EE 324: Homework #5

Due on March 9, 2016

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1. Match the load $Z_L = 20 + j40\Omega$ to a $Z_C = 50\Omega$ transmission line.

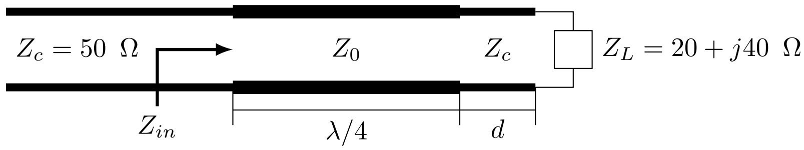

Figure 1: Problem 1, quarter wave transform, transmission line model.

(a) What is the shortest length d such that the impedance attached to the quarter wave section is purely real?

normalized impedances	$z_L = 0.4 + j0.8\Omega$
from smith chart	$d = (0.250 - 0.114)\lambda$

shortest length d is

$$\boxed{d = 0.136\lambda}$$

(b) What characteristic impedance value to we require for the quarter wave section?

$$\begin{aligned} &\text{from smith chart,} & z_1 &\approx 4.3\Omega \\ &\text{un-normalized,} & Z_1 &= 215\Omega \\ &\text{so we require} & Z_0 &= \sqrt{Z_1 Z_c} \\ && &= \sqrt{(215)(50)} \end{aligned}$$

$$\boxed{Z_0 = 103.7\Omega}$$

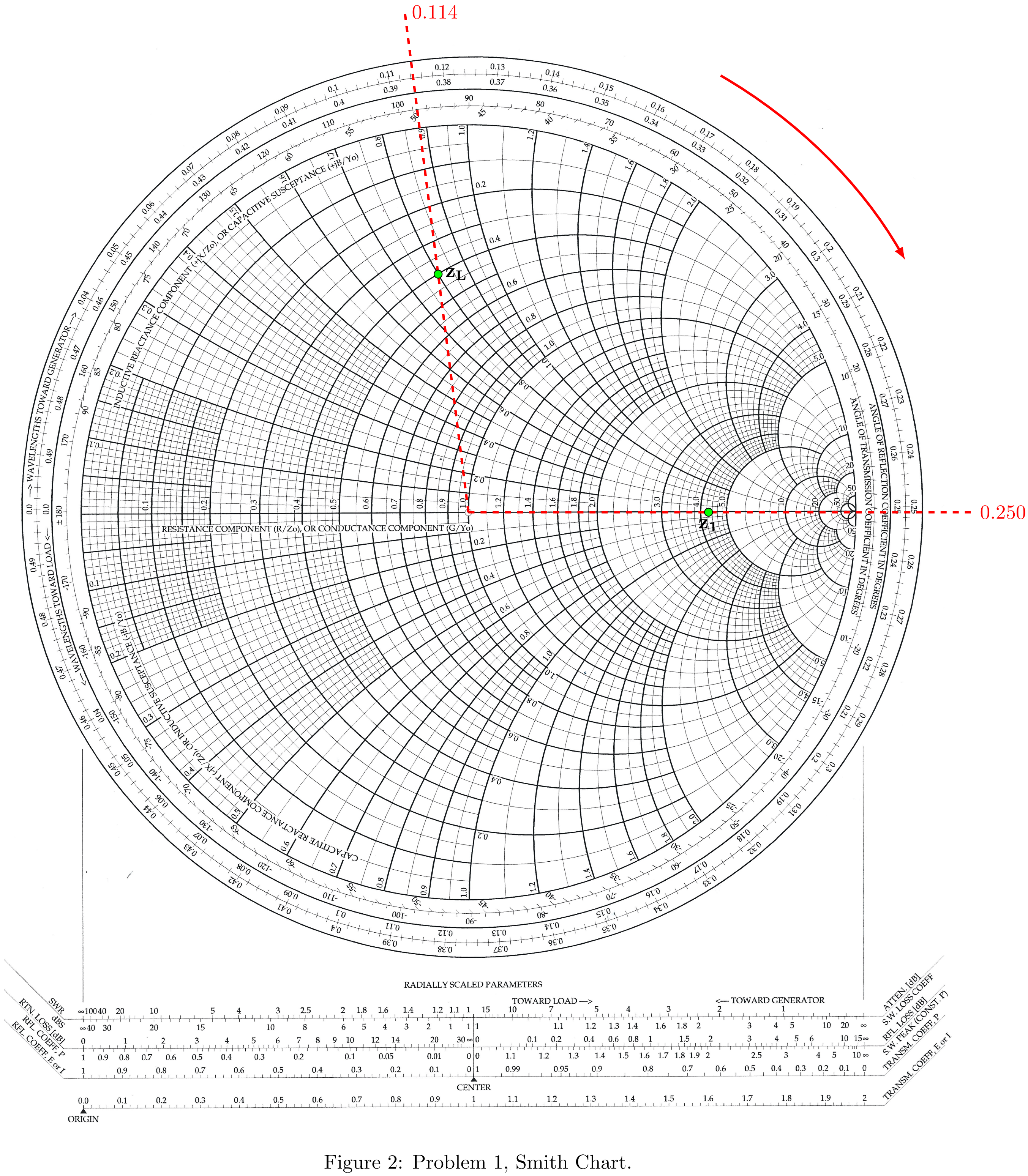

Figure 2: Problem 1, Smith Chart.

2. Use a parallel single stub tuner to match the load $Z_L = 120 + j30\Omega$ to a 50 ohm transmission line.

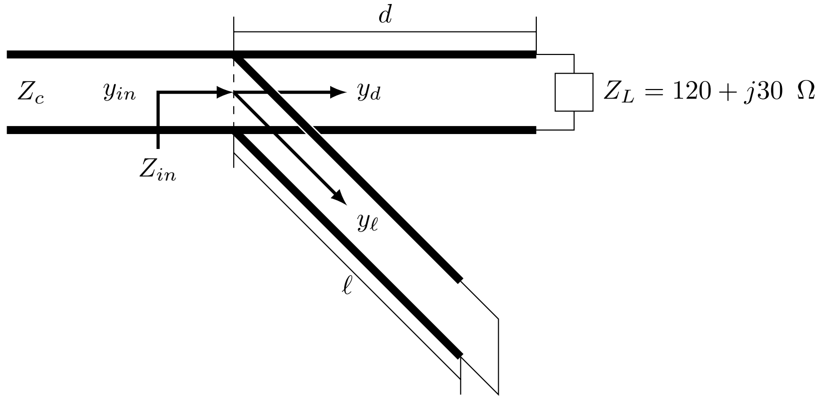

Figure 3: Problem 2, parallel single stub tuner.

(a) If all the sections of this line are 50 ohm, determine the lengths d and ℓ required to match the load.

normalized load	$z_L = 2.4 + j0.6\Omega$
match load requires	$y_d = 1 + jB$
we also know	$y_{in} = y_d + y_\ell$
from smith chart	$y_d = 1 + j$
therefore we require	$y_\ell = -j$
plot and rotate to short	
thus (from Smith Chart)	$d = ((0.5 - 0.482) + 0.162)\lambda$
	$\ell = \lambda/8$

$$\boxed{d = 0.180\lambda \qquad \ell = 0.125\lambda}$$

(b) Repeat the above, but this time for a stud characteristic impedance of 100 ohms.

In this case, everything remains the same, except this time the admittance we require for y_ℓ after renormalizing to the new characteristic impedance is $j2$.

From the Smith Chart, $\ell = (0.25 - 0.176)\lambda$

$$\boxed{d = 0.180\lambda \qquad \ell = 0.074\lambda}$$

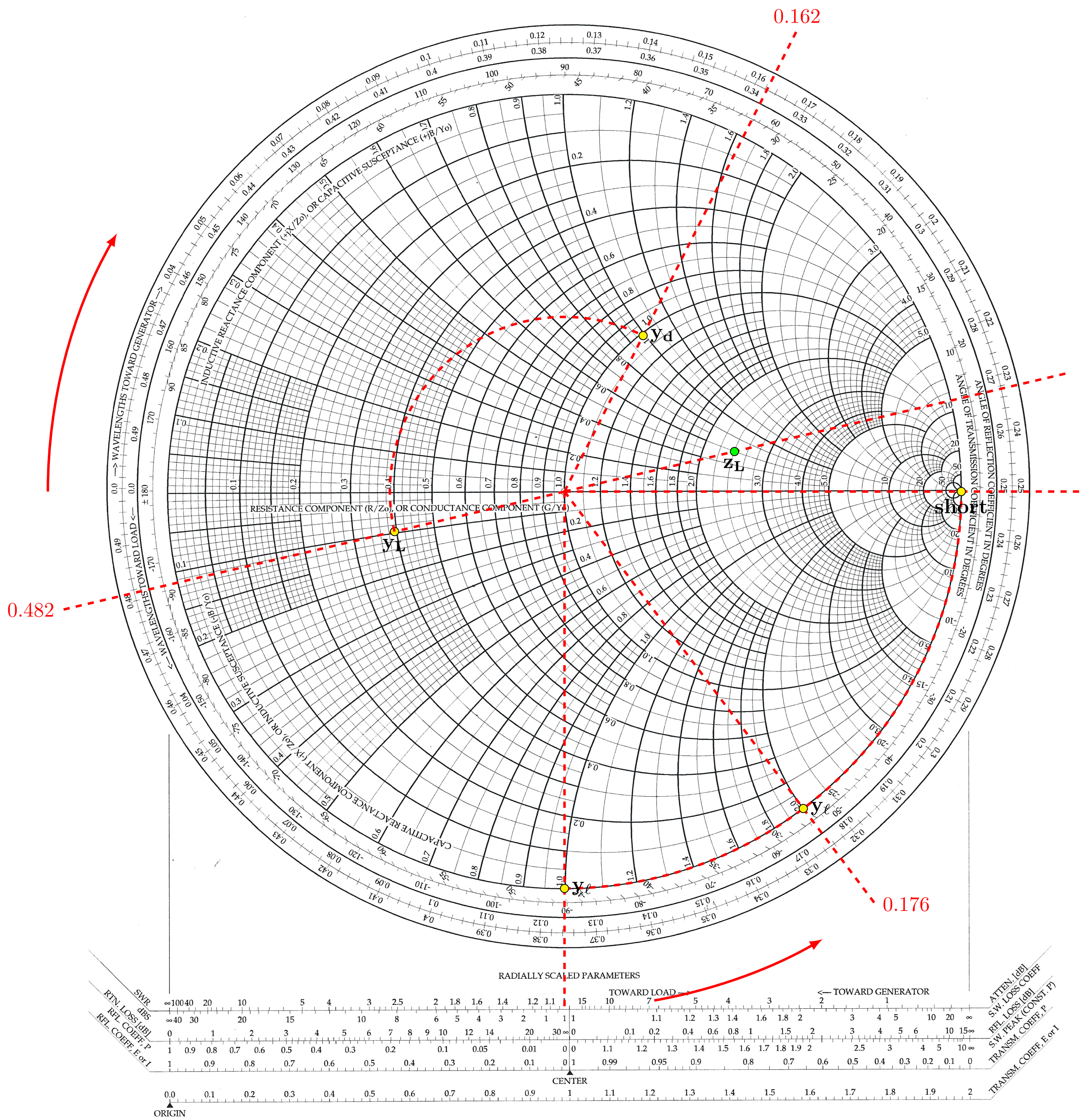

Figure 4: Problem 2, Smith Chart.

3. The parallel double stub method is used to match a load impedance of $Z_L = 200 + j200\Omega$ to a lossless transmission line of characteristic impedance $Z_c = 100\Omega$. The spacing between the stubs is 0.1λ, and one stub is connected directly in parallel with the load.

(a) If both stubs are short-circuited, determine stub lengths.

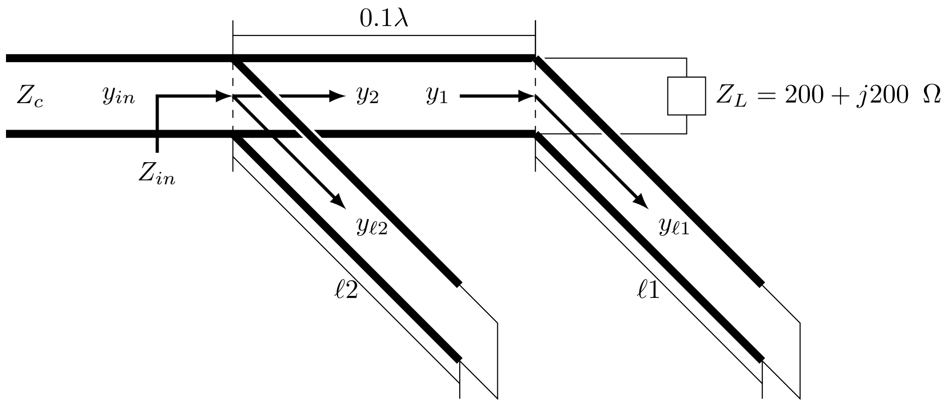

Figure 5: Problem 3, parallel double stub tuner, shorts.

Normalized load impedance: $z_L = 2 + j2\Omega$

We want $y_{in} = 1$, so $y_2 = 1 + jB_2$ and $y_{\ell 2} = -jB_2$

$y_L = 0.250 - j0.250$

The two possible y_1 admittances are $0.250 + j0.575$ and $0.250 + j2.15$

By $y_1 = y_{\ell 1} + y_L$, these two admittances correspond to $y_{\ell 1} = j0.825$ and $y_{\ell 1} = j2.40$

$y_{\ell 1} = j0.825$ is the closest to the short. This is 0.109+0.250 away from the short.

$$\boxed{\ell_1 = 0.359\lambda}$$

rotating through, y_1 maps onto y_2, which the smith chart says $y_2 = 1 + j1.9\Omega$

This means we want $y_{\ell 2} = -j1.9$

And we find that

$$\boxed{\ell_2 = 0.078\lambda}$$

(b) If both stubs are open-circuited, determine stub lengths. In this case, the same admittance values apply, but this time we rotate the stubs to the left horizontal instead of the right horizontal.

so,

$$\boxed{\ell_1 = 0.109\lambda \qquad \ell_2 = 0.328\lambda}$$

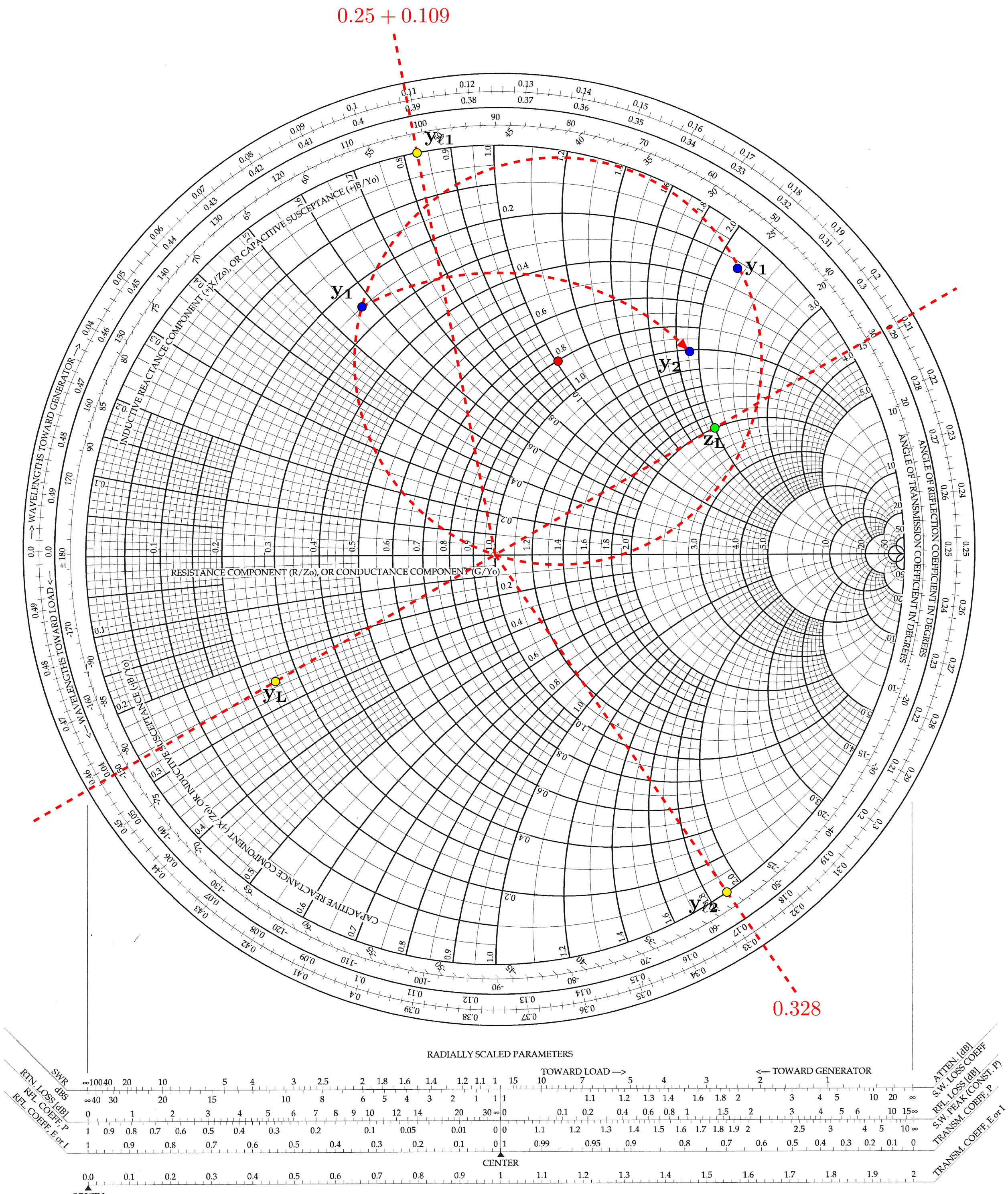

Figure 6: Problem 3, Smith Chart.

4. (I SWAPPED THE LOAD'S REAL AND IMAGINARY PARTS TO ACHIEVE THE OBJECTIVE OF THIS PROBLEM..)

The parallel double stub tuner will not work to match a $Z_L = 25 + j12.5\Omega$ load impedance to a $Z_c = 100\Omega$ lossless transmission line with stub spacing $d = \lambda/8$, and the first stub connected directly in parallel with the load. It will work however, if we add a little bit of transmission line in between the load and the first stub, call this length d_L.

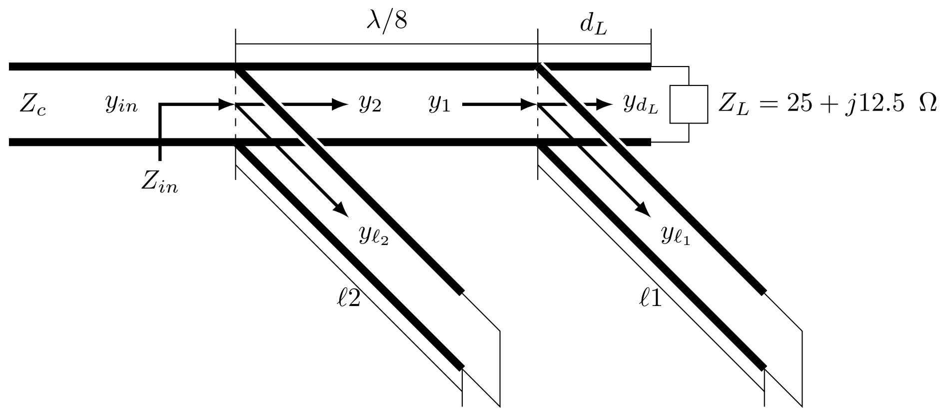

Figure 7: Problem 4, parallel double stub tuner, shorts.

(a) What minimum required additional length d_L do we need to match this load?

The normalized load impedance: $z_L = 0.25 + j0.125\Omega$ and $y_L = 2 - j1.9$

From the Smith Chart, the minimum length d_L is

$$\boxed{d_L = 0.021\lambda}$$

subitem**(b)** And the stub lengths will have to be $y_1 = 2 + j$

$y_{\ell 1} = (2 + j) - (2 - j1.9) = j2.9$

After rotating eighth a wavelength, $y_2 = 1 - j$ thus we want the second stub admittance to be $+j$

$$\boxed{\ell_1 = 0.447\lambda \qquad \ell_2 = 0.375\lambda}$$

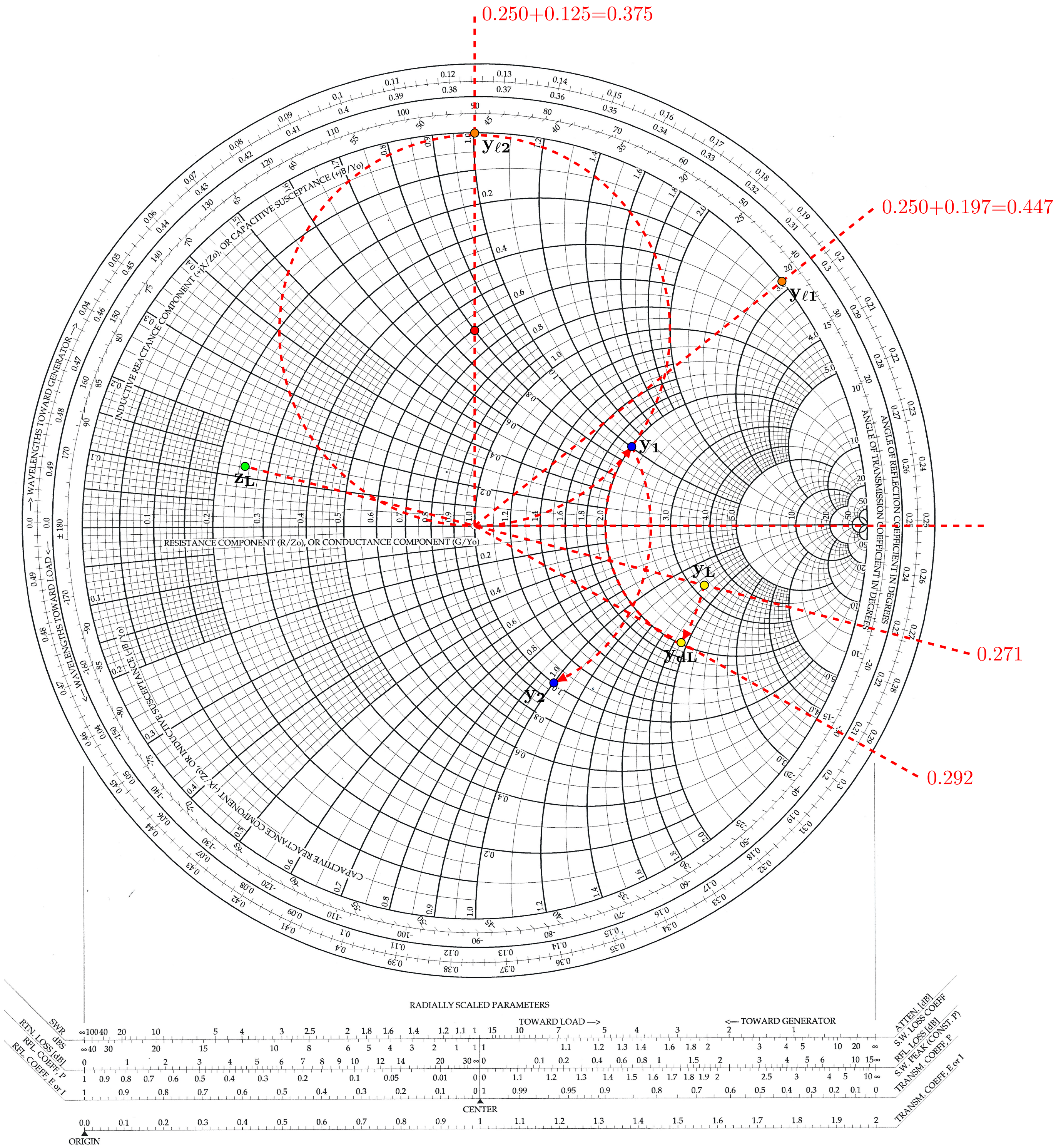

Figure 8: Problem 4, Smith Chart.

5. Figure out the "forbidden zones" for load impedances with the double stub tuner for the distance $d = \lambda/16$, $\lambda/8$, and $\lambda/4$.

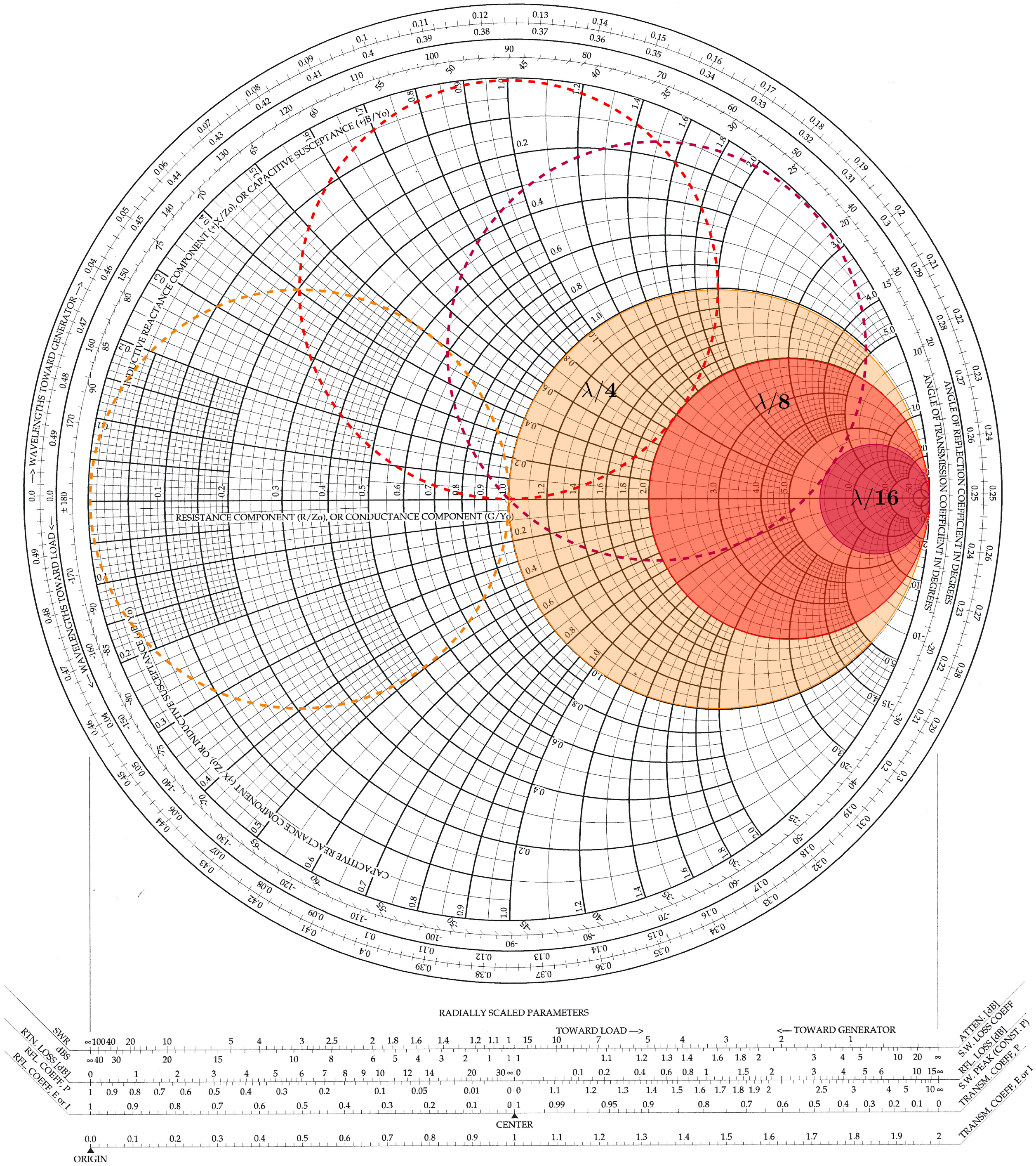

Figure 9: Problem 5, Smith Chart.