EE 481/581 Microwave Engineering
Quiz #4 (Fall 2025)

Name KEY A

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (60 Ω, 2.45 × 10^8 m/s) has a load with $\Gamma_L = 0.519\angle 110°$ at 700 MHz. Calculate the wavelength (cm). Then, using a Smith chart, find the load impedance and standing wave ratio (SWR). Next, design a single series **inductor** matching network, i.e., normalized match impedance, distance d (cm) & L, with the inductor as close as possible to the load. Sketch TL match circuit in box with **all** relevant quantities. **Show** and **clearly label** all work on the Smith chart (this will be graded).

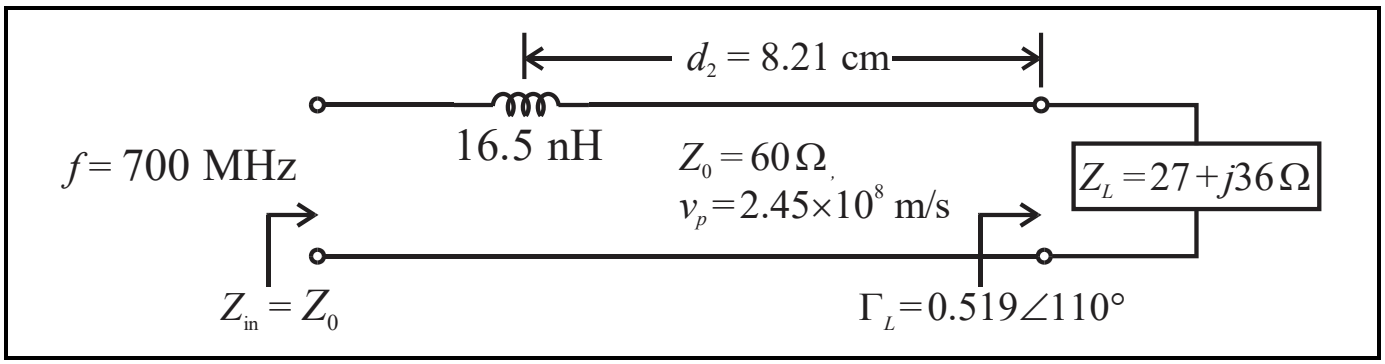
➢ Wavelength $\lambda = v_p / f = 2.45\times10^8/700\times10^6 \Rightarrow$ **$\lambda = 0.35$ m = 35 cm**.

Steps

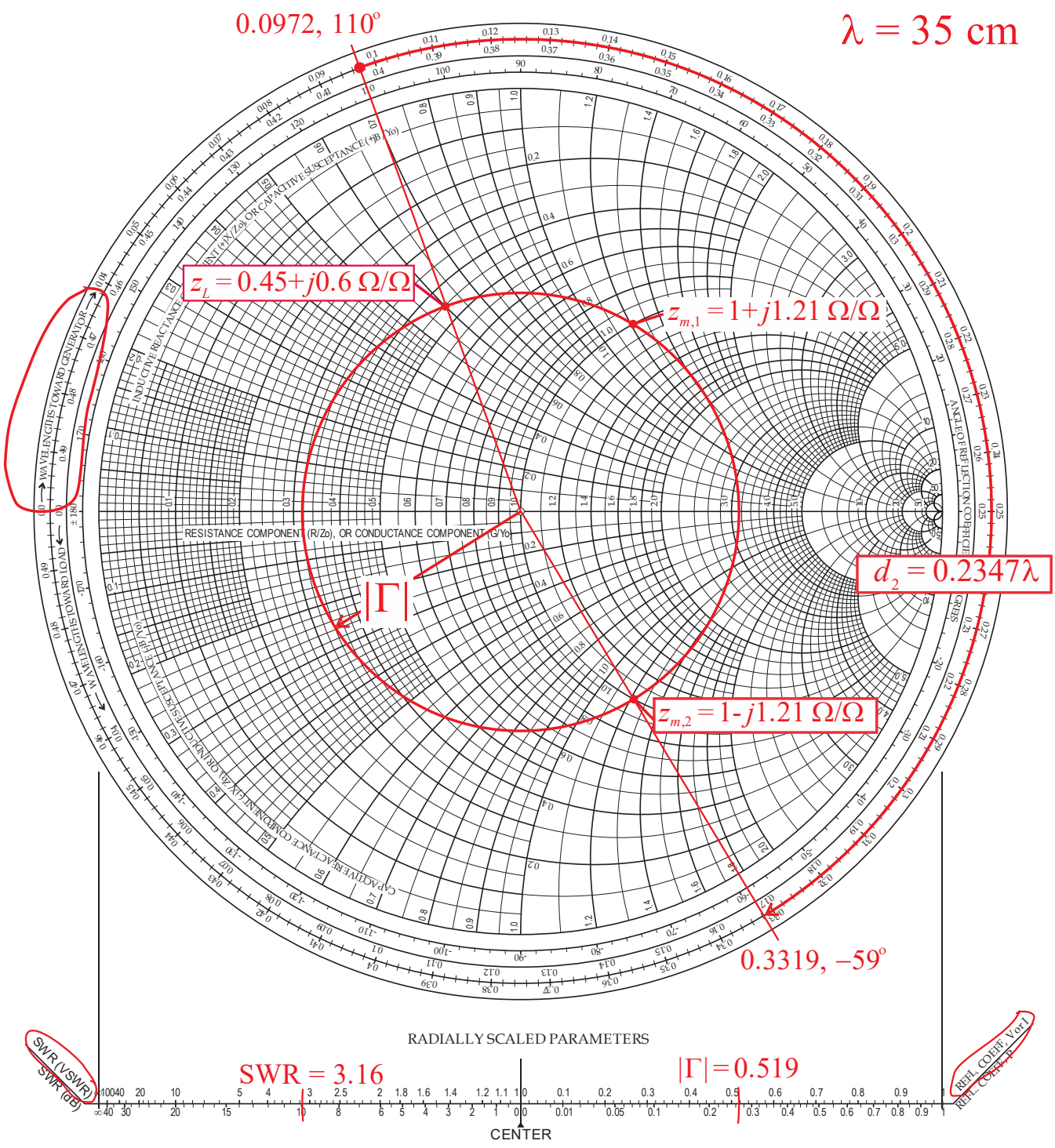
1) Set compass using scales at bottom to $|\Gamma| = 0.519$ and draw circle centered on Smith chart. Use straight edge to draw radial line at 110° on "ANGLE OF REFLECTION COEFFICIENT IN DEGREES". Plot $\Gamma_L = 0.519\angle 110°$ where line and circle intersect.
2) Read $z_L = \mathbf{0.45 + j\ 0.6\ \Omega/\Omega}$. Compute $Z_L = Z_0\, z_L = 60\,(0.45 + j\ 0.6) \Rightarrow$ **$Z_L = 27 + j\ 36\ \Omega$**.
3) Draw arc on SWR scale. Read **SWR = 3.16**.
4) Find where the circle of $|\Gamma| = 0.519$ intersects the circle of $r = 1$. Read the normalized impedance of the match points as $z_{m,1} = 1 + j1.21\ \Omega/\Omega$ and **$z_{m,2} = 1 - j1.21\ \Omega/\Omega$**. Choose $z_{m,2}$ as it has a capacitive reactance which can be matched with a series inductor.
5) Find the distance d_2 from z_L to $z_{m,2}$ using the "WAVELENGTHS TOWARD GENERATOR" scale as $d_2 = (0.3319 - 0.0972)\lambda \Rightarrow$ **$d_2 = 0.2347\,\lambda = 8.2145$ cm**.
6) At $Z_{m,2} = Z_0\, z_{m,2} = 60\,(1 - j\,1.21) = 60 - j\ 72.6\ \Omega$, add a series inductor with reactance $Z_{ind} = j\omega L = +j72.6\ \Omega$. Solving for $L = 72.6/(2\pi\ 700\times10^6) \Rightarrow$ **$L = 1.6507\times10^{-8}$ H = 16.5 nH**.

wavelength = **$\lambda = 35$ cm** Z_L = **$27 + j\ 36\ \Omega$** SWR = **3.16**

z_{match} = **$1 - j1.21\ \Omega/\Omega$** d = **$d_2 = 8.21$ cm** L = **16.5 nH**



Simple Smith Chart



EE 481/581 Microwave Engineering
Quiz #4 (Fall 2025)

Name KEY B

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (80 Ω, 2.88×10^8 m/s) has a load with $\Gamma_L = 0.602\angle -92.5°$ at 800 MHz. Calculate the wavelength (cm). Then, using a Smith chart, find the load impedance and standing wave ratio (SWR). Next, design a single series **inductor** matching network, i.e., normalized match impedance, distance d (cm) & L, with the inductor as close as possible to the load. Sketch TL match circuit in box with **all** relevant quantities. **Show** and **clearly label** all work on the Smith chart (this will be graded).

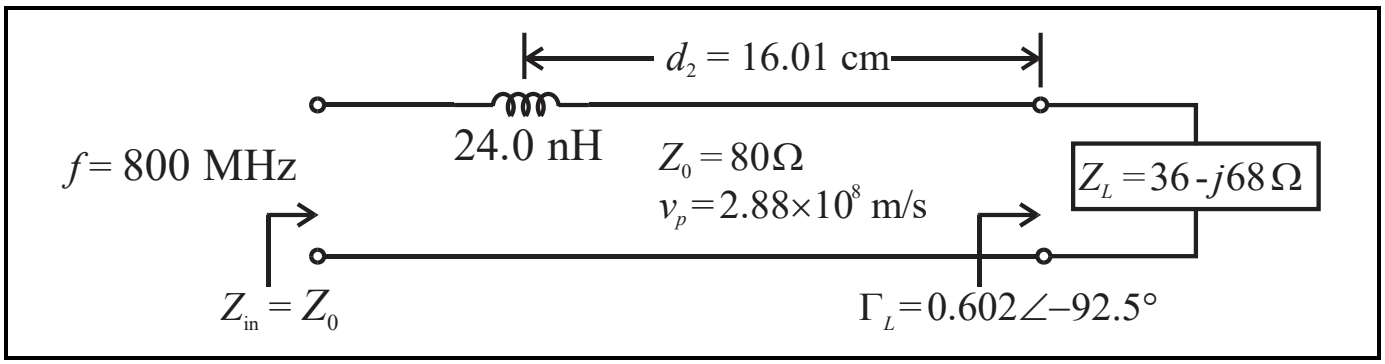
➢ Wavelength $\lambda = v_p / f = 2.88\times10^8/800\times10^6 \Rightarrow$ **$\lambda = 0.36$ m $= 36$ cm**.

Steps

1) Set compass using scales at bottom to $|\Gamma| = 0.602$ and draw circle centered on Smith chart. Use straight edge to draw radial line at -92.5° on "ANGLE OF REFLECTION COEFFICIENT IN DEGREES". Plot $\Gamma_L = 0.602\angle -92.5°$ where line & circle intersect.
2) Read $z_L = \mathbf{0.45 - j\ 0.85\ \Omega/\Omega}$. Compute $Z_L = Z_0\, z_L = 80\,(0.45 - j\ 0.85) \Rightarrow$ **$Z_L = 36 - j\ 68\ \Omega$**.
3) Draw arc on SWR scale. Read **SWR = 4.02**.
4) Find where the circle of $|\Gamma| = 0.602$ intersects the circle of $r = 1$. Read the normalized impedance of the match points as $z_{m,1} = 1 + j1.51\ \Omega/\Omega$ and **$z_{m,2} = 1 - j1.51\ \Omega/\Omega$**. Choose $z_{m,2}$ as it has a capacitive reactance which can be matched with a series inductor.
5) Find the distance d_2 from z_L to $z_{m,2}$ using the "WAVELENGTHS TOWARD GENERATOR" scale as $d_2 = (0.121 + 0.3238)\lambda \Rightarrow$ **$d_2 = 0.4448\,\lambda = 16.0128$ cm**.
6) At $Z_{m,2} = Z_0\, z_{m,2} = 80\,(1 - j\ 1.51) = 80 - j\,120.8\ \Omega$, add a series inductor with reactance $Z_{ind} = j\omega L = +j120.8\,\Omega$. Solving for $L = 120.8/(2\pi\,800\times10^6) \Rightarrow$ **$L = 2.403\times10^{-8}$ H $= 24.0$ nH**.

wavelength = **$\lambda = 36$ cm** Z_L = **$36 - j\ 68\ \Omega$** SWR = **4.02**

z_{match} = **$1 - j1.51\ \Omega/\Omega$** d = **$d_2 = 16.01$ cm** L = **24.0 nH**



Simple Smith Chart

$Z_0 = 80\ \Omega$

$\lambda = 36$ cm