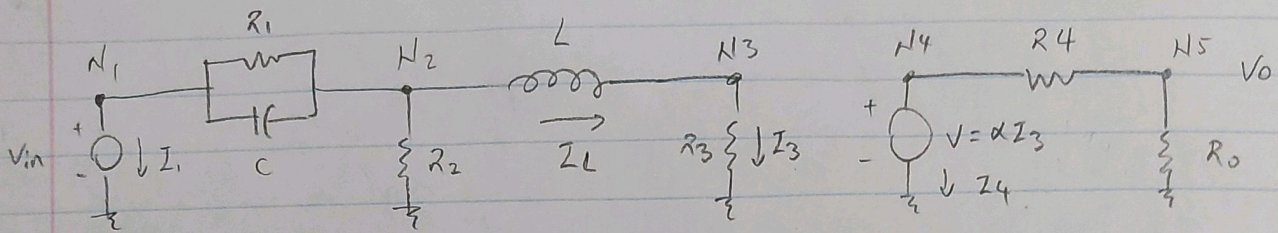


# Appendix A

PA 7

ELEC 4700 MNA Building



a) node  $N_1$  :  $N_1 = V_{in}$

$$I_1 + \frac{N_1 - N_2}{R_1} + C \frac{\partial(N_1 - N_2)}{\partial t} = 0$$

node  $N_2$  :

$$\frac{N_2 - N_1}{R_1} + C \frac{\partial(N_2 - N_1)}{\partial t} + \frac{N_2}{R_2} + I_L = 0$$

$$N_2 - N_3 = L \frac{\partial I_L}{\partial t}$$

node  $N_3$  :  $-I_L + I_3 = 0$

$$I_3 = \frac{N_3}{R_3}$$

node  $N_4$  :  $I_4 + \frac{N_4 - N_5}{R_4} = 0$

$$N_4 = \alpha I_3$$

node  $N_5$  :

$$\frac{N_5 - N_4}{R_4} + \frac{N_5}{R_0} = 0$$

$$V_o = N_5$$



$$C \frac{\partial \vec{V}}{\partial t} + G \vec{V} = \vec{F}$$

$$\begin{matrix} V(9 \times 1) & F(9 \times 1) \\ C(9 \times 9) & G(9 \times 9) \end{matrix}$$

$\wedge$  capacitor, L.

$$(1) \quad N_1 = V_{in}$$

$$(2) \quad C \frac{\partial N_1}{\partial t} - C \frac{\partial N_2}{\partial t} + \frac{1}{R_1} N_1 - \frac{1}{R_1} N_2 + I_1 = 0$$

$$(3) \quad -C \frac{\partial N_1}{\partial t} + C \frac{\partial N_2}{\partial t} + \frac{1}{R_1} N_1 + \left(\frac{1}{R_1} + \frac{1}{R_2}\right) N_2 + I_L = 0$$

$$(4) \quad -L \frac{\partial I_L}{\partial t} + N_2 - N_3 = 0$$

$$(5) \quad -I_L + I_3 = 0$$

$$(6) \quad -\frac{1}{R_3} N_3 + I_3 = 0$$

$$(7) \quad \frac{1}{R_4} N_4 - \frac{1}{R_4} N_5 + I_4 = 0$$

$$(8) \quad N_4 - \alpha I_3 = 0$$

$$(9) \quad -\frac{1}{R_4} N_4 + \left(\frac{1}{R_4} + \frac{1}{R_5}\right) N_5 = 0$$

$$\vec{V} = \begin{bmatrix} N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ I_1 \\ I_L \\ I_3 \\ I_4 \end{bmatrix} \quad \vec{F} = \begin{bmatrix} V_{in} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad C = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ C & -C & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -C & C & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -L & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$



$$G = \begin{matrix} & \begin{matrix} N_1 & N_2 & N_3 & N_4 & N_5 & I_1 & I_2 & I_3 & I_4 \end{matrix} \\ \begin{matrix} 1 \\ \frac{1}{R_1} \\ -\frac{1}{R_1} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{matrix} & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{R_1} & -\frac{1}{R_1} & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ \frac{1}{R_1} + \frac{1}{R_2} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & -\frac{1}{R_3} & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & \frac{1}{R_4} & -\frac{1}{R_4} & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -\frac{1}{R_4} & \frac{1}{R_4} + \frac{1}{R_0} & 0 & 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$C \frac{\partial \vec{V}}{\partial t} + G \vec{V} = \vec{F}$$

$$(G + j\omega C) \vec{V} = \vec{F}(\omega)$$