

Stuff to Grok - WK 7, 8

$$\text{Important relationship : } z_L = z_0 \left(\frac{V_0^+ + V_0^-}{V_0^+ - V_0^-} \right)$$

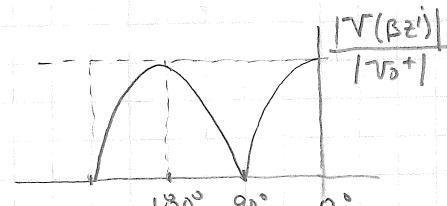
- relates $z_0 + z_L$ via forward and reverse voltages only

$$\Gamma_L \text{ (complex voltage reflection coefficient)} = \frac{V_0^-}{V_0^+} \quad \left\{ \begin{array}{l} \text{portion of incident} \\ \text{wave that is reflected} \end{array} \right.$$

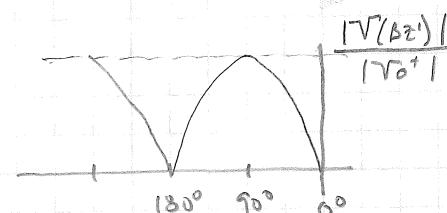
$$\Gamma_L = \frac{z_L - z_0}{z_L + z_0} \Rightarrow z_L = z_0 \left(\frac{1 + \Gamma_L}{1 - \Gamma_L} \right)$$

$$= |\Gamma_L| e^{j\theta_L} \quad \text{where } |\Gamma_L| = \sqrt{r_e^2 + m^2} \quad \theta_L = \tan^{-1} \left(\frac{im}{re} \right)$$

$$\text{Open circuit line : } V(z') = 2V_0 \cos(\beta z')$$



$$\text{Short circuit line : } V(z') = 2V_0 j \sin(\beta z')$$



Standing wave voltage patterns repeat every $\lambda/2$.

Standing waves do not move. (thus the name!)

SWR = ratio of V_{max} & V_{min} . It's also a measure of mismatch between z_0 of the T-line & z_L .

$$\text{NSWR} = \frac{|V_{max}|}{|V_{min}|} = \frac{1 + |\Gamma_L|}{1 - |\Gamma_L|} ; \text{ thus } \Gamma_L = \frac{\text{SWR} - 1}{\text{SWR} + 1}$$

$$\text{where } V_{max} = V_0^+ (1 + |\Gamma_L|)$$

$$V_{min} = V_0^+ (1 - |\Gamma_L|)$$

A load that is purely reactive can dissipate no power. Thus with completely reactive loads, SWR = ∞ .

A matched load ($z_L = z_0$) will exhibit an SWR of 1. (Flat line.)

$$V(z') = V_0 e^{j\theta_L} \left[1 + |R| e^{j(\theta_L - 2\beta z')} \right]; \text{ tells us that...}$$

- the magnitude of the reflection coefficient is unchanged with distance across a lossless line

- the phase of the reflection coefficient changes at a rate of $2x$ the electrical length from the load z_L .

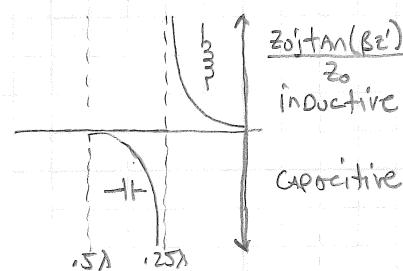
The points at which the standing wave voltages are at a maximum may be found from:

$$\beta z'_{\max} - \frac{\theta_L}{2} = n\pi \quad n=0, 1, 2, 3, \dots$$

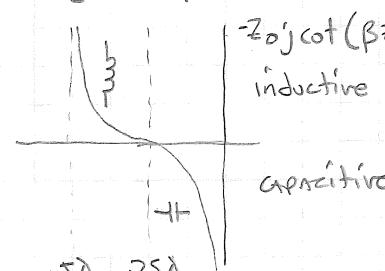
The voltage minimums are exactly $\frac{\lambda}{4}$ away.

$Z_{in}(z')$ is not necessarily equal to line impedance Z_0 .

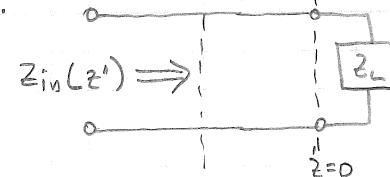
Shorted line: $Z_{in}(z') = Z_0 j \tan(\beta z')$ (purely reactive)



Open circuit line: $Z_{in}(z') = -Z_0 j \cot(\beta z')$ (purely reactive)



In the general case:



$$Z_{in}(z') = Z_0 \frac{(Z_L + Z_0 \tanh(\beta z'))}{(Z_L - Z_0 \tanh(\beta z'))}$$

$$Z_{in}(z') = Z_0 \frac{(Z_L + j Z_0 \tan(\beta z'))}{(Z_L - j Z_0 \tan(\beta z'))}$$