Homework 1
EENG530 Fall 2018

Lewis Setter

August 30, 2018

1.1

$$\begin{aligned}
Z_0 &= 75\Omega, l_{line} = 0.65\lambda \\
V_g &= 5\angle 90^\circ, Z_g = 10 + j20\Omega \\
Z_L &= 50\Omega
\end{aligned}$$

$$V_{line} = V(-l_{line}) - V(0)$$

$$\begin{aligned}
V(-l_{line}) &= V_0^+(e^{j\beta l_{line}} + \Gamma_l e^{-j\beta l_{line}}) \\
&= V_0^+(e^{j1.3\pi} + \Gamma_l e^{-j1.3\pi}) \\
V(0) &= V_0^+(1 + \Gamma_l) \\
\Rightarrow V_{line} &= V_0^+(e^{j1.3\pi} - 1 + \Gamma_l(e^{-j1.3\pi} - 1))
\end{aligned}$$

$$\begin{aligned}
V_0^+ &= V_g \frac{Z_0}{Z_0 + Z_g} \frac{e^{j\beta l_{line}}}{1 - \Gamma_g \Gamma_l e^{j2\beta l_{line}}} \\
&= V_g \frac{Z_0}{Z_0 + Z_g} \frac{e^{-j1.3\pi}}{1 - \Gamma_g \Gamma_l e^{-j2.6\pi}}
\end{aligned}$$

$$\begin{aligned}
\Gamma_l &= \frac{Z_L - Z_0}{Z_L + Z_0} = -0.2 \\
\Gamma_g &= \frac{Z_g - Z_0}{Z_g + Z_0} = 0.78\angle 150^\circ \\
\Rightarrow V_0^+ &= 3.8\angle - 163^\circ \\
\Rightarrow V_{line} &= 6.1\angle 55^\circ
\end{aligned}$$

$$P = \frac{1}{2}|V_g|^2 \frac{R_{in}}{(R_{in} + R_g)^2 + (X_{in} + X_g)^2}$$

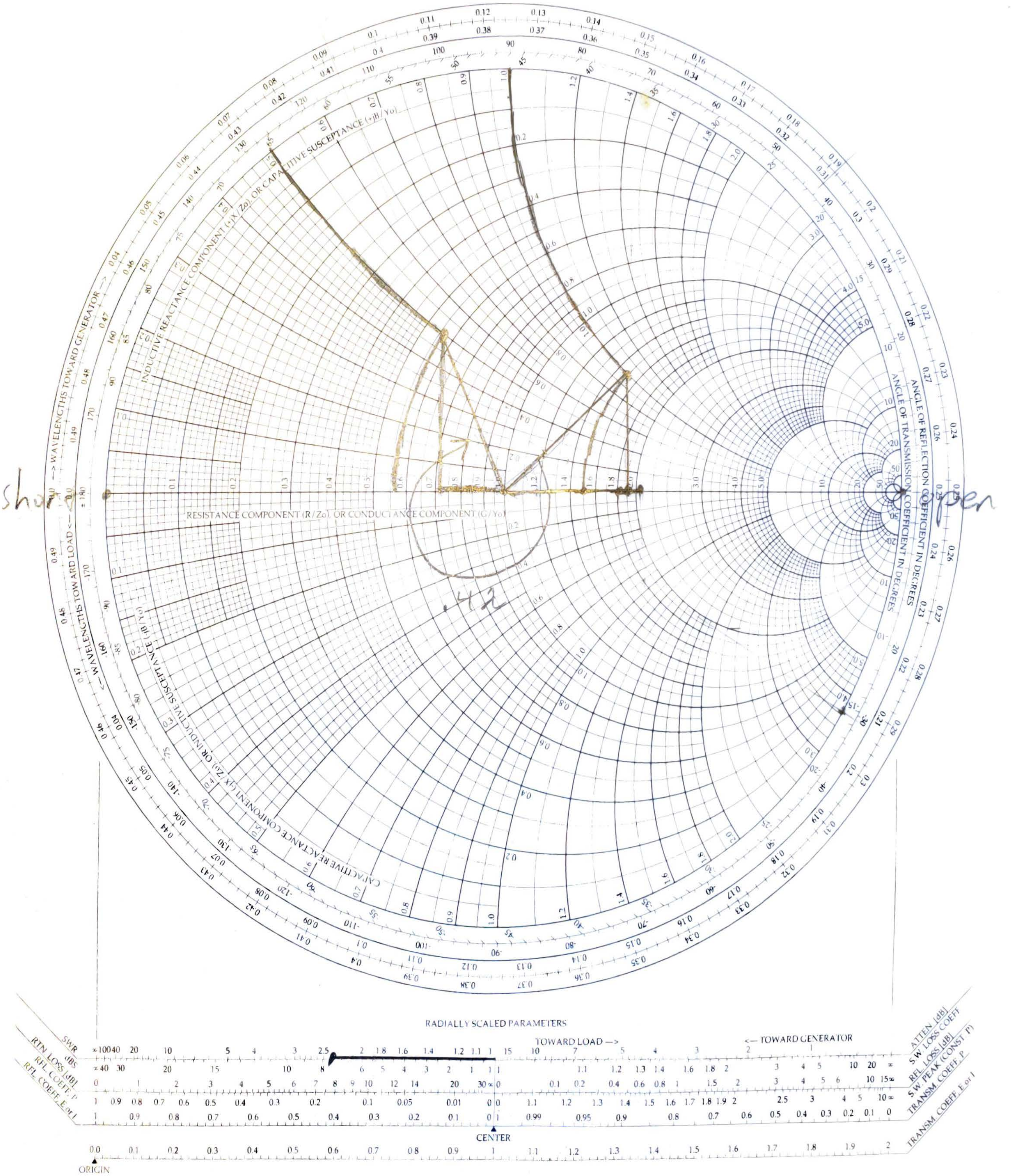
$$\begin{aligned}
Z_{in} &= Z_0 \frac{Z_L + jZ_0 \tan \beta l_{line}}{Z_0 + jZ_L \tan \beta l_{line}} \\
&= Z_0 \frac{Z_L + jZ_0 \tan 1.3\pi}{Z_0 + jZ_L \tan 1.3\pi} \\
&= 79 + j31\Omega \\
\Rightarrow P &= 0.094
\end{aligned}$$

1.2

$$\begin{aligned}
\Gamma &= 0.31 + j0.28 \\
\Gamma_{l=0.4\lambda} &= -0.24 + j0.34 \\
SWR &= 2.4 \\
Z_{in} &= (0.56 + j0.5)(50\Omega) = 28 + j25\Omega
\end{aligned}$$

The Complete Smith Chart

Black Magic Design



1.3

```
%% ZinSITL: plot Z_in for a simi-infinite transmission line carrying a sinusoid
%
% user specified variables:
%   - Z_0: charcteristic impedance of the line
%   - l: length of the line wavelengths of the transmitted wave
%   - Z_L: load impedance
%
% usage:
% When a user sets the specified inputs, the program produces plots
% of the magnitue and phase of the input impedance of a corresponding
% semi inifinite transmission line up to the desired length.

% user specified inputs
Z_0 = 50; l = 5; Z_L = 10+j20;

% compute Z_in
lVals = 0:l/1000:l;
Z_in = Z_0 * (Z_L + 1j*Z_0*tan(2*pi*lVals)) ./ (Z_0 + 1j*Z_L*tan(2*pi*lVals));

% create plots
figure
subplot(2,1,1)
plot(lVals,abs(Z_in))
ylabel('|Z_{in}|')
subplot(2,1,2)
plot(lVals,angle(Z_in)*180/pi)
ylabel('\angle Z_{in}')
xlabel('\lambda from generator')
```