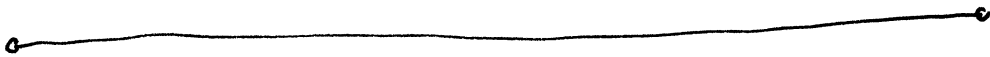
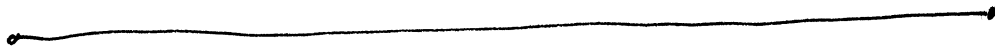


Phys 221

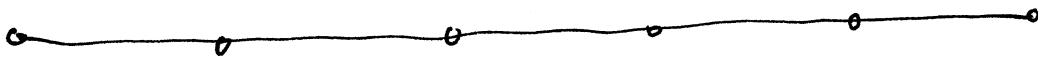
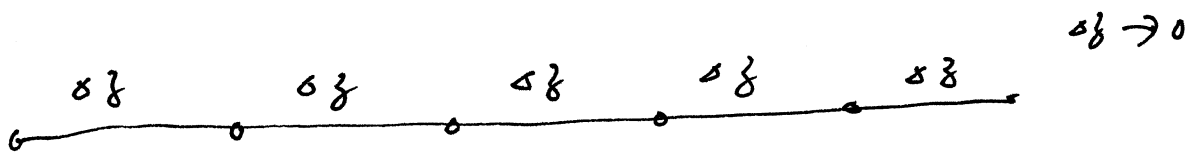
Lecture 29.

Ref. 8-1, 2, 3, 4.

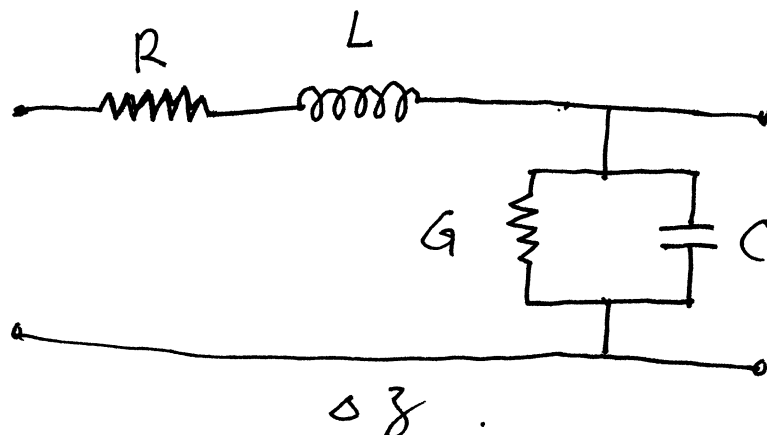
- How do we analyze a transmission line. (Lumped-Element Model)



Divide it into many differential sections, each Δz long.



for each section, use an equivalent circuit.



$$R = R' \Delta z$$

$$L = L' \Delta z$$

$$G = G' \Delta z$$

$$C = C' \Delta z$$

• Parameters representing the properties of the line

R' — Combined resistance of both conductors per unit length.
per unit length (Ω/m)

L' — Inductance H/m .

G' — Conductance of the insulating medium per unit length.
 S/m

C' — Capacitance per unit length F/m .

Results of R' , L' , G' , C'

for coaxial, two-wire, parallel-plate lines
are listed in Table 8-1 on page 251.

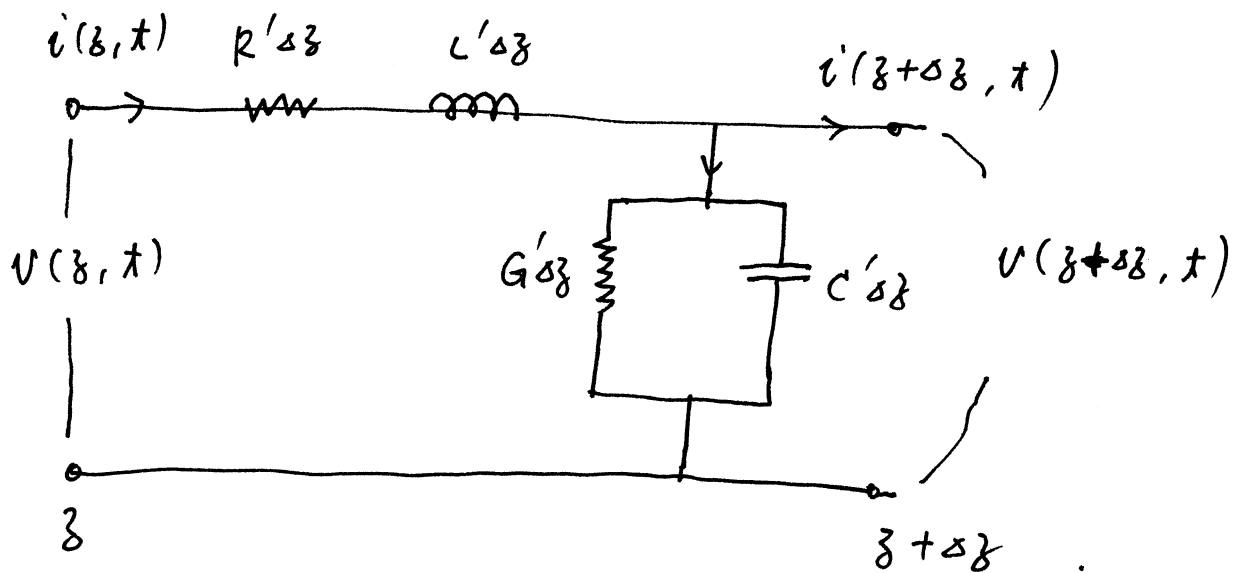
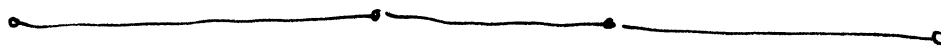
They depend on ① shape and dimensions

② material properties, (μ, ϵ, σ)

③ frequency.

• Transmission line equations

(for $V(z, t)$ and $i(z, t)$)



KVL:

$$V(z, t) - R' \Delta z \, i(z, t) - L' \Delta z \frac{\partial i(z, t)}{\partial t} - V(z + \Delta z, t) = 0$$

$$-\left[\frac{V(z + \Delta z, t) - V(z, t)}{\Delta z} \right] = R' i(z, t) + L' \frac{\partial i(z, t)}{\partial t}$$

$\Delta z \rightarrow 0$

$$-\frac{\partial V(z, t)}{\partial z} = R' i(z, t) + L' \frac{\partial i(z, t)}{\partial t} \quad (8.14)$$

KCL:

$$i = VG$$

$$i = \frac{\partial q}{\partial t} = C \frac{\partial V}{\partial t} \quad \begin{matrix} C = \frac{q}{V} \\ q = CV \end{matrix}$$

$$i(z, t) - G' \Delta z \cdot V(z + \Delta z, t) - C' \Delta z \frac{\partial V(z + \Delta z, t)}{\partial t} - i(z + \Delta z, t) = 0$$

$$-\left[\frac{i(z + \Delta z, t) - i(z, t)}{\Delta z} \right] = G' V(z + \Delta z, t) + C' \frac{\partial V(z + \Delta z, t)}{\partial t}$$

$\Delta z \rightarrow 0$

$$-\frac{\partial i(z, t)}{\partial z} = G' V(z, t) + C' \frac{\partial V(z, t)}{\partial t} \quad (8.16)$$

• phasor domain:

$$\left. \begin{aligned} -\frac{d\tilde{V}(z)}{dz} &= (R' + j\omega L) \tilde{I}(z) \\ -\frac{d\tilde{I}(z)}{dz} &= (G' + j\omega C) \tilde{V}(z) \end{aligned} \right\} \begin{array}{l} (8.18 \text{ a}) \\ 2 \times 2 \text{ system of } 1^{\text{st}} \text{ order ODEs} \\ 2 \text{ unknown functions} \end{array}$$