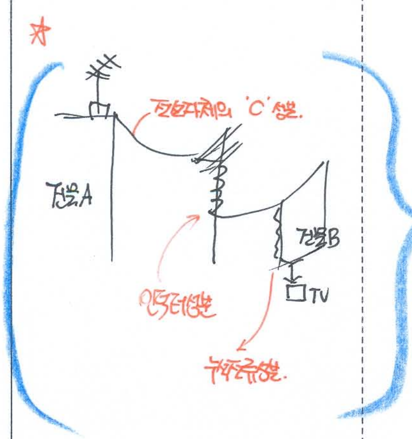
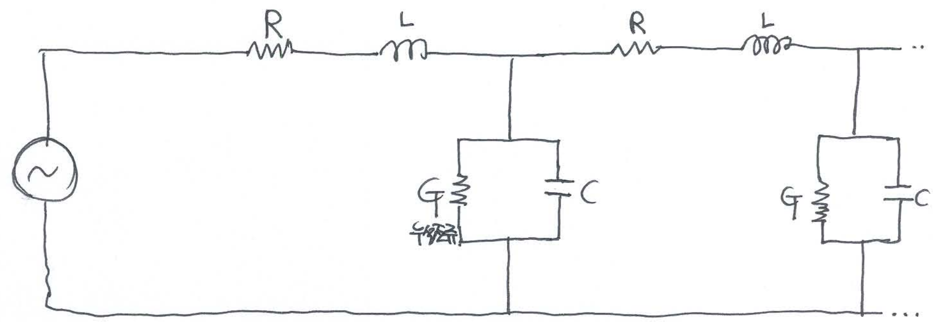
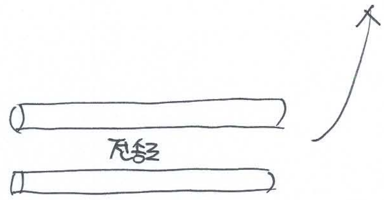






※ $\begin{cases} R & \Omega/m \\ L & H/m \\ G & \mho/m \\ C & F/m \end{cases}$

$$\begin{cases} \dfrac{dV(z)}{dz} = -I(z)\cdot Z \\ \dfrac{dI(z)}{dz} = -V(z)\cdot Y \end{cases}$$

where, $\begin{cases} Z = R + X_L = R + j\omega L \\ Y = G + 1/X_C = G + j\omega C \end{cases}$

$$\frac{d^2 V(z)}{dz^2} = \gamma^2 V(z)$$

※ $\gamma^2 = Z \cdot Y$.

$$\frac{d^2 I(z)}{dz^2} = \gamma^2 I(z)$$

전파상수

propagation Constant

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

$$= \text{Real} + \text{Imaginary}$$

$$= \alpha + j\beta$$

$$\frac{G}{C} = \sigma/\varepsilon$$

$$LC = \mu\varepsilon$$

$\mu\varepsilon$: 투자율.

→ γ 값을 알 수 있다.

< Chang 책 383p >*

1) 평행판 전송 선로 (parallel - plate transmission Line)

$C = \varepsilon\, S/d$

폭. w

두께 d.

(ε, μ) 파라미터)

$C = \varepsilon\, S/d$ 를 이용

$$C = \varepsilon\, w/d \quad [F/m]$$

$$L = \mu\frac{\varepsilon}{C} = \mu\, w/d \quad [H/m]$$

$$G = \sigma/\varepsilon \cdot C = \sigma \cdot w/d \quad [\mho/m]$$

※ $LC = \mu\varepsilon$

$\frac{G}{C} = \sigma/\varepsilon$

- 단위 길이당 R.

$$R = \frac{\overset{\text{길이.}}{l}}{\sigma_c \cdot \underset{\text{표피두께값.}}{S}}$$ 공식으로부터.

$$= \frac{l}{\sigma_c \cdot (\omega \cdot \delta)}$$ δ : 표피두께 $= 1/\alpha = 1/\sqrt{\pi \mu f \sigma}$

chang 전자기 7장 참고.

두 평행판 에서 (도체)

$$R = 2l/\sigma_c \cdot w \cdot \delta$$

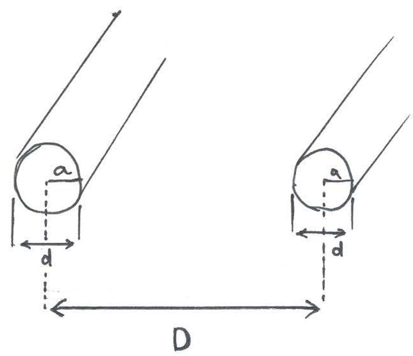
$$= \frac{2}{w} \cdot \sqrt{\pi f \mu_c / \sigma_c} \quad [\Omega/m]$$

주파수$\uparrow$ $\propto$ R$\uparrow$

$$\begin{cases} LC = \mu\varepsilon \\ G/C = \sigma/\varepsilon \end{cases}$$

2) two - wire (2선 전송 선로)
transmission Line.

: 반경이 각각 a 인 두개의 도선이 유도체 매질 (ε, μ) 에서
거리 D 만큼 떨어져 있는 경우.



$$C = \frac{\pi\varepsilon}{\cosh^{-1}(D/2a)} \quad [F/m]$$

$$L = \frac{\mu}{\pi} \cdot \cosh^{-1}\left(\frac{D}{2a}\right) \quad [H/m]$$

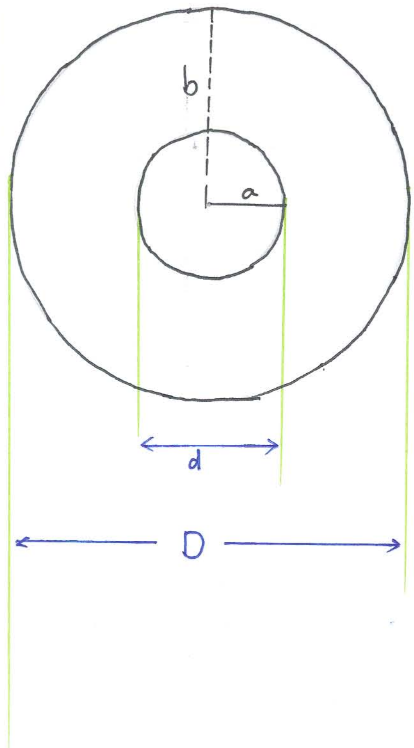
$$G = \pi\sigma / \cosh^{-1}(D/2a)$$

$$R = l/\sigma S = l / \sigma(\pi a s) \quad [R = \Omega/m]$$

or

$$\frac{1}{\pi a}\sqrt{\frac{\pi f \mu_c}{\sigma_c}}$$

동축 케이블 (coaxial transmission Line)



$$* \begin{cases} d = 2a \\ D = 2b \end{cases}$$

$C = Q/V$ 로 부터.

$$= 2\pi\varepsilon / \ln(b/a)$$

$$L = \frac{\mu}{2\pi} \ln\left(\frac{b}{a}\right)$$

$$G = \frac{2\pi\sigma}{\ln\left(\frac{b}{a}\right)} \quad [\,S/m\,]$$

길이

$$R = \frac{l}{\sigma \cdot S_{inner}} + \frac{l}{\sigma \cdot S_{out}}$$

내부 도체 단면적 외부도체 단면적

$$* \begin{cases} S_{inner} = 2\pi a \delta \\ S_{out} = 2\pi b \delta \end{cases}$$

$$= \frac{l}{2\pi\delta}\left(\frac{1}{a} + \frac{1}{b}\right)$$

or.

$$R = \frac{l}{2\pi}\left(\frac{1}{a} + \frac{1}{b}\right)\sqrt{\pi f \mu / \sigma}$$ (f: 주파수)

* Infinite trans. Line (무한장 전송 선로.)

※ 필기본 7p − 식(2)

식 (2) 에서 $V_{(z)}$. $I_{(z)}$ 를 구하면

$$\begin{cases} \dfrac{d^2V}{dz^2} = \gamma^2 V_{(z)} \\ \dfrac{d^2I}{dz^2} = \gamma^2 I_{(z)} \end{cases}$$

독립적인 해 $e^{-\gamma z}$, $e^{\gamma z}$

$$\left.\begin{aligned} \therefore\ V_{(z)} &= V_0^+ e^{-\gamma z} + V_0^- e^{+\gamma z} \\ I_{(z)} &= I_0^+ e^{-\gamma z} + I_0^- e^{+\gamma z} \end{aligned}\right\} \text{(7)식.}$$

→ 전송 선로의 전류 · 전압 방정식.

※ 식(1)

$$(1)\begin{cases} \dfrac{dV_{(z)}}{dz} = -z \cdot I_{(z)} \\ \dfrac{dI_{(z)}}{dz} = -Y \cdot V_{(z)} \end{cases}$$

식(7) → 식 (1) 에 대입

$$\frac{d(V_0^+ e^{-\gamma z} + V_0^- e^{\gamma z})}{dz} = -I_{(z)} \cdot Z$$

$$-\gamma V_0^+ e^{+\gamma z} + \gamma V_0^- e^{+\gamma z} = -I_{(z)} \cdot Z$$

$$\therefore\ I_{(z)} = \frac{\gamma (V_0^+ e^{-\gamma z} - V_0^- e^{\gamma z})}{Z} = \frac{\gamma}{Z}(V_0^+ e^{-\gamma z} - V_0^- e^{\gamma z})$$

$$* \text{ where, } \frac{\gamma}{Z} = \frac{\sqrt{Z \cdot Y}}{Z} = \sqrt{\frac{Y}{Z}} = \frac{1}{Z_c} = \frac{1}{Z_0}$$

특성 임피던스.

(따서 $V = V_0^+ e^{-\gamma z} + V_0^- e^{\gamma z}$

$I = I_0^+ e^{-\gamma z} + I_0^- e^{\gamma z}$)

where, $Z_c , Z_0 = \sqrt{\frac{Z}{Y}}$

"Characteristic Impedance of Line."

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

※ $\gamma = \alpha + j\beta$
↓
감쇠상수.

$R \ll j\omega L$

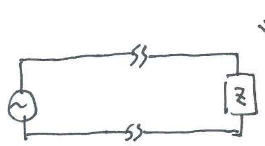
$G \ll j\omega C$

$\Rightarrow$

∘ 매우 낮은 주파수 에서 $Z_0 = \sqrt{\frac{R}{G}}$.

∘ 매우 높은 주파수 에서 $Z_0 = \sqrt{\frac{L}{C}}$

무손실 $R = G = \alpha = 0$



$$I(z) = \frac{1}{Z_0} (\underbrace{V_0^+ e^{-\gamma z}}_{V_1} - \underbrace{V_0^- e^{\gamma z}}_{V_2})$$

If 1) $z \to \infty$ (선로의 길이가 매우 길다. 무한 길이)

$e^{\gamma z} \to \infty$ 되어 $V_2 = 0$ 이어야 함.

$\therefore I(z) = 1/Z_0$

$$\therefore \left.\begin{aligned} V(z) &= V_0^+ e^{-\gamma z} \\ I(z) &= \frac{V_0^+}{Z_0} e^{-\gamma z} \end{aligned}\right\}$$

무한장 선로에서 전류 전압 방정식