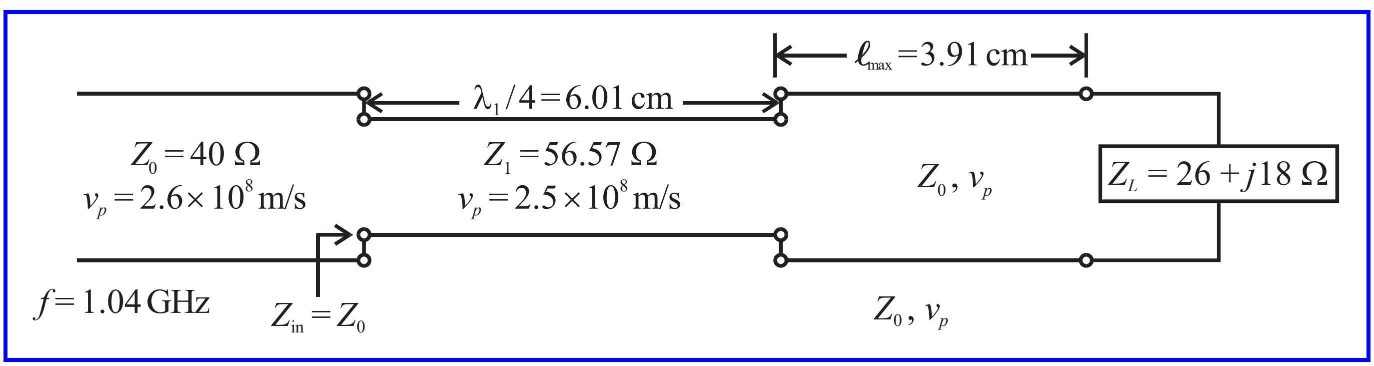
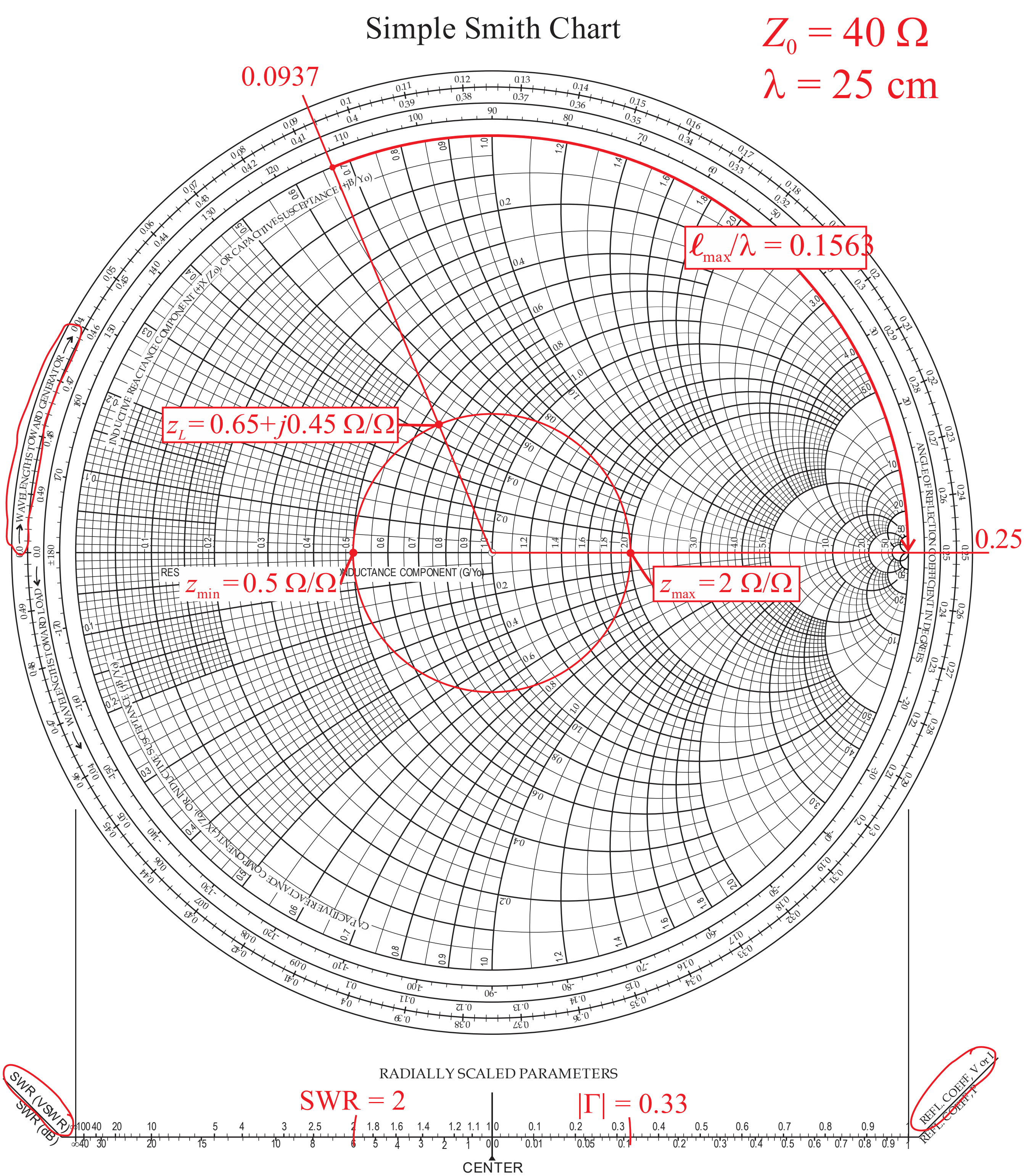
A lossless transmission line (40 Ω, 2.6×10^8 m/s) has a load $Z_L = 26 + j18\ \Omega$ at 1.04 GHz. Design and sketch a quarter-wave transformer (QWT), using a Smith chart, to match the load with the QWT placed as close as possible to the load. Assume that the QWT section has a phase velocity of 2.5×10^8 m/s.

- Calculate wavelength $\lambda = v_p / f = 2.6 \times 10^8 / 1.04 \times 10^9 \Rightarrow$ **λ = 0.25 m = 25 cm**.
- Calculate the normalized load impedance $z_L = Z_L / Z_0 = (26 + j18) / 40$ $\Rightarrow$ **$z_L = 0.65 + j0.45$ Ω/Ω**. Plot z_L on Smith chart.
- Use compass to draw a circle through z_L, centered on Smith chart. Use a straight edge to draw line through center of Smith chart & z_L to outer rings of Smith chart. Note $|\Gamma| = 0.5$ and SWR = 3.
- Note circle intersects the horizontal axis (real impedances) at **z_{max} = 2 Ω/Ω** (closest) and $z_{min} = 0.5$ Ω/Ω. Then, **$Z_{max} = z_{max} Z_0 = 2\,(40) = 80$ Ω/Ω.**
- The distance from z_L to z_{max} along the circle of constant $|\Gamma| = 0.5$ in the "WAVELENGTHS TOWARD GENERATOR" direction is $\ell_{max} / \lambda = 0.25 - 0.0937$ $\Rightarrow$ **$\ell_{max} = 0.1563\lambda = 3.91$ cm**.
- Use (5.25) $Z_1 = \sqrt{Z_0 Z_L} = \sqrt{40(80)}$ to calculate the impedance of the QWT as $\Rightarrow$ **$Z_1 = 56.57\ \Omega$**.
- Calculate wavelength of QWT as $\lambda_1 = v_p' / f = 2.5 \times 10^8 / 1.04 \times 10^9 \Rightarrow$ **λ_1 = 0.240385 m = 24.04 cm**. This yields at QWT length of $\Rightarrow$ **$\lambda_1 / 4 = 6.01$ cm**.




Simple Smith Chart
Z0 = 40 Ω
λ = 25 cm
0.0937
ℓmax/λ = 0.1563
zL = 0.65+j0.45 Ω/Ω
0.25
zmin = 0.5 Ω/Ω
zmax = 2 Ω/Ω
RADIALLY SCALED PARAMETERS
SWR = 2
|Γ| = 0.33
CENTER