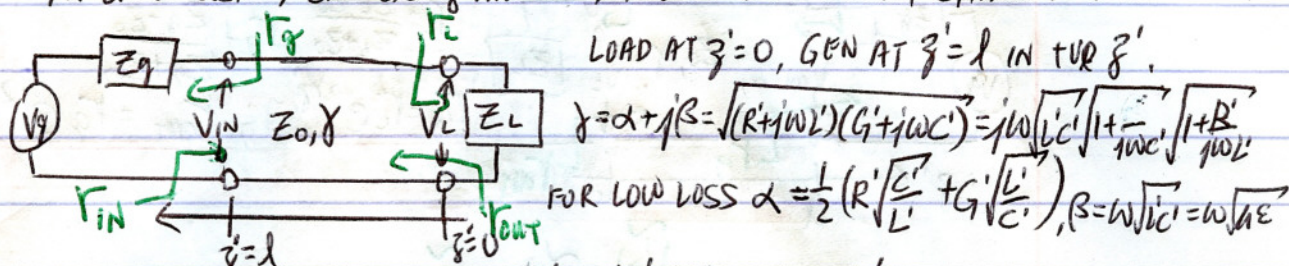


11/30/11

TX LINE USING CHENG'S γ APPROACH, ACCORDING TO SMITH CHART. P450

$$\tilde{V}(z') = V_0^+ (e^{j\beta z'} + r_L e^{-j\beta z'})$$

$$\tilde{I}(z') = I_0^+ e^{j\beta z'} + I_0^- e^{-j\beta z'} = \frac{V_0^+}{Z_0} (e^{j\beta z'} - r_L e^{-j\beta z'})$$

$$\tilde{V}_L = \tilde{V}(z'=0) = \tilde{I}_L Z_L = V_0^+ (1 + r_L) = V_0^+ + V_0^-$$

$$\tilde{I}_L = \tilde{I}(z'=0) = \frac{V_0^+}{Z_0} (1 - r_L) = \frac{V_0^+ - V_0^-}{Z_0}$$

$$\Rightarrow \tilde{V}_L + \tilde{I}_L Z_0 = 2V_0^+ \Rightarrow V_0^+ = \frac{1}{2}(\tilde{V}(z'=0) + \tilde{I}(z'=0)Z_0) = \frac{1}{2}(\tilde{V}_L + \tilde{I}_L Z_0) = \frac{\tilde{I}_L}{2}(Z_L + Z_0)$$

$$V_0^- = \frac{1}{2}(\tilde{V}_L - \tilde{I}_L Z_0) = \frac{\tilde{I}_L}{2}(Z_L - Z_0)$$

$$\tilde{V}(z') = V_0^+ e^{j\beta z'} + V_0^- e^{-j\beta z'} = \frac{\tilde{I}_L}{2} [Z_L + Z_0] e^{j\beta z'} + [Z_L - Z_0] e^{-j\beta z'} \quad (9-99a)$$

$$\tilde{I}(z') = \frac{\tilde{I}_L}{2Z_0} [Z_L + Z_0] e^{j\beta z'} - [Z_L - Z_0] e^{-j\beta z'} \quad (9-99b) = \frac{V_0^+}{Z_0} (e^{j\beta z'} - r_L e^{-j\beta z'})$$

$$Z(z') = \frac{\tilde{V}(z')}{\tilde{I}(z')} = Z_0 \frac{(1 + r_L e^{-2j\beta z'})}{(1 - r_L e^{-2j\beta z'})}$$

P451 IMPEDANCE:

$$\Rightarrow \tilde{V}(z') = I_L (Z_L \cosh \gamma z' + Z_0 \sinh \gamma z'), \quad \tilde{I}(z') = \frac{I_L}{Z_0} (Z_L \sinh \gamma z' + Z_0 \cosh \gamma z') \quad 9-100$$

$$Z(z') = \frac{\tilde{V}(z')}{\tilde{I}(z')} = Z_0 \frac{Z_L \cosh \gamma z' + Z_0 \sinh \gamma z'}{Z_L \sinh \gamma z' + Z_0 \cosh \gamma z'} = Z_0 \frac{Z_L + Z_0 \tanh \gamma z'}{Z_0 + Z_L \tanh \gamma z'} \quad \Omega \quad 9-101$$

$$Z_{IN} = Z(z'=l) = Z_0 \frac{Z_L + Z_0 \tanh \gamma l}{Z_0 + Z_L \tanh \gamma l} \quad \Omega \quad 9-102$$

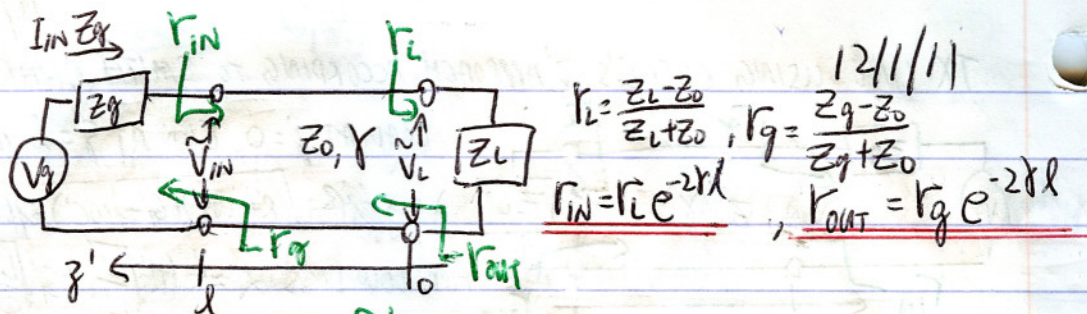
REFLECTION COEFF. (9-134)

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = |r| e^{j\theta_r}, \quad \Gamma_g = \frac{Z_g - Z_0}{Z_g + Z_0} = |r| e^{j\theta_r}, \quad r_{IN} = \frac{Z_{IN} - Z_0}{Z_{IN} + Z_0}, \quad r_{OUT} = \frac{Z_{OUT} - Z_0}{Z_{OUT} + Z_0}$$

$$r_{IN} = \frac{Z_{IN} - Z_0}{Z_{IN} + Z_0} = \frac{Z_0 \left(\frac{1+A}{1-A} \right) - Z_0}{Z_0 \left(\frac{1+A}{1-A} \right) + Z_0} \quad (A = r_L e^{-2j\beta l}) = \frac{Z_0(1+A) - Z_0(1-A)}{Z_0(1+A) + Z_0(1-A)} = A = r_L e^{-2j\beta l}$$

$$r_{OUT} = \frac{Z_{OUT} - Z_0}{Z_{OUT} + Z_0} = \frac{Z_0 \left(\frac{1+B}{1-B} \right) - Z_0}{Z_0 \left(\frac{1+B}{1-B} \right) + Z_0} \quad (B = r_L e^{-2j\beta l}) = r_L e^{-2j\beta l}$$

$$\Gamma(z') = r_L e^{-2j\beta z'}$$



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VOLTAGE PHASOR RELATION

RELATION TO \tilde{V}_g \tilde{I}_{in}

$$\tilde{V}_g = \tilde{V}_{in} + \tilde{I}_{in} Z_g = \tilde{V}_{in}^+ + \tilde{V}_{in}^- + \left(\frac{\tilde{V}_{in}^+}{Z_o} - \frac{\tilde{V}_{in}^-}{Z_o} \right) Z_g$$

$$\Rightarrow V_g Z_o = \tilde{V}_{in}^+ Z_o + \tilde{V}_{in}^- Z_o + \tilde{V}_{in}^+ Z_g - \tilde{V}_{in}^- Z_g = \tilde{V}_{in}^+ (Z_g + Z_o) - \tilde{V}_{in}^- (Z_g - Z_o)$$

$$\Rightarrow \frac{V_g Z_o}{Z_g + Z_o} = \tilde{V}_{in}^+ - \tilde{V}_{in}^- \left(\frac{Z_g - Z_o}{Z_g + Z_o} \right) = \tilde{V}_{in}^+ - \tilde{V}_{in}^- r_g$$

$\tilde{V}_{in} = \tilde{V}_{in}^+ + \tilde{V}_{in}^-$

$$\tilde{V}_{in}^+ (1 - r_{in} r_g)$$

V_o^+, V_o^-

$V_o^+ = V_{(z'=0)}^+$, $V_o^- = V_{(z'=0)}^- = V_{(z'=0)}^- r_L$

$$\tilde{V}_{in}^+ = \frac{V_g Z_o}{Z_g + Z_o} \frac{1}{(1 - r_{in} r_g)} = V_o^+ e^{\gamma l} \Rightarrow V_o^+ = \frac{V_g Z_o e^{-\gamma l}}{(Z_g + Z_o) (1 - r_g r_L e^{2\gamma l})}$$

$(r_{in} = r_L e^{-2\gamma l})$

$$\tilde{V}_o^+ = \frac{V_g e^{-\gamma l}}{\left(\frac{Z_g}{Z_o} + 1 \right) (1 - r_g r_L e^{-2\gamma l})} = \frac{V_g e^{-\gamma l}}{\left(\frac{1 + r_g}{1 - r_g} \right) (1 - r_g r_L e^{-2\gamma l})} = \frac{V_g e^{-\gamma l} (1 - r_g)}{2 (1 - r_g r_L e^{-2\gamma l})}$$

I_o^+, I_o^-

$$I_o^+ = \frac{V_o^+}{Z_o} = \frac{V_g e^{-\gamma l} (1 - r_g)}{2 Z_o (1 - r_g r_L e^{-2\gamma l})}$$

$$I_o^- = -\frac{V_o^-}{Z_o} = -\frac{V_o^+ r_L}{Z_o} = -\frac{V_g e^{-\gamma l} (1 - r_g) r_L}{2 Z_o (1 - r_g r_L e^{-2\gamma l})}$$

$$\tilde{V}_{in} = V_o^+ (e^{\gamma l} + r_L e^{-\gamma l}) = \frac{V_g e^{-\gamma l} (1 - r_g)}{2 (1 - r_g r_L e^{-2\gamma l})} (e^{\gamma l} + r_L e^{-\gamma l}) = \frac{V_g (1 + r_L e^{-2\gamma l}) (1 - r_g)}{2 (1 - r_g r_L e^{-2\gamma l})}$$

\tilde{V}_{in} vs V_g

$$\tilde{V}_{in} = \left[\frac{V_g e^{-\gamma l} (1 - r_g)}{2 (1 - r_g r_L e^{-2\gamma l})} \right] e^{\gamma l} (1 + r_L e^{-2\gamma l})$$

\tilde{I}_{in} vs V_g

$$\tilde{I}_{in} = \frac{V_o^+}{Z_o} (e^{\gamma l} - r_L e^{-\gamma l}) = \frac{V_o^+ e^{\gamma l} (1 - r_L e^{-2\gamma l})}{Z_o} = \left[\frac{V_g e^{-\gamma l} (1 - r_g)}{2 Z_o (1 - r_g r_L e^{-2\gamma l})} \right] e^{\gamma l} (1 + r_L e^{-2\gamma l})$$

V_{OUT} vs V_g

$$V_{OUT} = V_0^+(1+r_L) = \frac{V_g e^{-\gamma l} (1-r_g)(1+r_L)}{2(1-r_g r_L e^{-2\gamma l})}$$

I_{OUT} vs V_g

$$\tilde{I}_{OUT} = \frac{V_0^+(1-r_L)}{Z_0} = \frac{V_g e^{-\gamma l} (1-r_g)(1-r_L)}{2Z_0(1-r_g r_L e^{-2\gamma l})}$$

V_{g'} vs V_g

$$\tilde{V}_{g'} = \tilde{V}_{g'}^+ + \tilde{V}_{g'}^- = V_0^+ e^{\gamma z'} (1+r_L e^{-2\gamma z'}) = \frac{V_g e^{-\gamma l} (1-r_g)}{2(1-r_g r_L e^{-2\gamma l})} e^{\gamma z'} (1+r_L e^{-2\gamma z'})$$

I_{g'} vs V_g

$$\tilde{I}_{g'} = \frac{V_0^+}{Z_0} (e^{\gamma z'} - r_L e^{-\gamma z'}) = \frac{V_g e^{-\gamma l} (1-r_g) e^{\gamma z'} (1-r_L e^{-2\gamma z'})}{2Z_0(1-r_g r_L e^{-2\gamma l})}$$