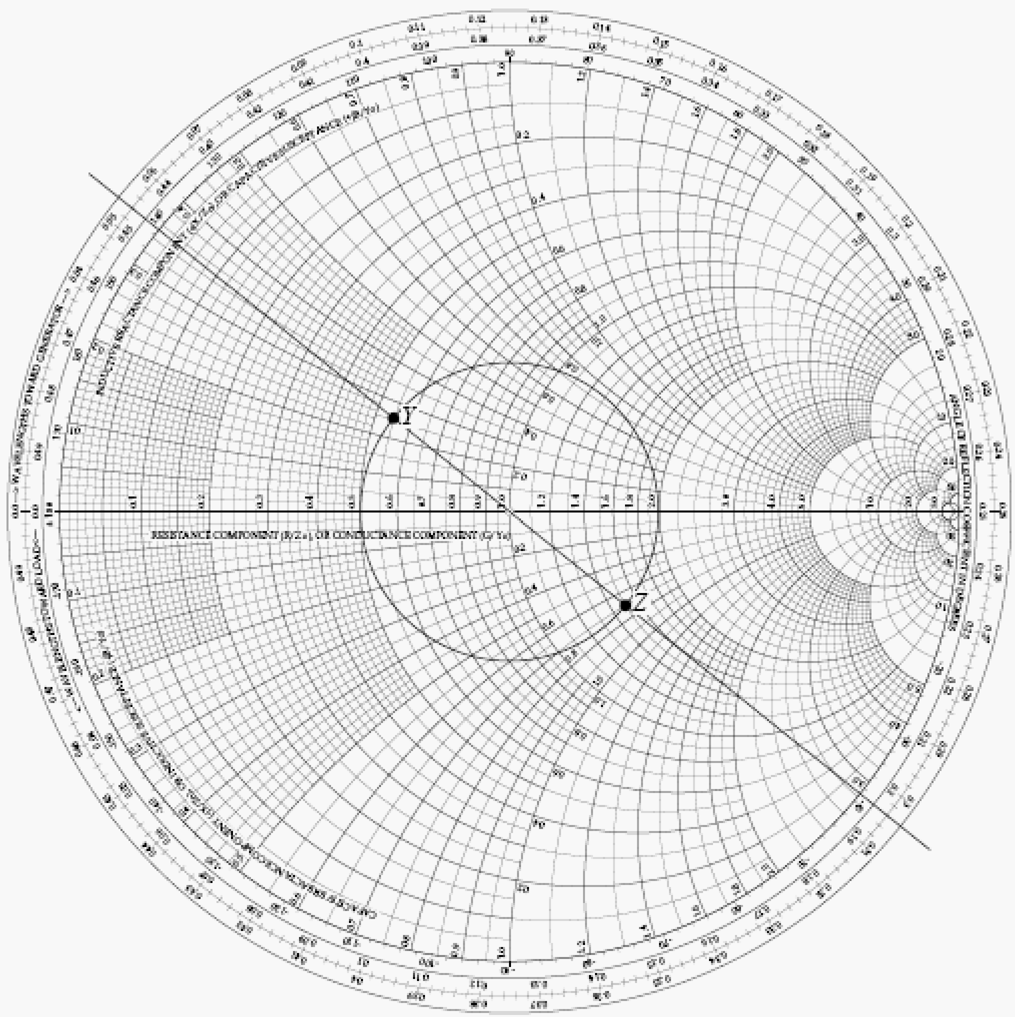
$$Y_{in} = \frac{y_{in}}{Z_0} = \frac{(1.64 \quad j0.06)}{50\ \Omega} = (32.7 \quad j1.17)\ \text{mS}.$$

(e) Traveling from the point *Z-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-LOAD* to *SWR* one must travel $0.250\lambda \quad 0.144\lambda = 0.106\lambda$. (Readings are on the wavelengths to generator scale.) So the shortest line length would be 0.106λ.

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

Problem 2.40 Use the Smith chart to find y_L if $z_L = 1.5 - j0.7$.

Solution: Refer to Fig. P2.40. The point Z represents $1.5 - j0.7$. The reciprocal of point Z is at point Y, which is at $0.55 + j0.26$.



Problem 2.41 A lossless 100-Ω transmission line $3\lambda/8$ in length is terminated in an unknown impedance. If the input impedance is $Z_{\text{in}} = -j2.5\ \Omega$,

(a) use the Smith chart to find Z_{L}.

(b) What length of open-circuit line could be used to replace Z_{L}?

Solution: Refer to Fig. P2.41. $z_{\text{in}} = Z_{\text{in}}/Z_0 = -j2.5\ \Omega/100\ \Omega = 0.0 - j0.025$ which is at point *Z-IN* and is at 0.004λ on the wavelengths to load scale.

(a) Point *Z-LOAD* is 0.375λ toward the load from the end of the line. Thus, on the wavelength to load scale, it is at $0.004\lambda \;,\; 0.375\lambda = 0.379\lambda$.

$$Z_{\text{L}} = z_{\text{L}} Z_0 = (0 \;,\; j0.95) \times 100\ \Omega = j95\ \Omega.$$

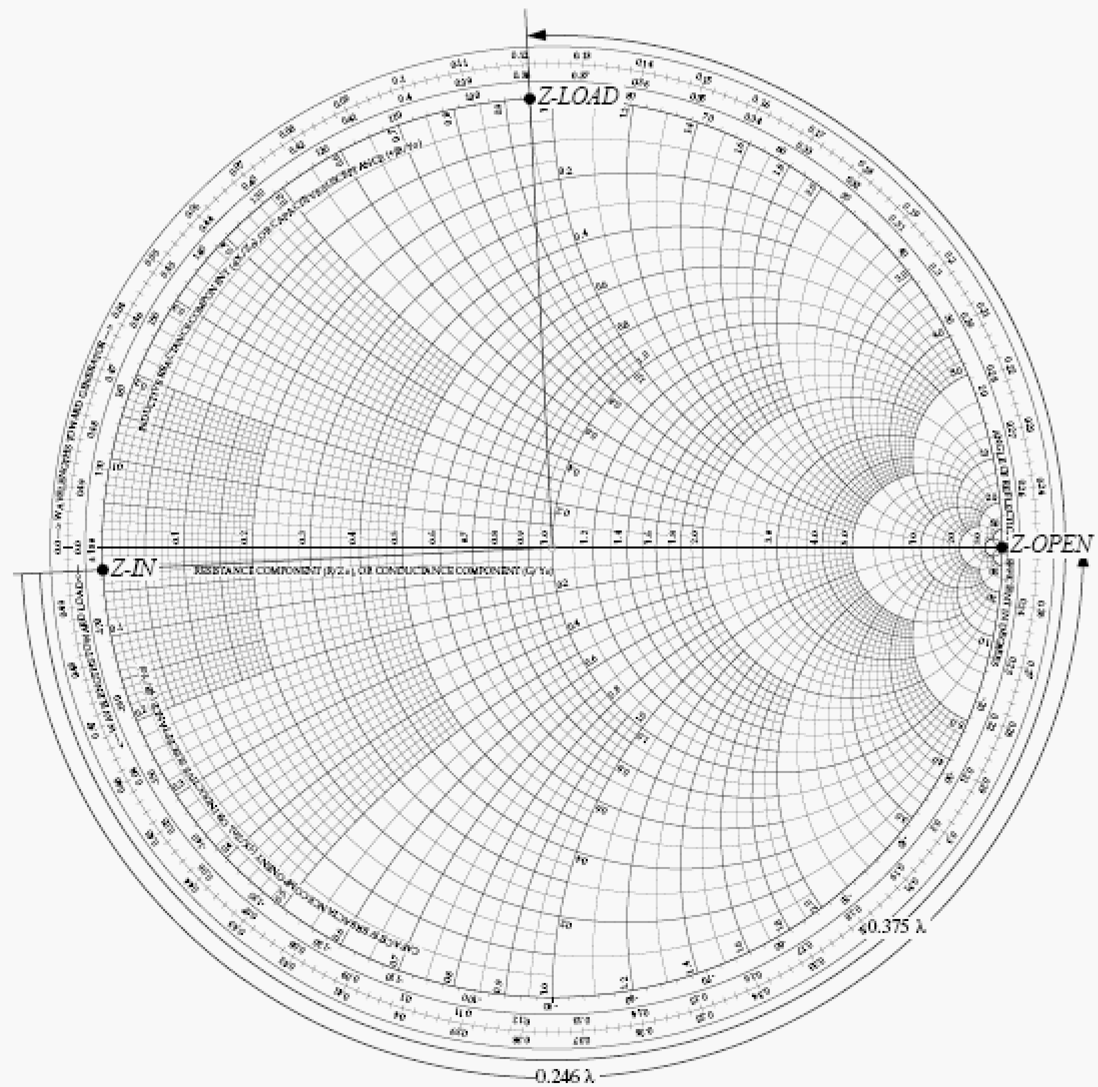


Figure P2.41: Solution of Problem 2.41.

(b) An open circuit is located at point *Z-OPEN*, which is at 0.250λ on the wavelength to load scale. Therefore, an open circuited line with $Z_{\text{in}} = \quad j0.025$ must have a length of $0.250\lambda \quad 0.004\lambda = 0.246\lambda$.