$$\frac{dV}{dx} = -(R+j\omega L)I \quad \frac{dI}{dx} = -(G+j\omega C)V \rightarrow \frac{d^2V}{dx^2} = \gamma^2 V \quad \frac{d^2I}{dI^2} = \gamma^2 I$$

$$\gamma = \alpha + j\beta = \sqrt{(R+j\omega L)(G+j\omega C)}$$

α – Nepers/m , 1 nep/m = 8.68 dB/m

$$\beta = \frac{2\pi}{\lambda}$$

$$Z_0 = \sqrt{\frac{(R+j\omega L)}{(G+j\omega C)}}$$

Loss less: $\alpha = 0 \Rightarrow R = 0, G = 0$

$\gamma = j\omega\sqrt{LC}$, Z_0 (real) $= \sqrt{\frac{L}{C}}$, $v_p = 3\times10^8$ m/s

Distortion less:

- Equal raise and fall time
- series time constant = shunt time constant

$RC = LG$

$\gamma = \sqrt{RG}\left(1 + j\omega\frac{L}{R}\right)$; $Z_0 = \sqrt{\frac{R}{G}}$ (real)

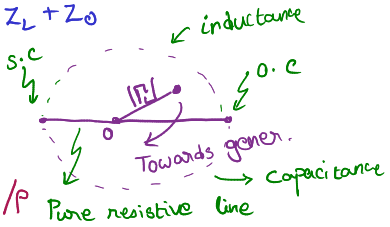
v_p = constant

– α depends on ω → delay distortion

β depends on ω → freq. distortion

Reflection coefficient $\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$

VSWR : $\rho = \frac{1+|\Gamma_L|}{1-|\Gamma_L|}$



$R_{max} = Z_0\rho$, $R_{min} = Z_0/\rho$

$Z_l = \begin{cases} jZ_0\tan\beta l \rightarrow \text{s.c} \\ -jZ_0\cot\beta l \rightarrow \text{o.c} \end{cases}$