2.62 At an operating frequency of 5 GHz, a 50-Ω lossless coaxial line with insulating material having a relative permittivity $\varepsilon_r = 2.25$ is terminated in an antenna with an impedance $Z_L = 150\ \Omega$. Use the Smith chart to find Z_{in}. The line length is 30 cm.

Solution: To use the Smith chart the line length must be converted into wavelengths. Since $\beta = 2\pi/\lambda$ and $u_p = \omega/\beta$,

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi u_p}{\omega} = \frac{c}{\sqrt{\varepsilon_r} f} = \frac{3 \times 10^8 \text{ m/s}}{\sqrt{2.25} \times (5 \times 10^9 \text{ Hz})} = 0.04 \text{ m}.$$

Hence, $l = \frac{0.30 \text{ m}}{0.04 \text{ m}} \lambda = 7.5\lambda$. Since this is an integral number of half wavelengths,

$$Z_{in} = Z_L = 150\ \Omega.$$