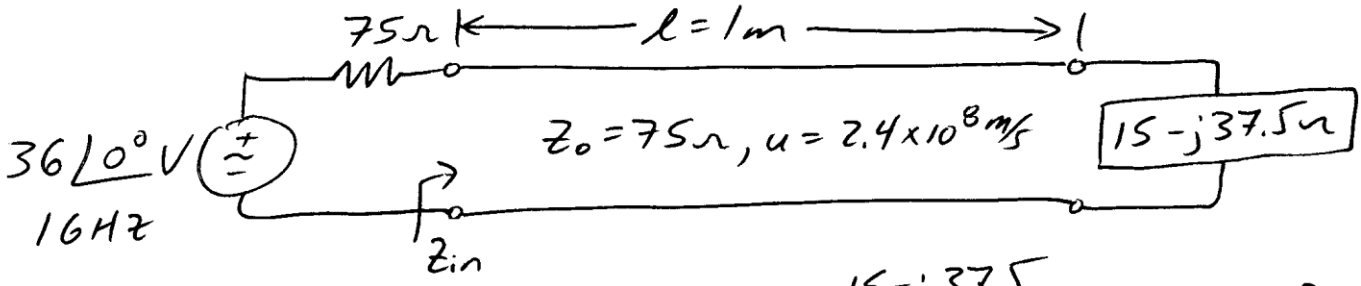
A load of $Z_L = 15 - j\,37.5\,\Omega$ is connected to a $75\,\Omega$, $36\angle 0°$ V, 1 GHz, sinusoidal generator by a lossless, coaxial transmission line ($u = 2.4 \times 10^8$ m/s, $Z_0 = 75\ \Omega$) of length 1 m. With no matching, how much power is delivered to the load? Match the load to the generator by placing a single discrete capacitor in **series** with the transmission line as close to the load as possible. Sketch the resulting circuit with all relevant values. How much power is delivered to the load after matching?



→ Normalize load impedance $z_L = \frac{15 - j37.5}{75} = 0.2 - j0.5\ \Omega$
and plot on Smith Chart

→ Calculate wavelength $\lambda = u/f = \frac{2.4\times10^8}{1\times10^9} = 0.24\,m$

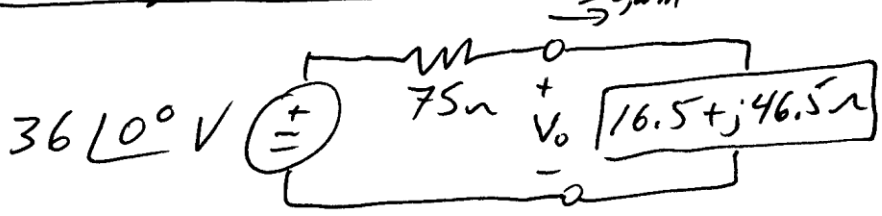
No Match

→ Find $\ell/\lambda = \frac{1}{0.24} = 4.1\overline{66}$

→ Move $0.1\overline{66}\,\lambda$ from z_L to $z_{in,NM} = 0.22 + j0.62\ \Omega$
"WAVELENGTHS TWD GENERATOR" on circle of $|\Gamma| = 0.725$

→ $Z_{in,NM} = z_{in,NM} Z_0 = 75(0.22 + j0.62) = 16.5 + j46.5\,\Omega$

N.M. Equiv. Circuit



$$I_{0,NM} = \frac{36\angle 0°}{75 + (16.5 + j46.5)} = 0.35075\angle -26.94°\ A$$

$$P_{L,NM} = P_{in,NM} = \tfrac{1}{2}|I_0|^2 \mathrm{Re}\{Z_{in}\} = \tfrac{1}{2}(0.35075)^2 16.5$$

$$P_{L,NM} = 1.015\ W$$

Matching

→ Identify the two series match impedance points

$y_{m1} = 1 + j2.08$ ℧/Ω and $y_{m2} = 1 - j2.08$ ℧/Ω

↳ Inductive Reactance

→ Choose y_{m1} and find distance $\ell_{m1} = (0.076 + 0.1085)\lambda$

$$\ell_{m1} = 0.2645\lambda = 0.2645(0.24\text{m}) = 6.348\text{ cm}$$

→ Calculate $z_{m1} = z_0 y_{m1} = 75(1 + j2.08) = 75 + j156\ \Omega$

→ $z_{m1} + z_{cap} = z_0$ to find C_{series}

$$75 + j156 - \frac{j}{2\pi(1\times10^9)C_s} = 75$$

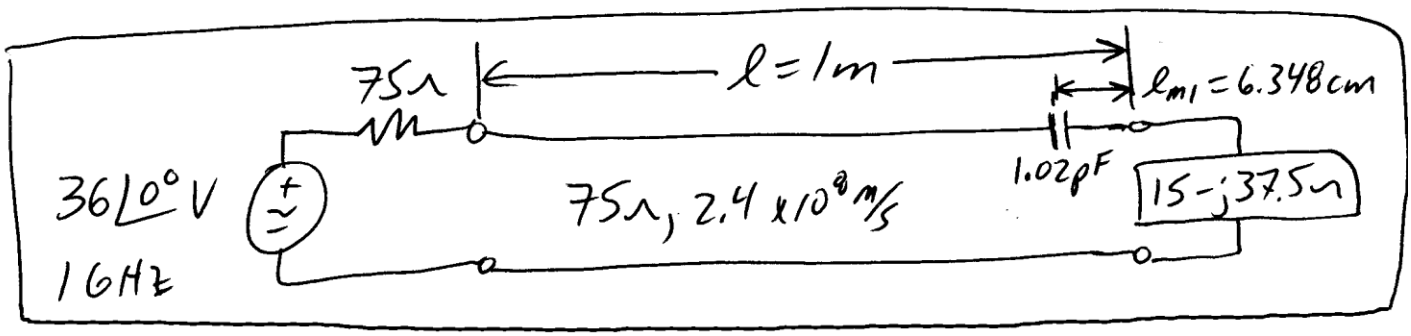
↳ $C_s = \frac{1}{2\pi(1\times10^9)156} \Rightarrow C_{series} = 1.0202\text{ pF}$

Equiv. CKT w/ Matching

$$I_{0,m} = \frac{36\angle0°}{75+75} = 0.24\angle0°\text{ A}$$

over twice $P_{L,NM}$!!

$$P_{IN,m} = P_{L,m} = \tfrac{1}{2}|I_{0,m}|^2 75 = \tfrac{1}{2}(0.24)^2 75 \Rightarrow P_{L,m} = 2.16\text{ W}$$

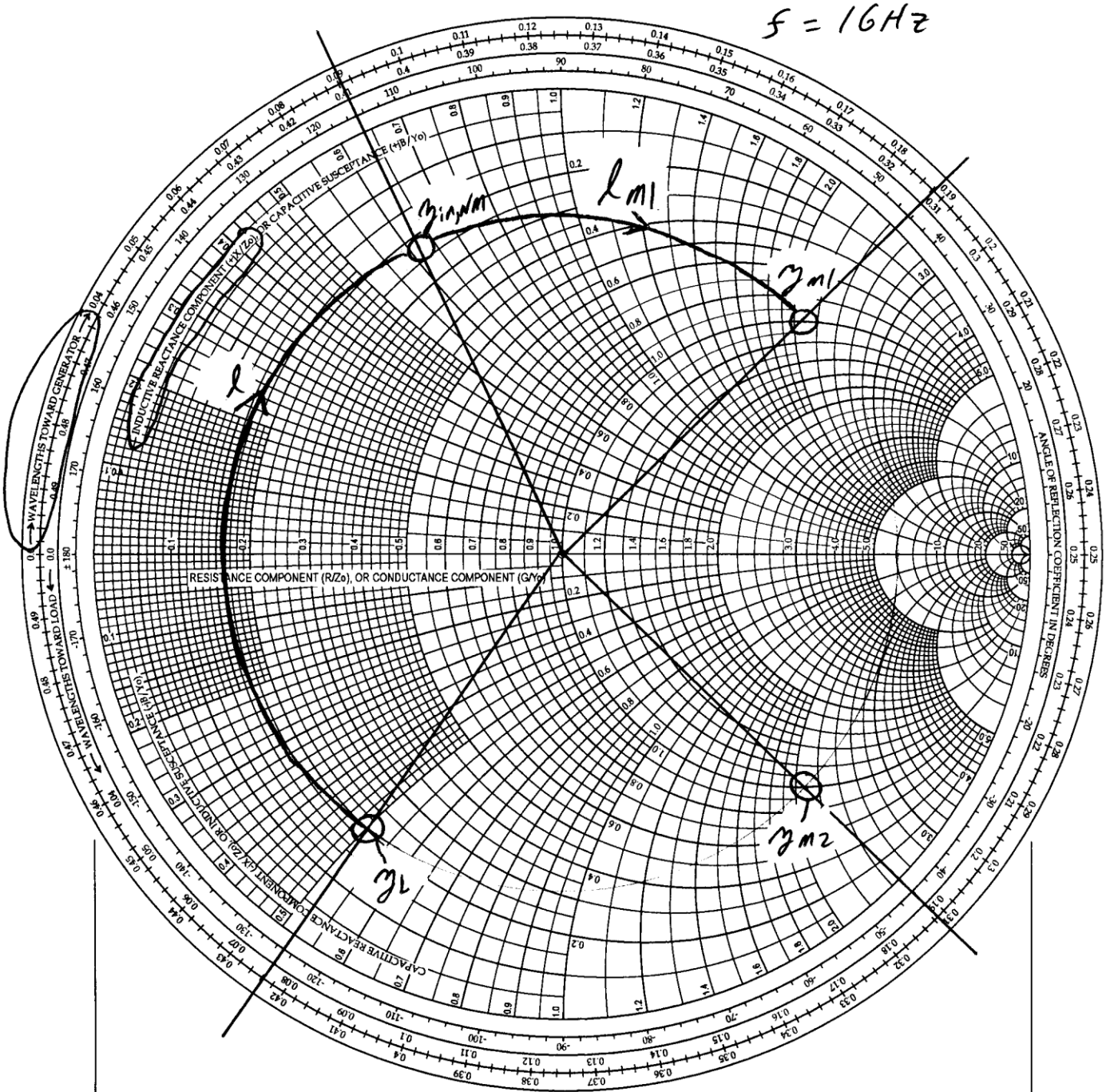


Simple Smith Chart

$Z_o = 75\Omega$

$u = 2.4 \times 10^8$ m/s

$f = 1$ GHz



VSWR = 6.03

|Γ| = 0.725

RADIALLY SCALED PARAMETERS

SWR (VSWR)
SWR (dB)
REFL. COEFF. V or I
REFL. COEFF. P
CENTER