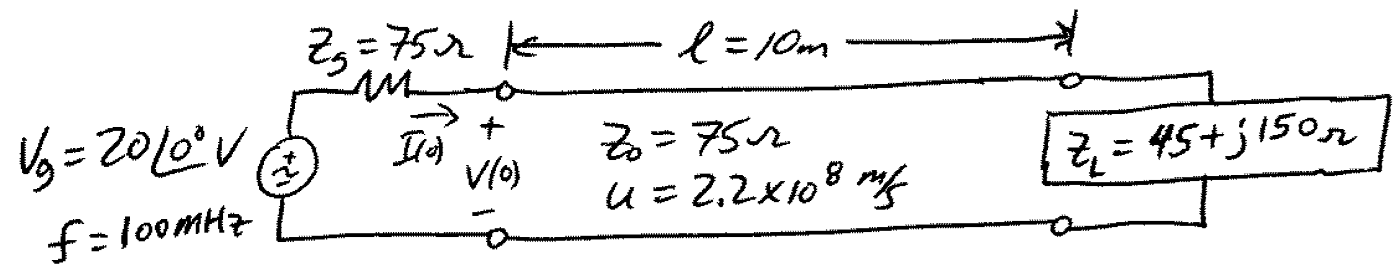
Matching load using a discrete series inductor

Using a discrete inductor placed in series w/ the transmission line, match the load to the transmission line and generator. The inductor should be placed as close to the load as possible. How much power is delivered to the load without matching? How much w/ matching?



$$\lambda = \frac{u}{f} = \frac{2.2\times10^8}{100\times10^6} = \underline{2.2\text{m}} \qquad \frac{\ell}{\lambda} = \frac{10}{2.2} = 4.5\overline{45}$$

$$z_L = \frac{Z_L}{Z_0} = \frac{45+j150}{75} = 0.6 + j2\ \Omega/\Omega \leftarrow \text{plot on Smith Chart}$$

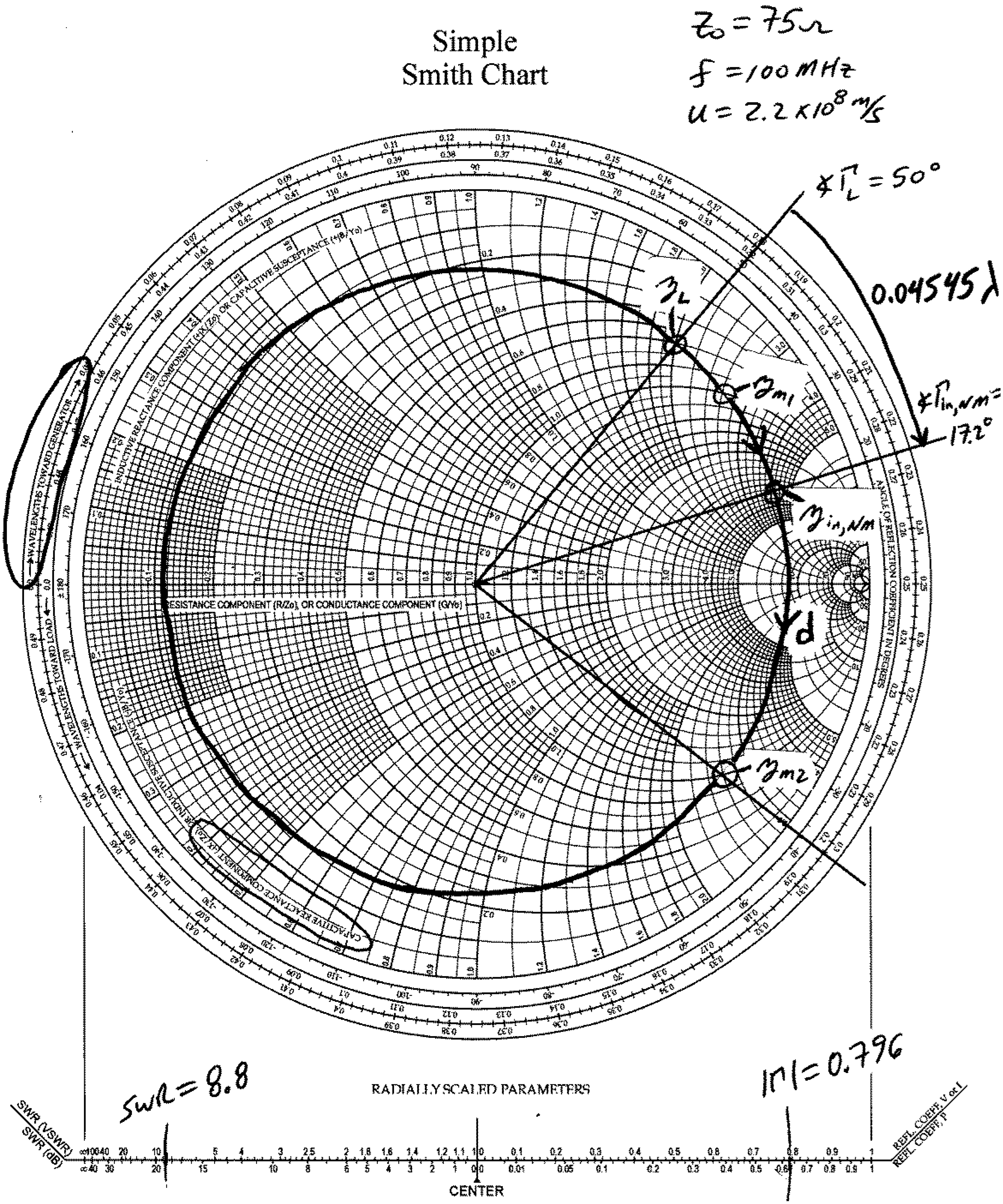
<u>No Match</u>

VSWR = 8.8 (from Smith Chart)

Move $\ell/\lambda = 4.5\overline{45} \xrightarrow{-4.5} 0.04545$ "Toward Generator" to

$$z_{in,NM} = 3.2 + j4.2\ \Omega/\Omega \quad (3.236 + j4.176\ \Omega/\Omega \text{ analytic})$$

$$Z_{in,NM} = (3.2 + j4.2)75 = \underline{240 + j315\ \Omega}$$


Simple
Smith Chart
$Z_0 = 75\Omega$
$f = 100$ MHz
$u = 2.2 \times 10^8$ m/s
$\measuredangle\Gamma_L = 50°$
0.04545λ
$\measuredangle\Gamma_{in,NM} = 17.2°$
y_L
y_{m1}
$y_{in,NM}$
y_{m2}
y_d
SWR = 8.8
|Γ| = 0.796
RADIALLY SCALED PARAMETERS
CENTER

No Match cont.

No Match:

$$I(0) = \frac{V_g}{Z_g + Z_{in,NM}} = \frac{20\angle 0^\circ}{75 + (240 + j315)} = \underline{0.044896\angle -45^\circ \text{ A}}$$

$$V(0) = V_g \frac{Z_{in,NM}}{Z_g + Z_{in,NM}} = 20\angle 0^\circ \frac{240 + j315}{75 + (240 + j315)} = 17.7792\angle 7.696^\circ \text{ V}$$

$$P_{in,NM}(0) = P_{L,NM} = \tfrac{1}{2}\operatorname{Re}\{V(0)\, I^*(0)\} = \tfrac{1}{2}\operatorname{Re}\{17.8\angle 7.7^\circ\,(0.045\angle +45^\circ)\}$$

$$\underline{\underline{P_{L,NM} = 0.242 \text{ W}}}$$

Matching

The match points are $y_m = 1 \pm j2.6$ ℧/Ω.

To cancel the reactance with a series inductor $\left(+\frac{j\omega L}{Z_0}\right)$, choose $y_{m2} = 1 - j2.6$ ℧/Ω which is located $d = 0.3025\lambda - 0.1805\lambda = \underline{\underline{0.122\lambda}} = \underline{\underline{0.2684 \text{ m}}}$ from the load.

Let $y_{m2} + y_{ind} = (1 - j2.6) + \frac{j\omega L}{Z_0} = 1$

Matching cont.

$$L = \frac{2.6 Z_0}{\omega} = \frac{2.6(75)}{2\pi(100\times10^6)}$$

$$L = 0.31035 \mu H = 310.35 nH$$

matched

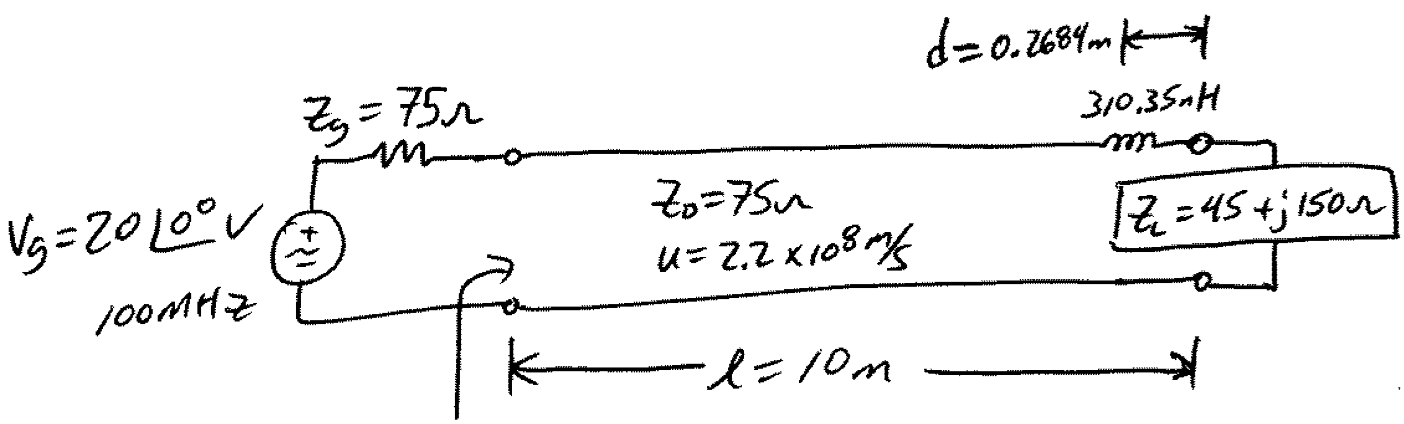
$$I(0) = \frac{V_g}{Z_g + Z_{in,m}} = \frac{20\angle 0^\circ}{75+75} = 0.1\overline{33}\angle 0^\circ A$$

$$V(0) = V_g \frac{Z_{in,m}}{Z_g + Z_{in,m}} = 20\angle 0^\circ \frac{75}{75+75} = 10\angle 0^\circ V$$

$$P_{in_m}(0) = P_{L,m} = \tfrac{1}{2}\mathrm{Re}\{10\angle 0^\circ (0.1\overline{33}\angle 0^\circ)\}$$

$$P_{L,m} = 0.66\overline{6} W$$

(275 % of unmatched power delivered !



$$Z_{in} = Z_0 = 75\Omega$$