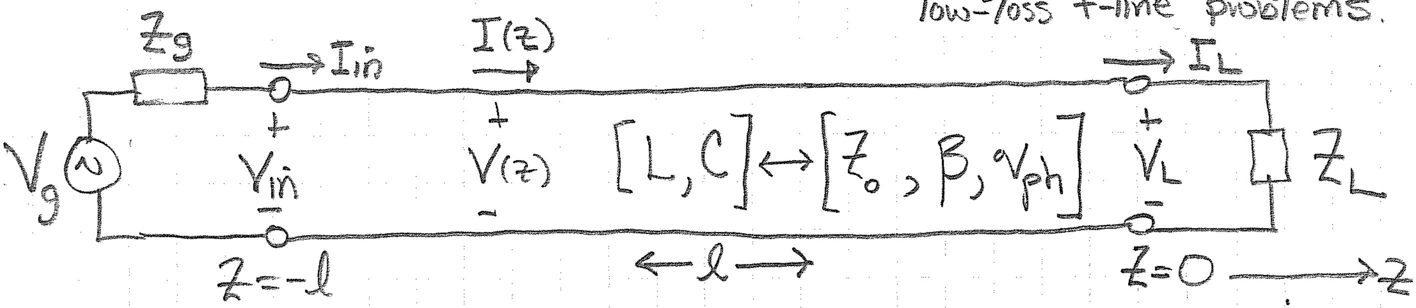
Lossless T-line $[e^{+j\omega t}]$; $\{R \sim 0, G \sim 0 \rightarrow \alpha \cong 0$

good for solving short low-loss t-line problems.



Z_{in}

$\Gamma_{in} = \Gamma_L e^{-j2\beta\ell}$

lossless:

$\gamma \rightarrow j\beta = j\omega\sqrt{LC}$

$\beta = \dfrac{\omega}{v_{ph}} = \dfrac{2\pi}{\lambda}$

$Z_o = \sqrt{\dfrac{L}{C}}$; $v_{ph} = \dfrac{1}{\sqrt{LC}} = \dfrac{c}{\sqrt{\varepsilon_{reff}}}$

$\Gamma_L = \dfrac{Z_L - Z_o}{Z_L + Z_o} = \dfrac{V^r}{V^i}$

$\dfrac{V(z=0)}{I(z=0)} = \dfrac{V_L}{I_L}$

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$V(z) = [V^i e^{-j\beta z} + V^r e^{+j\beta z}] \rightarrow |V(z)| = |V^i| \left|1 + \Gamma_L e^{+j\frac{4\pi}{\lambda}z}\right|$

$\hookrightarrow$ Voltage standing wave on Tline

$I(z) = \left[\dfrac{V^i}{Z_o} e^{-j\beta z} - \dfrac{V^r}{Z_o} e^{+j\beta z}\right]$

Voltage Standing Wave Ratio: $VSWR = \dfrac{V_{max}}{V_{min}} = \dfrac{1 + |\Gamma_L|}{1 - |\Gamma_L|}$

$\downarrow z = -\ell$

* $Z_{in} = \dfrac{V_{in}}{I_{in}} = Z_o \left[\dfrac{e^{+j\beta\ell} + \Gamma_L e^{-j\beta\ell}}{e^{+j\beta\ell} - \Gamma_L e^{-j\beta\ell}}\right] = Z_o \left[\dfrac{1 + \Gamma_L e^{-j2\beta\ell}}{1 - \Gamma_L e^{-j2\beta\ell}}\right] = Z_o \left(\dfrac{1 + \Gamma_{in}}{1 - \Gamma_{in}}\right)$

$\Gamma_{in} = \Gamma_L e^{-j2\beta\ell}$

$\tanh j\beta\ell = j\tan\beta\ell \rightarrow Z_{in} = Z_o \left[\dfrac{Z_L + jZ_o \tan\beta\ell}{Z_o + jZ_L \tan\beta\ell}\right]$

also sin/cos expressions used

$V_{in} = \dfrac{Z_{in}}{Z_{in} + Z_g} V_g$; $V^i = \dfrac{V_{in}}{e^{j\beta\ell} + \Gamma_L e^{-j\beta\ell}} = \dfrac{V_{in}}{1 + \Gamma_{in}(\ell)} e^{-j\beta\ell}$

$\rightarrow$ can now solve for $V(z), V_L$

* $\lambda_{air} = c/f$; $\lambda = \lambda_{air}/\sqrt{\varepsilon_{reff}}$, $v_{ph} = c/\sqrt{\varepsilon_{reff}}$; $Z_o = Z_{air}/\sqrt{\varepsilon_{reff}}$