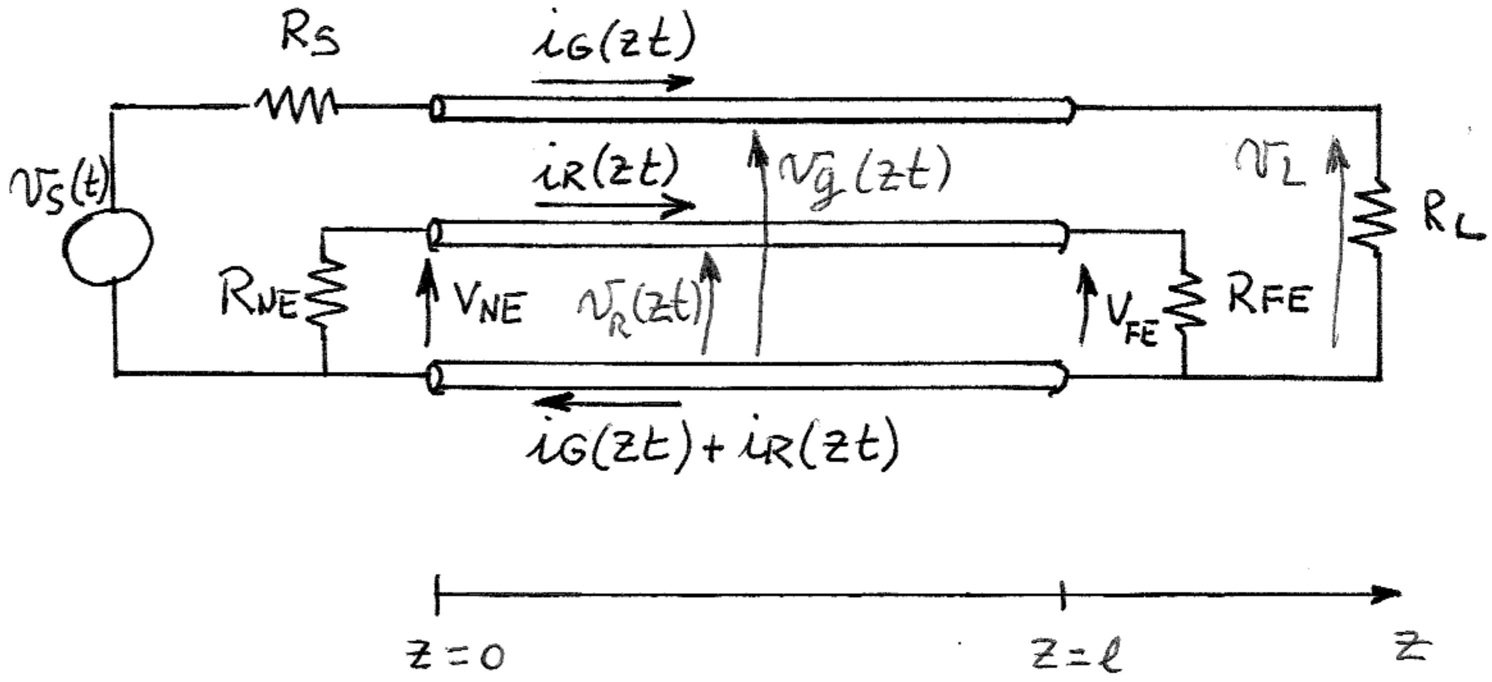
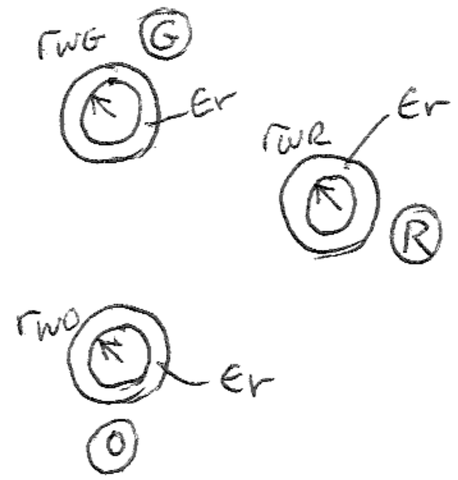
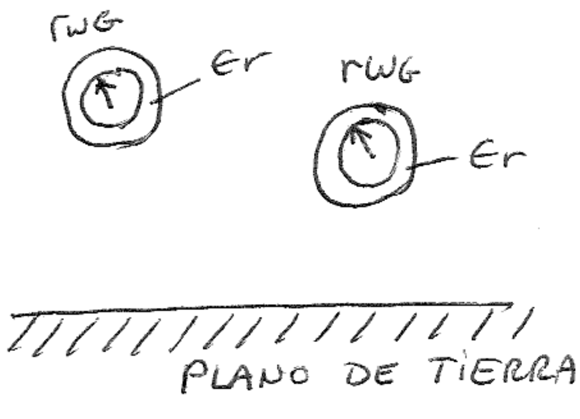
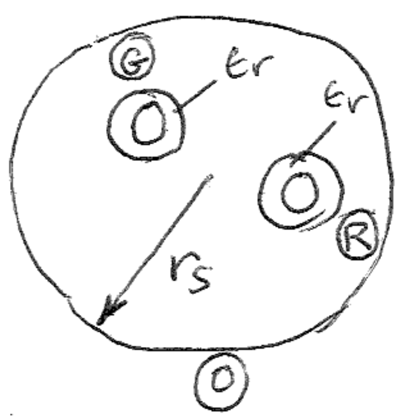
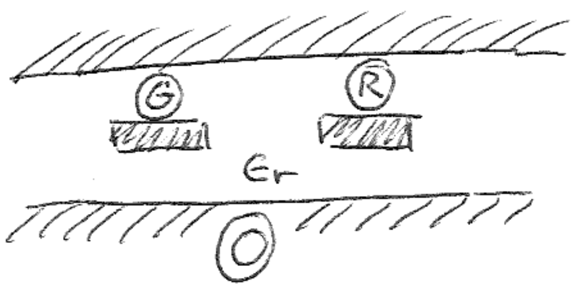
LINEA DE TRANSMISION DE 3 CONDUCTORES
CROSS TALK

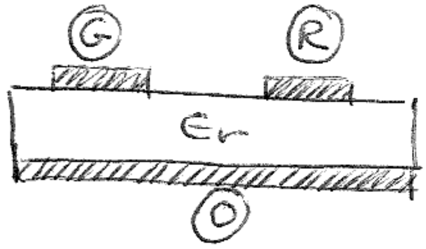


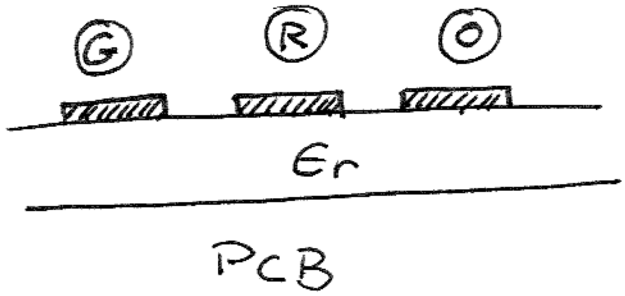


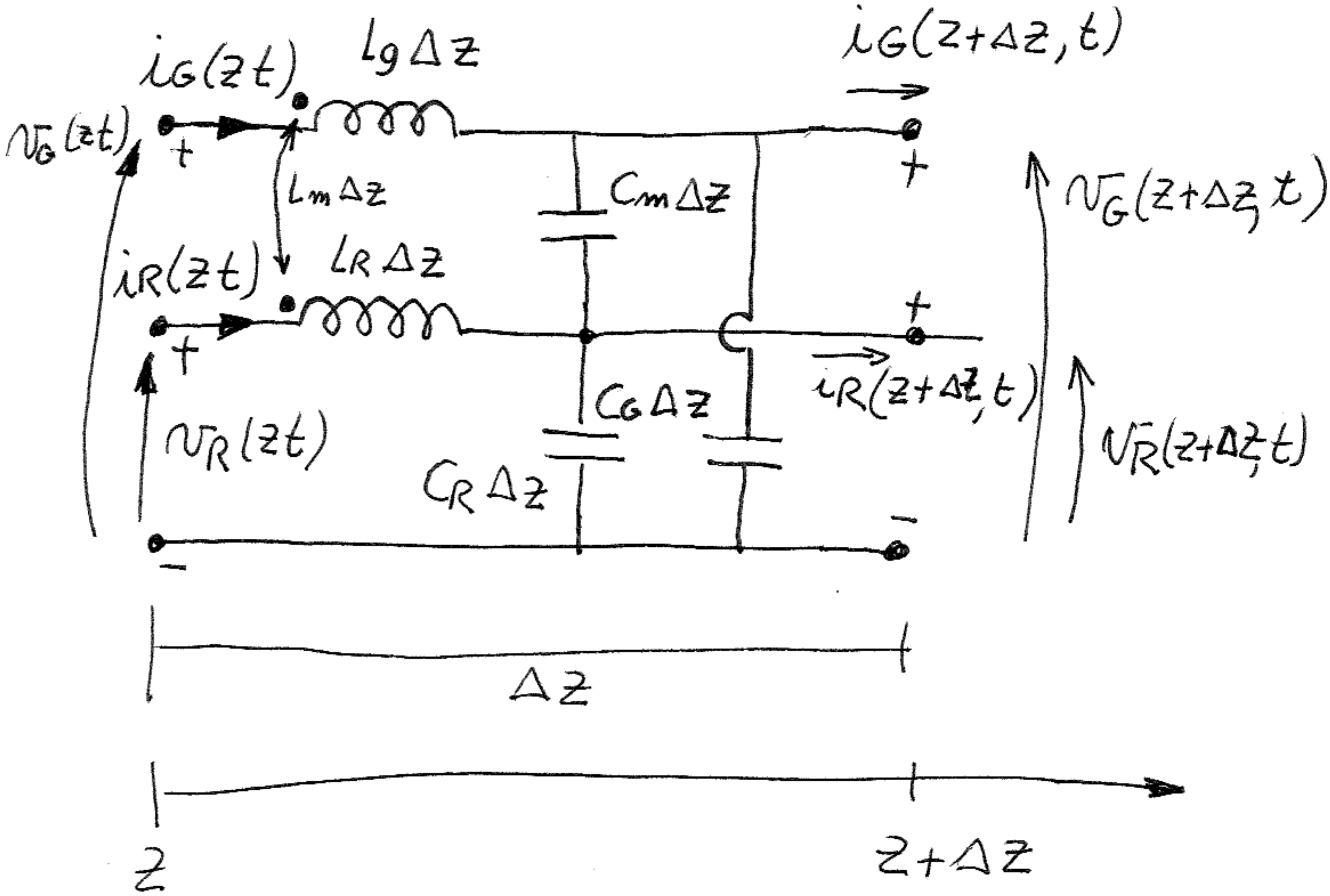





G
R
εr
O


G
R
εr
O


G
R
O
εr
PCB



EC. KVL

$$v_G(z+\Delta z, t) - v_G(z t) = -l_g \Delta z \frac{\partial I_G(z t)}{\partial t} - l_m \Delta z \frac{\partial I_R(z t)}{\partial t}$$

$$v_R(z+\Delta z, t) - v_R(z t) = -l_m \Delta z \frac{\partial I_G(z t)}{\partial t} - l_R \Delta z \frac{\partial I_R(z t)}{\partial t}$$

KCL

$$I_G(z+\Delta z,t) - I_G(z,t) = -C_G \Delta z \frac{\partial V_G(z+\Delta z,t)}{\partial t} - C_m \Delta z \cdot \frac{\partial [V_G(z+\Delta z,t) - V_R(z+\Delta z,t)]}{\partial t}$$

$$I_R(z+\Delta z,t) - I_R(z,t) = -C_m \Delta z \frac{\partial [V_R(z+\Delta z,t) - V_G(z+\Delta z,t)]}{\partial t} - C_R \Delta z \cdot \frac{\partial V_R(z+\Delta z,t)}{\partial t}$$

DIVIDIENDO POR Δz Y HACIENDO $\Delta z \to 0$

$$\frac{\partial V_G(z,t)}{\partial z} = -l_g \frac{\partial I_G(z,t)}{\partial t} - l_m \frac{\partial I_R(z,t)}{\partial t}$$

$$\frac{\partial V_R(z,t)}{\partial z} = -l_m \frac{\partial I_G(z,t)}{\partial t} - l_R \frac{\partial I_R(z,t)}{\partial t}$$

$$\frac{\partial I_G(z,t)}{\partial z} = -(C_G + C_m) \frac{\partial V_G(z,t)}{\partial t} + C_m \frac{\partial V_R(z,t)}{\partial t}$$

$$\frac{\partial I_R(z,t)}{\partial z} = C_m \frac{\partial V_G(z,t)}{\partial t} - (C_R + C_m) \frac{\partial V_R(z,t)}{\partial t}$$

$$\begin{bmatrix} \dfrac{\partial v_G(zt)}{\partial z} \\[2ex] \dfrac{\partial v_R(zt)}{\partial z} \end{bmatrix} = -\begin{bmatrix} L_g & L_m \\ L_m & L_R \end{bmatrix} \cdot \begin{bmatrix} \dfrac{\partial I_G(zt)}{\partial t} \\[2ex] \dfrac{\partial I_R(zt)}{\partial t} \end{bmatrix}$$

$$\begin{bmatrix} \dfrac{\partial I_G(zt)}{\partial z} \\[2ex] \dfrac{\partial I_R(zt)}{\partial z} \end{bmatrix} = \begin{bmatrix} -(C_G + C_m) & C_m \\ C_m & -(C_R + C_m) \end{bmatrix} \cdot \begin{bmatrix} \dfrac{\partial v_G(zt)}{\partial t} \\[2ex] \dfrac{\partial v_R(zt)}{\partial t} \end{bmatrix}$$

$$\frac{\partial}{\partial z} \mathbb{V}(zt) = -\mathbf{L} \frac{\partial}{\partial t} . \mathbb{I}(zt)$$

$$\frac{\partial}{\partial z} \mathbb{I}(zt) = -\mathbb{C} \frac{\partial}{\partial t} . \mathbb{V}(zt)$$

DONDE

$$\mathbb{V}(zt) = \begin{bmatrix} V_G(zt) \\ V_R(zt) \end{bmatrix} \qquad \mathbb{I}(zt) = \begin{bmatrix} I_G(zt) \\ I_R(zt) \end{bmatrix}$$

$$\mathbb{L} = \begin{bmatrix} L_g & L_m \\ L_m & L_R \end{bmatrix} \qquad \mathbb{C} = \begin{bmatrix} C_G + C_m & -C_m \\ -C_m & C_R + C_m \end{bmatrix}$$

$$\boxed{\begin{aligned}\frac{\partial^2}{\partial z^2}\mathbb{V}(z t) &= \mathbb{L}\mathbb{C}\,\frac{\partial^2}{\partial t^2}\mathbb{V}(z t)\\ \frac{\partial^2}{\partial z^2}\mathbb{I}(z t) &= \mathbb{C}\mathbb{L}\,\frac{\partial^2}{\partial t^2}\mathbb{I}(z t)\end{aligned}}$$

SI LAS LÍNEAS ESTAN EN UN MEDIO HOMOGENEO $\mathbb{L}\mathbb{C} = \mathbb{C}\mathbb{L} = \underbrace{\mu\epsilon}_{\frac{1}{v^2}}\,\mathbb{1}_{2\times 2}$

DONDE

$$\mathbb{1}_{2\times 2} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\mathbb{L} = \frac{1}{v^2}\,\mathbb{C}^{-1}$$

$$\mathbb{C} = \frac{1}{v^2}\,\mathbb{L}^{-1}$$

DONDE UNA MATRIZ INV:

$$\underline{\mathbb{M}}^{-1} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc}\cdot\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

PARA EXCITACION SINUSOIDAL

$$\boxed{\begin{aligned} &\frac{d}{dz}\mathbf{V}(z) = -j\omega\,\mathbf{L}\,\mathbf{I}(z) \\ &\frac{d}{dz}\mathbf{I}(z) = -j\omega\,\mathbf{C}\,\mathbf{V}(z) \\ &\frac{d^2}{dz^2}\mathbf{V}(z) = -\omega^2\,\mathbf{L}\,\mathbf{C}\,\mathbf{V}(z) \\ &\frac{d^2}{dz^2}\mathbf{I}(z) = -\omega^2\,\mathbf{C}\,\mathbf{L}\,\mathbf{I}(z) \end{aligned}}$$

PARAMETROS POR UNIDAD DE LONGITUD

FLUJOS MAGNETICOS POR UNIDAD DE LONGITUD

$$\Psi_G = l_g I_G + l_m I_R$$

$$\Psi_R = l_m I_G + l_R I_R$$

$$\boldsymbol{\Psi} = \mathbf{L}\,\mathbf{I}$$

CAPACIDADES POR UNIDAD DE LONGITUD.

$$q_G = (C_G + C_m) V_G - C_m V_R$$

$$q_R = -C_m V_G + (C_R + C_m) V_R$$

$$\mathbf{q} = \mathbf{C}\,\mathbf{V}$$

$$l_g = \left.\frac{\Psi_G}{I_G}\right|_{I_R=0}$$

$$l_R = \left.\frac{\Psi_R}{I_R}\right|_{I_G=0}$$

$$l_m = \left.\frac{\Psi_G}{I_R}\right|_{I_G=0} = \left.\frac{\Psi_R}{I_G}\right|_{I_R=0}$$

$$C_G + C_m = \left.\frac{q_G}{V_G}\right|_{V_R=0}$$

$$C_R + C_m = \left.\frac{q_R}{V_R}\right|_{V_G=0}$$

$$C_m = -\left.\frac{q_G}{V_R}\right|_{V_G=0} = -\left.\frac{q_R}{V_G}\right|_{V_R=0}$$