$$\begin{cases} -\dfrac{dV}{dz} = (R+j\omega L)I \\ -\dfrac{dI}{dz} = (G+j\omega C)V \end{cases}$$

$$\begin{cases} V(z) = V_{i0}\, e^{-\gamma z} + V_{r0}\, e^{\gamma z} \\ I(z) = \dfrac{V_{i0}}{Z_0} e^{-\gamma z} - \dfrac{V_{r0}}{Z_0} e^{\gamma z} \end{cases}$$

$$\begin{cases} \gamma = \sqrt{(R+j\omega L)(G+j\omega C)} = \alpha + j\beta \\ Z_0 = \sqrt{\dfrac{R+j\omega L}{G+j\omega C}} \end{cases}$$

有兩個重要特例

① 無損傳輸線

② 無失真傳輸線

① $R=0$, $G=0$

$$\gamma = j\omega\sqrt{LC} = \alpha + j\beta$$

$$\beta = \omega\sqrt{LC}$$

$$Z_0 = \sqrt{\frac{L}{C}}$$

$$\frac{\omega}{\beta} = \frac{2\pi f}{\frac{2\pi}{\lambda}} = \frac{\lambda}{T} = v_{phase} = \frac{1}{\sqrt{LC}}$$

② $\dfrac{R}{L} = \dfrac{G}{C}$

$$\gamma = \sqrt{L\times\left(\frac{R}{L}+j\omega\right)\times C\times\left(\frac{G}{C}+j\omega\right)} = \left(\frac{R}{L}+j\omega\right)\sqrt{LC} = R\cdot\sqrt{\frac{C}{L}} + j\omega\sqrt{LC} = \alpha + j\beta$$

$$\frac{\omega}{\beta} = \frac{1}{\sqrt{LC}} = v_p$$

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