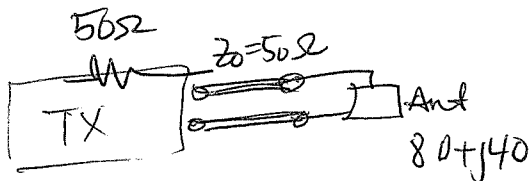


HW #1 needs

$$2.2 \quad Z_0 = \sqrt{\frac{R+j\omega L}{G+j\omega C}} = \sqrt{\frac{(5+j628)}{(0.01+j0.94)}} = \sqrt{\frac{628 \angle 89.54^\circ}{0.94 \angle 89.39^\circ}} = 25.8 \angle 0.08^\circ = 25.8 + j0.03 \Omega$$

$$\gamma = \sqrt{(R+j\omega L)(G+j\omega C)} = \sqrt{(5+j628)(0.01+j0.94)} = \sqrt{628 \angle 89.4^\circ \cdot 0.94 \angle 89.39^\circ} = 24.3 \angle 89.465^\circ = 0.23 + j24.3$$

2.12



$$P_L = P_{in}(1 - |\Gamma|^2) = 30(1 - (0.37)^2) = 25.9 \text{ W}$$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{80 + j40 - 50}{80 + j40 + 50} = \frac{30 + j40}{130 + j40} = \frac{50 \angle 53^\circ}{136.47} = 0.37 \angle 36^\circ$$

2.15

$$V_g = 15 \text{ V rms}$$

$$Z_g = 75 \Omega$$

$$Z_0 = 75 \Omega$$

$$Z_L = 60 - j40 \Omega$$

$$l = 0.7 \lambda$$

a) find Γ ; true for lossless line case only

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{60 - j40 - 75}{60 - j40 + 75} = \frac{-15 - j40}{135 - j40} = \frac{42.7 \angle 249^\circ}{140.8 \angle -16.5^\circ}$$

$$|\Gamma| = 0.303 \angle -94.5^\circ$$

$$\Gamma = -0.024 - j0.302$$

$$\tan \beta l = \tan \frac{2\pi}{\lambda} \cdot 0.7 \lambda$$

$$P_L = \left(\frac{15}{2}\right)^2 \frac{1}{75} [1 - (0.303)^2] = 0.681 \text{ W}$$

$$= \tan 25.2 = 3.08$$

b) find Z_{in} ; true for lossless line case only

$$Z_{in} = Z_0 \frac{Z_L + jZ_0 \tan \beta l}{Z_0 + jZ_L \tan \beta l} = 75 \frac{60 - j40 + j231}{75 + j184.8 + j23.2} = 75 \frac{60 + j190.8}{198.1 + j184.8}$$

$$Z_{in} = 75 \frac{200 \angle 72.5^\circ}{270.8 \angle 43^\circ} = 55.4 \angle 29.5^\circ = 48.2 + j27.3 \Omega$$

$$P_L = \left| \frac{V_g}{Z_g + Z_{in}} \right|^2 \text{Re}(Z_{in}) = \left| \frac{15}{75 + 48.2 + j27.3} \right|^2 (48.2) = \left| \frac{15}{126 \angle 12.49^\circ} \right|^2 (48.2) = 0.683 \text{ W}$$

(c) find V_L ; Can be applied to lossy and lossless lines.

$$V(z) = V^+(e^{-j\beta z} + \Gamma e^{j\beta z})$$

$$V(0) = V^+(1 + \Gamma) = 7.5(1 - 0.24 - j0.302) = 7.32 - j2.265 = 7.66 \angle -17.2^\circ \text{ V}$$

$$V^+ = \frac{V_g \cdot 75}{150} = 15 \left(\frac{1}{2}\right) = 7.5 \text{ V}$$

$$P_L = \left| \frac{V_L}{Z_L} \right|^2 \text{Re}(Z_L) = \left(\frac{7.66}{72.1} \right)^2 (60) = 0.677 \text{ W}$$

2.19 $\text{SWR} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$ $\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{60 + j50 - 50}{60 + j50 + 50} = \frac{10 + j50}{110 + j50} = \frac{50.99 \angle 78.7^\circ}{120.8 \angle 24.4^\circ}$

(b) $\Gamma = 0.422 \angle 54.3^\circ$ $|\Gamma| = 0.422$

(a) $\text{SWR} = \frac{1 + 0.422}{1 - 0.422} = 2.46$

(c) $\tilde{z}_L = \frac{Z_L}{Z_0} = \frac{60 + j50}{50} = 1.2 + j1$

$$y_L = \frac{1}{\tilde{z}_L} = \frac{1}{1.2 + j1} \cdot \frac{1.2 - j1}{1.2 - j1} = \frac{1.2 - j1}{2.44} = 0.49 - j0.41$$

$$Y_L = \frac{y_L}{Y_0} = 9.8 - j8.2 \text{ mS}$$

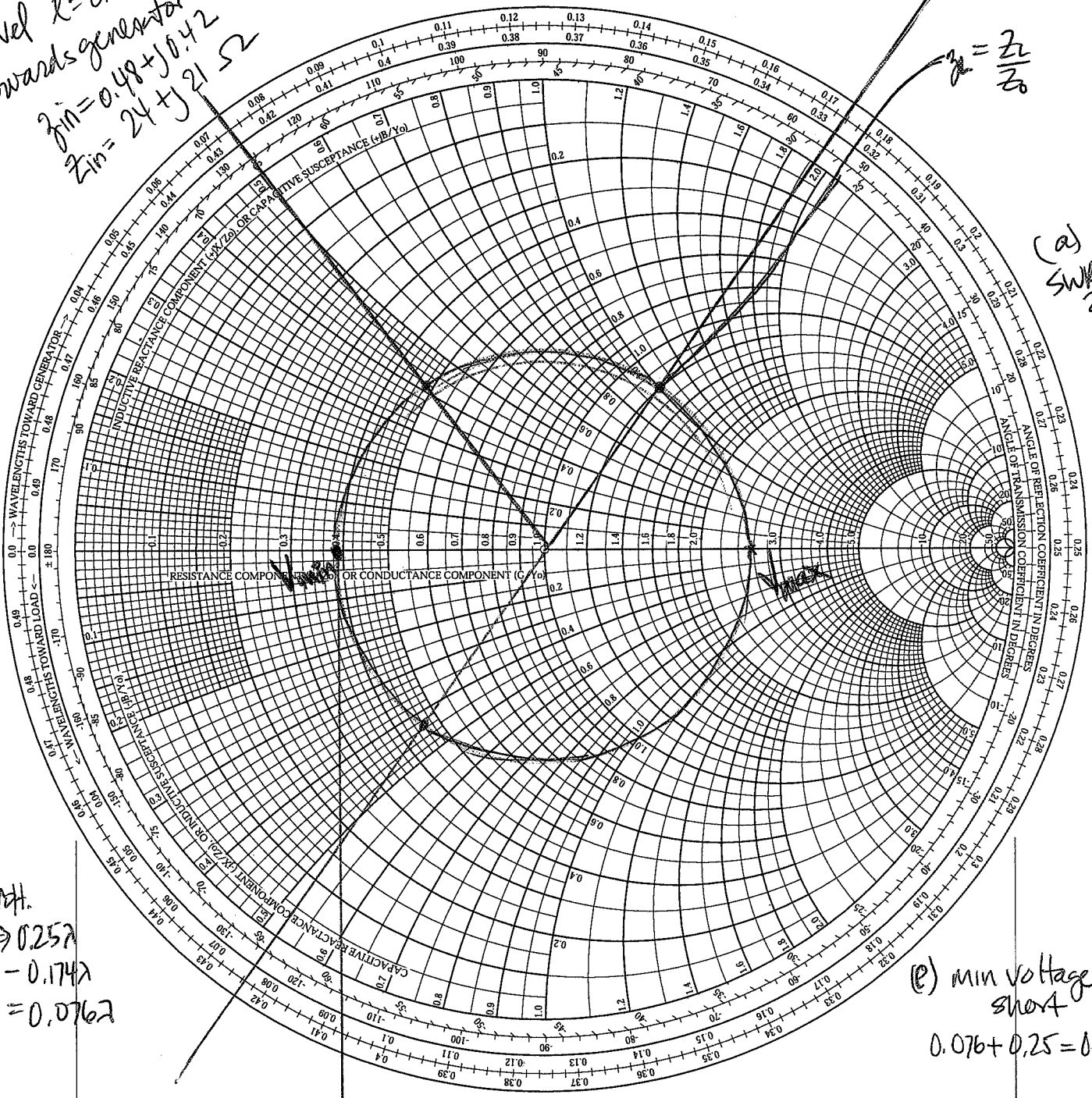
(d) $Z_{in} = Z_0 \frac{Z_L + jZ_0 \tan \beta l}{Z_0 + jZ_L \tan \beta l}$

2.19

The Complete Smith Chart

Black Magic Design

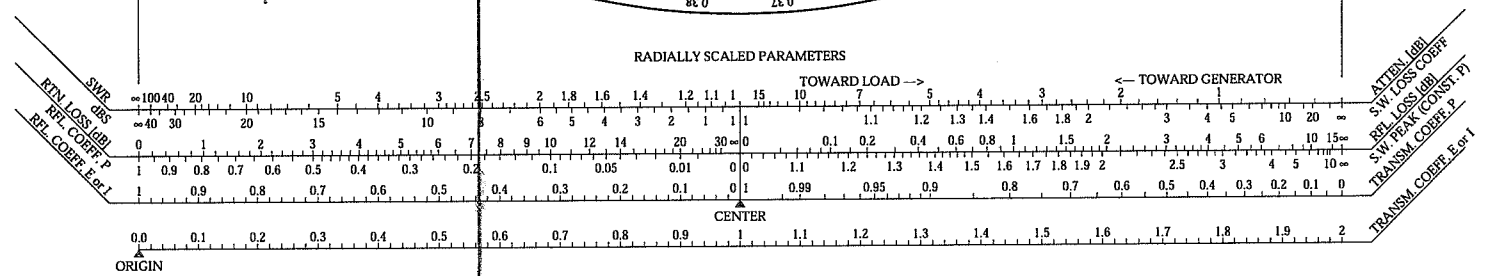
(d)
 travel $l = 0.4\lambda$
 towards generator
 $Z_{in} = 0.48 + j0.42$
 $Z_{in} = 24 + j21 \Omega$



(a) SWR = 2.45

max V_{th}
 open $\Rightarrow 0.25\lambda$
 $- 0.174\lambda$
 $= 0.076\lambda$

(e) min voltage short
 $0.076 + 0.25 = 0.326\lambda$



(b) $\Gamma = 0.44 \angle 55^\circ$

(c) $Y_L = 0.48 - j0.42 \Rightarrow Y_L = 9.6 - j8.4 \text{ mS}$

