

$$R1 = 100 \times (9+1) = 1000 \, \Omega$$

$$R2 = 5+1 = 6 \, \Omega$$

$$C1 = 6+1 = 7 \times 10^{-4} \, \text{F}$$

$$L2 = 3+1 = 4 \, \text{H}$$

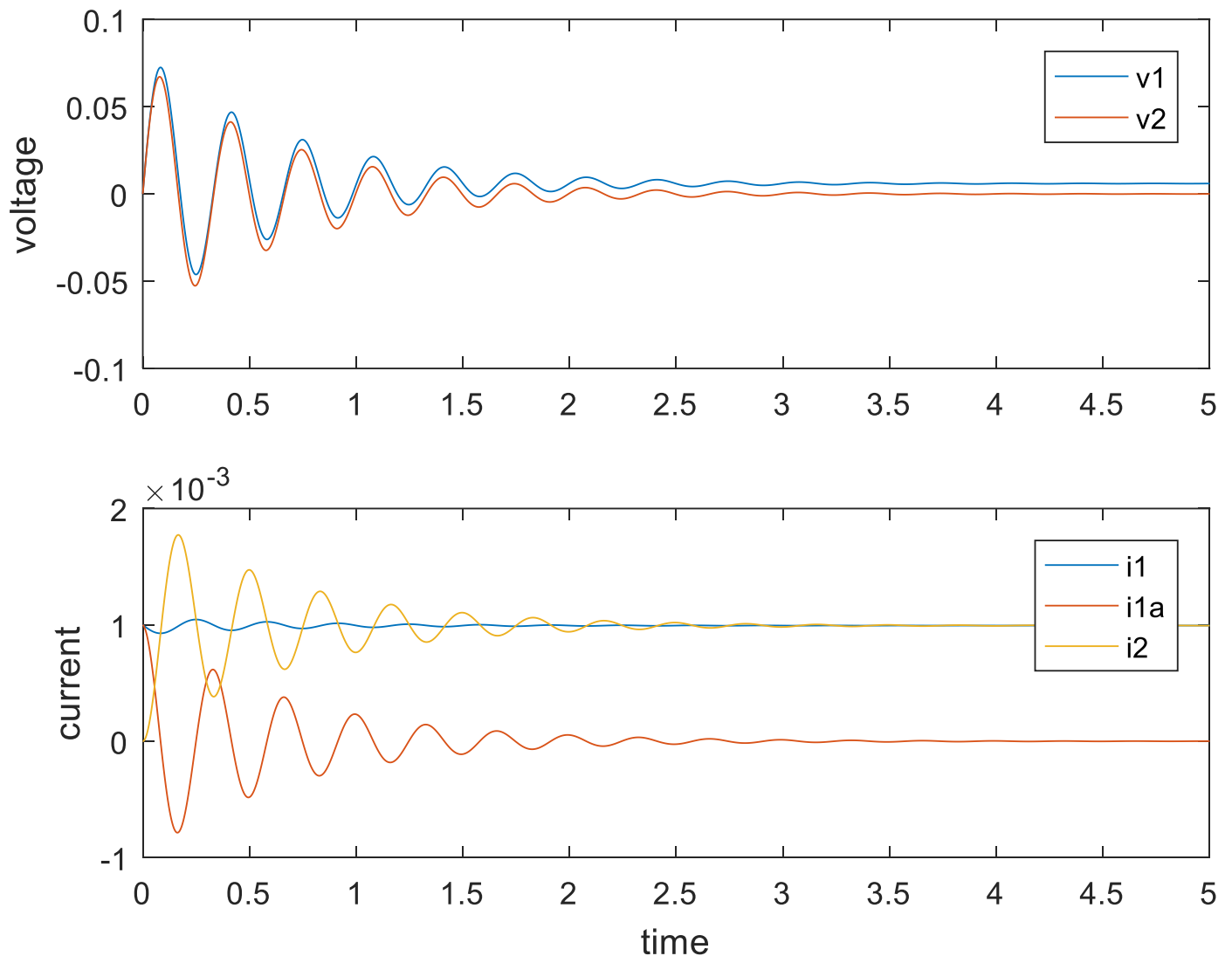


Figure 1.1 – Dynamic response of voltages and currents

Steady state voltages (using $T = 100$, 4dp):

$$V1 \approx 0.0060 \, \text{V}$$

$$V2 \approx -4.3368 \times 10^{-16} \approx 0.0000 \, \text{V}$$

Steady state currents (using $T = 100$, 4dp):

$$I1 \approx 9.9404 \times 10^{-4} \, \text{A}$$

$$I1a \approx 0.0000 \, \text{A}$$

$$I2 \approx 9.9404 \times 10^{-4} \, \text{A}$$

Note: Convergence checked with $T = 10\,000$ in case of doubt. Waveforms & values checked with LTSpice.

$$R1 = 100 \times (9+1) = 1000 \, \Omega$$

$$R2 = 5+1 = 6 \, \Omega$$

$$C1 = 6+1 = 7 \times 10^{-4} \, \text{F}$$

$$L2 = 3+1 = 4 \, \text{H}$$

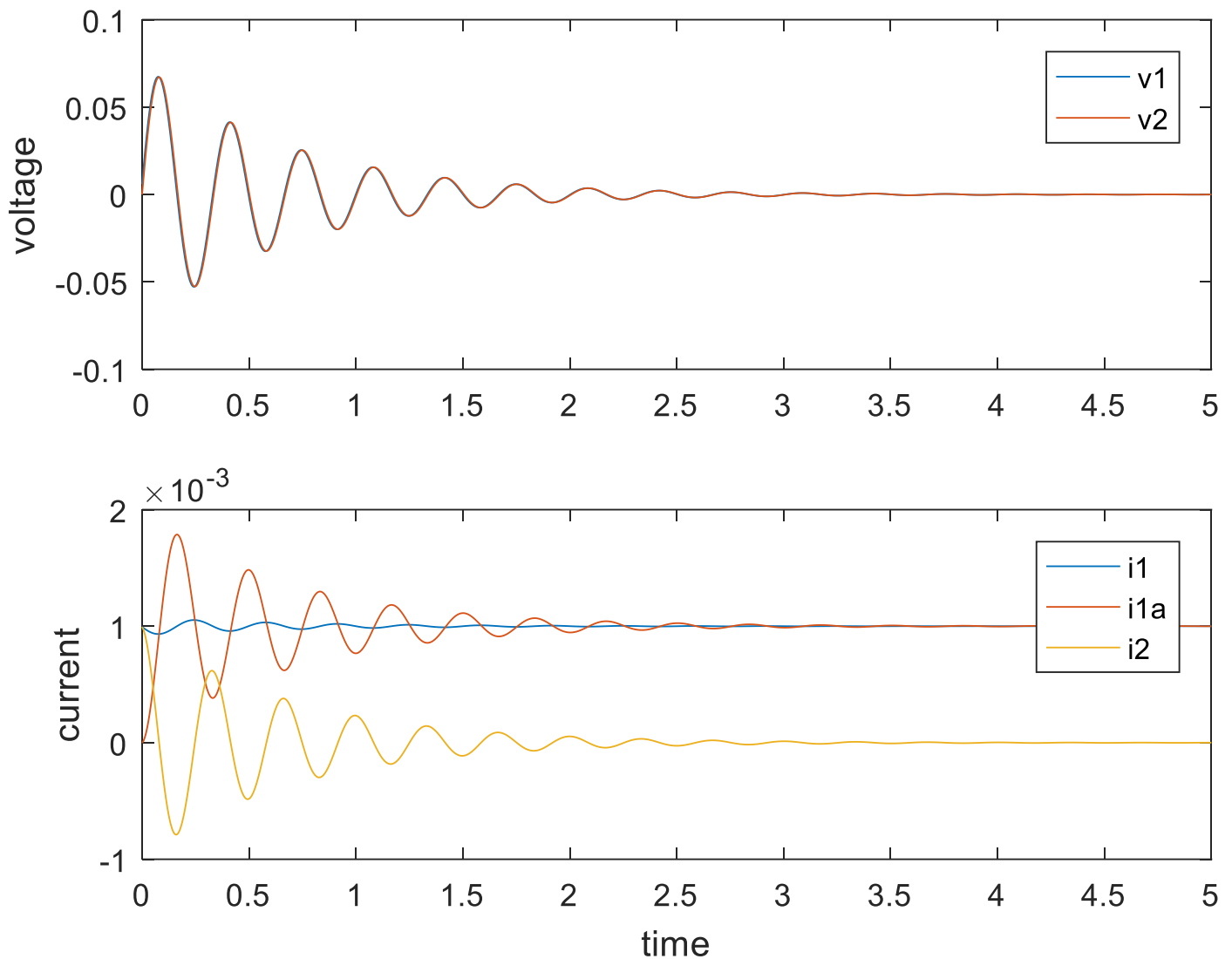


Figure 2.1 – Dynamic response of voltages and currents

Steady state voltages (using $T = 100$, 4dp):

$$V1 \approx -1.4398 \times 10^{-16} \approx 0.0000 \, \text{V}$$

$$V2 \approx -1.0903 \times 10^{-16} \approx 0.0000 \, \text{V}$$

Steady state currents (using $T = 100$, 4dp):

$$I1 \approx 1.0000 \times 10^{-3} \, \text{A}$$

$$I1a \approx 1.0000 \times 10^{-3} \, \text{A}$$

$$I2 \approx 0.0000 \, \text{A}$$

Note: Convergence checked with $T = 10\,000$ in case of doubt. Waveforms & values checked with LTSpice.

$$R1 = 20 \times (2+1) = 60 \, \Omega$$

$$R2 = 4+1 = 5 \, \Omega$$

$$R3 = 3+1 = 4 \, \Omega$$

$$R4 = 6+1 = 7 \, \Omega$$

$$R5 = 5+1 = 6 \, \Omega$$

$$R6 = 9+1 = 10 \, \Omega$$

$$L1 = 9 \, \text{H}$$

$$L2 = 5 \, \text{H}$$

$$C3 = 7 \times 10^{-4} \, \text{F}$$

$$L4 = 3 \, \text{H}$$

$$C5 = 5 \times 10^{-4} \, \text{F}$$

$$C6 = 3 \times 10^{-4} \, \text{F}$$

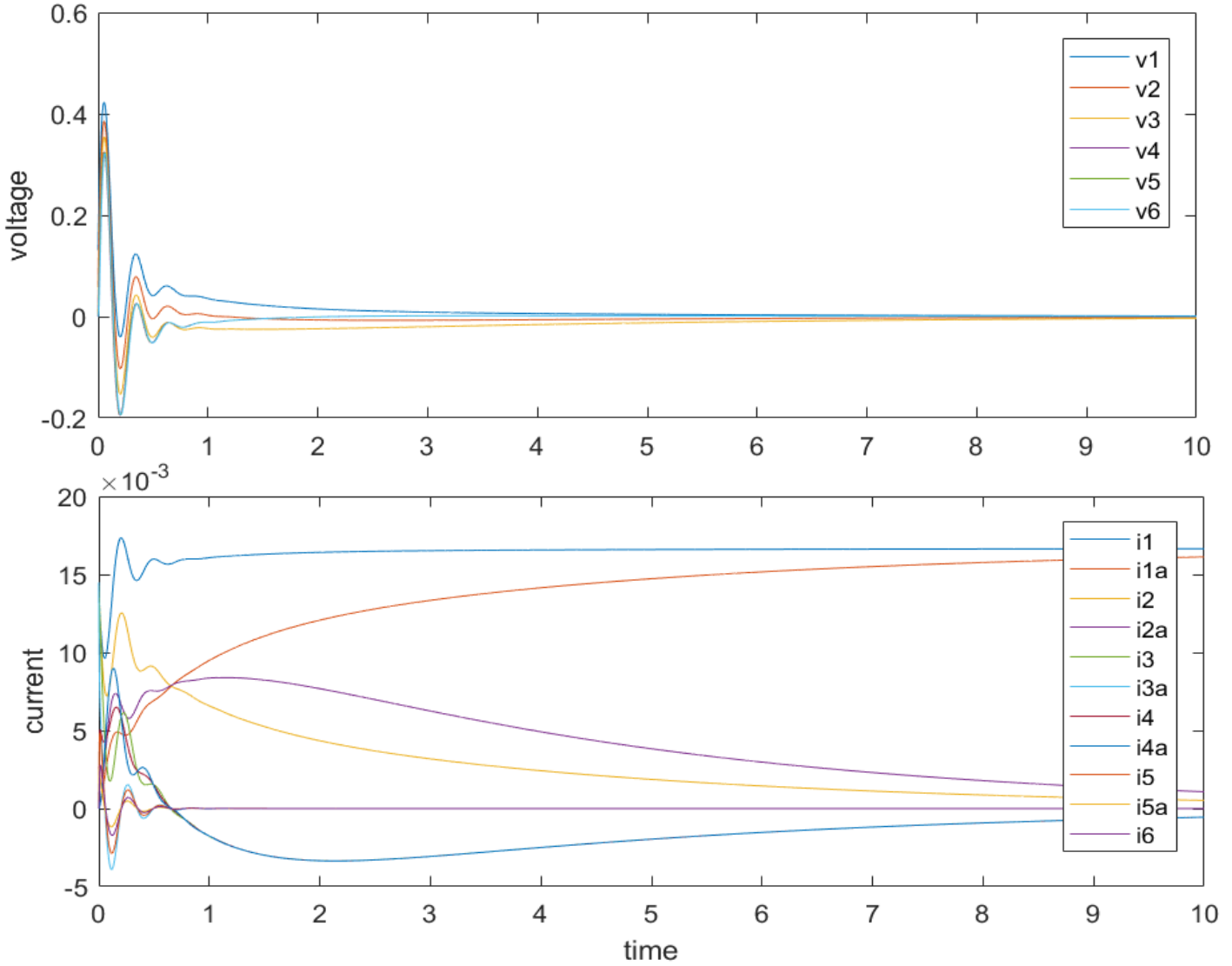


Figure 3.1 – Dynamic response of voltages and currents

Steady state voltages:

$$V1 = 1.4125 \times 10^{-13} \approx 0.0000 \, \text{V}$$

$$V2 = -1.5932 \times 10^{-13} \approx 0.0000 \, \text{V}$$

$$V3 = -3.9980 \times 10^{-13} \approx 0.0000 \, \text{V}$$

$$V4 = 4.6334 \times 10^{-14} \approx 0.0000 \, \text{V}$$

$$V5 = 4.6378 \times 10^{-14} \approx 0.0000 \, \text{V}$$

$$V6 = 4.6421 \times 10^{-14} \approx 0.0000 \, \text{V}$$

Steady state currents:

$$I1 = 0.0167 \, \text{A}$$

$$I1a = 0.0167 \, \text{A}$$

$$I2 = 6.0113 \times 10^{-14} \approx 0.0000 \, \text{A}$$

$$I2a = 1.2378 \times 10^{-13} \approx 0.0000 \, \text{A}$$

$$I3 = -6.3667 \times 10^{-14} \approx 0.0000 \, \text{A}$$

$$I3a = 6.6436 \times 10^{-17} \approx 0.0000 \, \text{A}$$

$$I4 = 6.3733 \times 10^{-14} \approx 0.0000 \, \text{A}$$

$$I4a = 6.3726 \times 10^{-14} \approx 0.0000 \, \text{A}$$

$$I5 = -7.3423 \times 10^{-18} \approx 0.0000 \, \text{A}$$

$$I5a = -2.9809 \times 10^{-18} \approx 0.0000 \, \text{A}$$

$$I6 = -4.3613 \times 10^{-18} \approx 0.0000 \, \text{A}$$

Note: Convergence checked with $T = 10\,000$ in case of doubt. Waveforms & values checked with LTSpice. (see .m file attached for the MATLAB code developed)

Extra

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NA Lab 02

Node Voltage

$$\begin{aligned} v_0 - v_1 &= i_1 R_1 \\ v_1 - v_2 &= i_2 R_2 \\ v_2 - v_3 &= i_3 R_3 \\ v_3 - v_4 &= i_4 R_4 \\ v_4 - v_5 &= i_5 R_5 \\ v_5 - v_6 &= i_6 R_6 \end{aligned}$$

Mesh current

$$\begin{aligned} i_1 &= i_{1A} \\ i_2 &= i_{2A} + i_1 \\ i_3 &= i_{3A} + i_2 \\ i_4 &= i_{4A} + i_3 \\ i_5 &= i_{5A} + i_4 \\ i_6 &= i_{6A} + i_5 \end{aligned}$$

components

$$\begin{aligned} \frac{v_1}{L_1} &= \frac{di_{1A}}{dt} \\ \frac{v_2}{L_2} &= \frac{di_{2A}}{dt} \\ \frac{dv_3}{dt} &= \frac{1}{C_3} i_{3A} \\ \frac{v_4}{L_4} &= \frac{di_{4A}}{dt} \\ \frac{dv_5}{dt} &= \frac{1}{C_5} i_{5A} \\ \frac{dv_6}{dt} &= \frac{1}{C_6} i_{6A} \end{aligned}$$

(x)

$$\frac{d}{dt} \begin{bmatrix} i_{1A} \\ i_{2A} \\ v_3 \\ i_{4A} \\ v_5 \\ v_6 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_{1A} \\ i_{2A} \\ v_3 \\ i_{4A} \\ v_5 \\ v_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

(w)

$$\begin{bmatrix} v_1 \\ v_2 \\ v_4 \\ i_1 \\ i_2 \\ i_3 \\ i_{3A} \\ i_4 \\ i_5 \\ i_{5A} \\ i_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

(m)

$$\begin{bmatrix} -1 & 0 & 0 & -R_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & -R_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -R_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & -R_4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -R_5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -R_6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_4 \\ i_1 \\ i_2 \\ i_3 \\ i_{3A} \\ i_4 \\ i_5 \\ i_{5A} \\ i_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

(n)

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_4 \\ i_1 \\ i_2 \\ i_3 \\ i_{3A} \\ i_4 \\ i_5 \\ i_{5A} \\ i_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

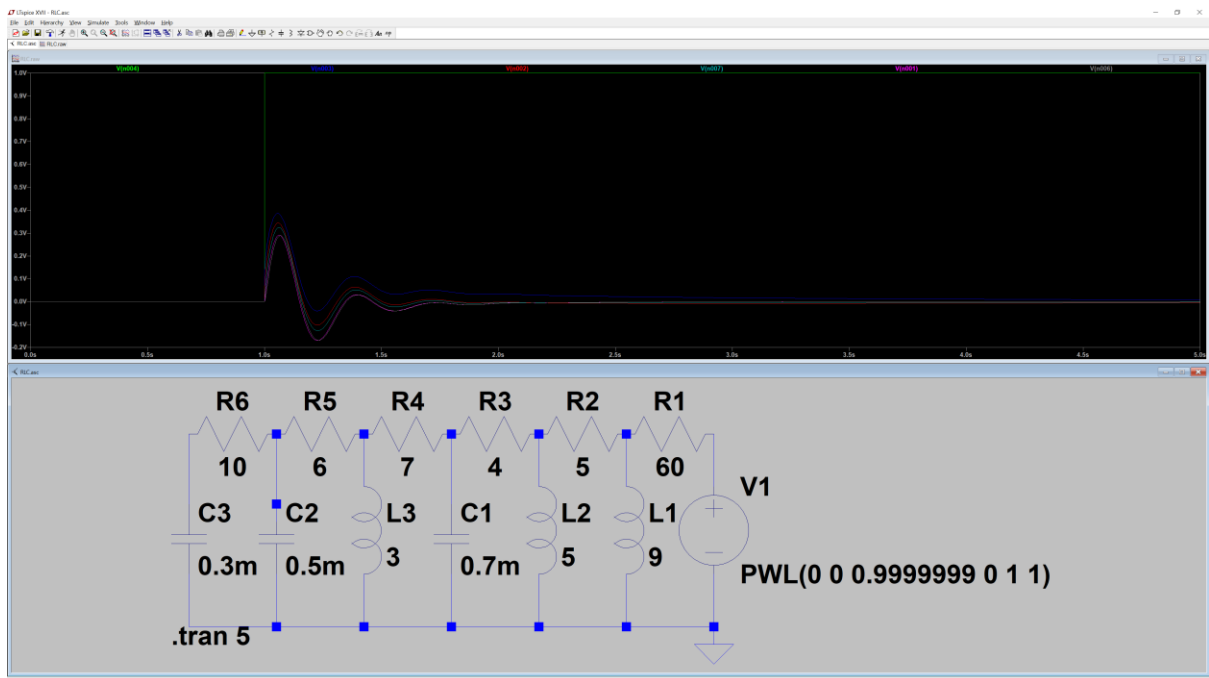
(o)

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_{1A} \\ i_{2A} \\ i_{3A} \\ i_{4A} \\ i_{5A} \\ i_{6A} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

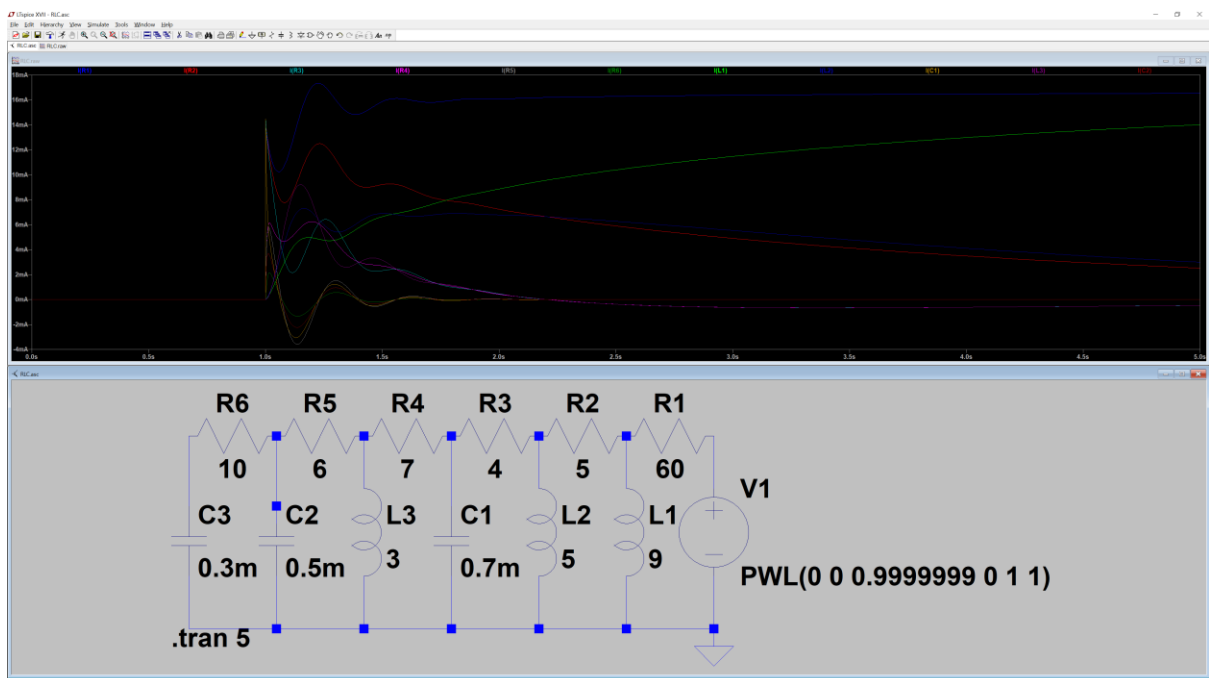
(p)

$$\begin{bmatrix} i_1 \\ i_{1A} \\ i_2 \\ i_{2A} \\ i_3 \\ i_{3A} \\ i_4 \\ i_{4A} \\ i_5 \\ i_{5A} \\ i_6 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_{1A} \\ i_{2A} \\ i_{3A} \\ i_{4A} \\ i_{5A} \\ i_{6A} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Matrices



Voltage simulations



Current simulations