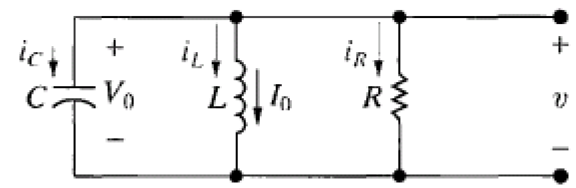
Mathcad Solutions to Assessment Problems from Nilsson and Riedel
Electric Circuits 9th edition, © 2012 R. Doering.
Chapter 8

AP 8.1 The resistance and inductance of the circuit in Fig. 8.5 are 100 Ω and 20 mH, respectively.
a) Find the value of C that makes the voltage response critically damped.
b) If C is adjusted to give a neper frequency of 5 krad/s, find the value of C and the roots of the characteristic equation.
c) If C is adjusted to give a resonant frequency of 20 krad/s, find the value of C and the roots of the characteristic equation.



useful functions:

$\alpha(RC) := \frac{1}{2RC}$ neper frequency

$\omega_0(LC) := \frac{1}{\sqrt{LC}}$ radian resonant frequency

characteristic roots:

$$s_1(R,L,C) := -\alpha(R\cdot C) + \sqrt{\alpha(R\cdot C)^2 - \omega_0(L\cdot C)^2}$$

$$s_2(R,L,C) := -\alpha(R\cdot C) - \sqrt{\alpha(R\cdot C)^2 - \omega_0(L\cdot C)^2}$$

$$\text{overdamped}(R,L,C) := \omega_0(L\cdot C)^2 < \alpha(R\cdot C)^2$$

$$\text{underdamped}(R,L,C) := \omega_0(L\cdot C)^2 > \alpha(R\cdot C)^2$$

$$\text{criticallydamped}(R,L,C) := \omega_0(L\cdot C)^2 = \alpha(R\cdot C)^2$$

$R := 100\Omega$ $L := 20\text{mH}$

$\text{krad} \equiv 10^3\text{rad}$

a) Given $\text{criticallydamped}(R, L, C_1) = 1$ $\quad C_1 := \text{Find}(C_1) \rightarrow \frac{mH}{2000 \cdot \Omega^2}$ $\quad C_1 = 0.5 \cdot \mu F$

b) Given $\alpha(R \cdot C_2) = 5 \frac{krad}{s}$ $\quad C_2 := \text{Find}(C_2) \rightarrow \frac{s}{1000000 \cdot \Omega \cdot rad}$ $\quad C_2 = 1 \cdot \mu F$

$s_1(R, L, C_2) = (-5 + 5j) \cdot \frac{krad}{s}$ $\quad s_2(R, L, C_2) = (-5 - 5j) \cdot \frac{krad}{s}$

c) Given $\omega_0(L \cdot C_3) = 20 \frac{krad}{s}$ $\quad C_3 := \text{Find}(C_3) \rightarrow \frac{s^2}{8000000000 \cdot mH \cdot rad^2}$ $\quad C_3 = 0.125 \cdot \mu F$

$s_1(R, L, C_3) = -5.359 \cdot \frac{krad}{s}$ $\quad s_2(R, L, C_3) = -74.641 \cdot \frac{krad}{s}$

$$\mathrm{rlc}\left(R_1, L_1, C_1, v_0, dv_{0dt}\right) := \text{if criticallydamped}\left(R_1, L_1, C_1\right)$$

$$D2 \leftarrow v_0$$

$$\alpha_c \leftarrow \alpha\left(R_1 \cdot C_1\right)$$

$$D1 \leftarrow dv_{0dt} + \alpha_c \cdot D2$$

$$\text{return} \begin{pmatrix} 3 & \dfrac{D1 \cdot s}{V} & \dfrac{D2}{V} & \alpha_c \cdot s & 1 \end{pmatrix}^T$$

$$s1 \leftarrow s_1\left(R_1, L_1, C_1\right)$$

$$s2 \leftarrow s_2\left(R_1, L_1, C_1\right)$$

$$A \leftarrow \begin{pmatrix} 1 & 1 \\ s1 \cdot s & s2 \cdot s \end{pmatrix}^{-1} \cdot \begin{pmatrix} v_0 \\ dv_{0dt} \cdot s \end{pmatrix}$$

$$\text{return} \begin{pmatrix} 1 & \dfrac{A_0}{V} & \dfrac{A_1}{V} & s1 \cdot s & s2 \cdot s \end{pmatrix}^T \quad \text{if overdamped}\left(R_1, L_1, C_1\right)$$

otherwise

$$B \leftarrow \begin{bmatrix} A_0 + A_1 \\ j \cdot \left(A_0 - A_1\right) \end{bmatrix}$$

$$\omega_d \leftarrow \frac{s1 - s2}{2j}$$

$$\alpha \leftarrow \frac{s1 + s2}{-2}$$

$$\begin{pmatrix} 2 & B_0 & B_1 & \cdots \end{pmatrix}^T$$

$$\text{return}\ \left(2 \quad \frac{}{V} \quad \frac{}{V} \quad \alpha\cdot s \quad \omega_d\cdot s\right)$$

$$v_{rlc}(A,t) := V\cdot \begin{cases} A_1 e^{A_3\frac{t}{s}} + A_2 e^{A_4\cdot\frac{t}{s}} & \text{if } A_0 = 1 \\ \left(A_1\cdot\cos\left(A_4\cdot\frac{t}{s}\right) + A_2\cdot\sin\left(A_4\cdot\frac{t}{s}\right)\right)\cdot e^{-A_3\cdot\frac{t}{s}} & \text{if } A_0 = 2 \\ \left(A_1\frac{t}{s} + A_2\right)\cdot e^{-A_3\frac{t}{s}} & \text{if } A_0 = 3 \\ 0 & \text{otherwise} \end{cases}$$

$C_1 :=$ undef $\qquad C_1 := C_1$

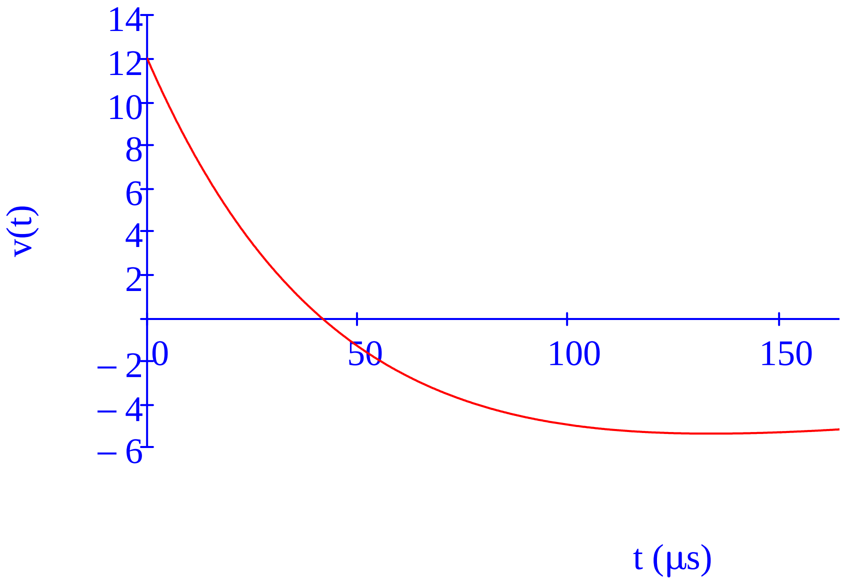
$$\text{simprlc}(R_1, L_1, C_1, v_0, i_0, I) := \left| \begin{array}{l} i_{L_0} \leftarrow i_0 \\ v_{C_0} \leftarrow v_0 \\ f \leftarrow \dfrac{1}{2\pi\cdot\sqrt{L_1\cdot C_1}} \\ NN \leftarrow 2048\cdot 8 - 2 \\ \Delta t \leftarrow 2^{\left(\text{floor}\left(\log\left(\frac{4}{f\cdot NN\cdot s}, 2\right)\right)\right)}\cdot s \\ \text{for } n \in 0..NN \\ \quad \left| \begin{array}{l} v_{C_{n+1}} \leftarrow v_{C_n} + \left(I - i_{L_n} - \dfrac{v_{C_n}}{R_1}\right)\cdot\dfrac{\Delta t}{C_1} \\ i_{L_{n+1}} \leftarrow i_{L_n} + \dfrac{v_{C_{n+1}}}{L_1}\cdot\Delta t \end{array}\right. \\ \text{return } \begin{pmatrix} \text{augment}\left(\dfrac{v_C}{V}, \dfrac{i_L}{A}\right) \\ \dfrac{\Delta t}{s} \end{pmatrix} \end{array}\right.$$

$$\frac{v_C}{V} \qquad \frac{i_L}{A}$$

Ex 8.2

$$S := rlc\left(200\Omega, 50mH, 0.2\mu F, 12V, -450\frac{kV}{s}\right)$$

$$v(t) := v_{rlc}(S, t)$$



$$S^T = \begin{pmatrix} 1 & -14 & 26 & -5\times 10^3 & -2\times 10^4 \end{pmatrix}$$

$$S := \begin{pmatrix} 1 & -14 & 26 & -5\times 10^3 & -2\times 10^4 \end{pmatrix}^T$$

$$v(t) := v_{rlc}(S, t)$$

$$v(t) \rightarrow -V\cdot\left(14\cdot e^{-\frac{5000\cdot t}{s}} - 26\cdot e^{-\frac{20000\cdot t}{s}}\right)$$

$$v(t) := \left(-14e^{-5000\cdot\frac{t}{s}} + 26e^{-20000\frac{t}{s}}\right)V$$

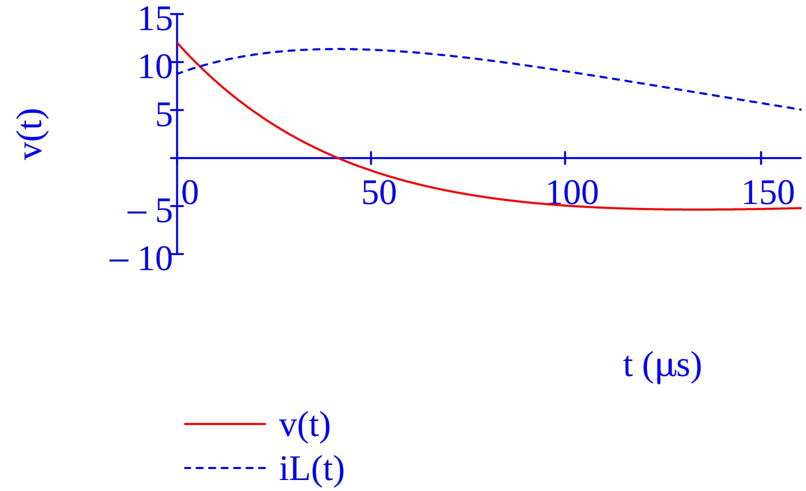
$r1 := 200\Omega$

$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}(r1, 50mH, 0.2\mu F, 12V, 30mA, 0A)$$

$\text{rows}(X) = 16384$

$n := 0 .. 16383$

Simulation

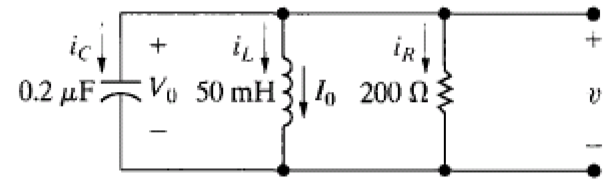


AP 8.2

Use the integral relationship between i_L and v to find the expression for i_L in Fig. 8.6.

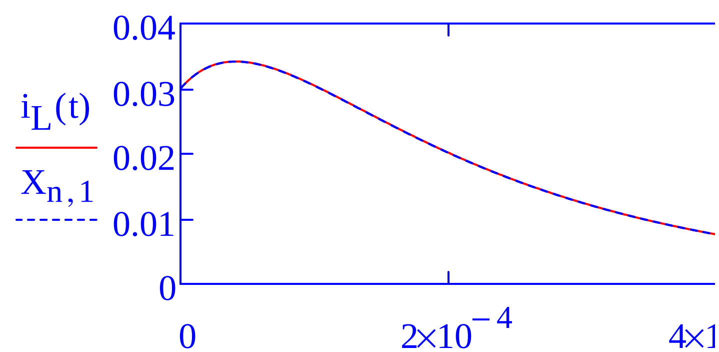
r: $i_L(t) = (56e^{-5000t} - 26e^{-20{,}000t})$ mA, $t \geq 0.$

$$i_L(t) := \frac{1}{50\text{mH}} \cdot \int_0^t v(u)\,du + 30\,\frac{\text{V}\cdot\text{s}}{\text{mH}} \cdot 10^{-6}$$

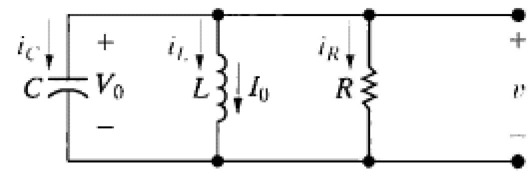


$$i_L(t) \cdot \frac{\text{mH}}{\text{V}\cdot\text{s}} \cdot \frac{\text{mA}}{10^{-6}} \text{ expand } \rightarrow 56\cdot\text{mA}\cdot e^{-\frac{5000\cdot t}{\text{s}}} - 26\cdot\text{mA}\cdot e^{-\frac{20000\cdot t}{\text{s}}}$$

$$\frac{\text{mH}}{\text{V}\cdot\text{s}} \cdot \frac{\text{mA}}{10^{-6}} = 1$$



AP 8.3 The element values in the circuit shown are R = 2 kΩ, L = 250 mH, and C = 10 nF. The initial current I_0 in the inductor is -4 A, and the initial voltage on the capacitor is 0 V. The output signal is the voltage v. Find (a) $i_R(0^+)$; (b) $i_c(0^+)$; (c) $dv(0^+)/dt$; (d) A_1; (e) A_2; and (f) v(t) when t > 0.



$R_3 := 2k\Omega \quad L_3 := 250mH \quad C_3 := 10nF$

a) $i_R(O) := 0A$

b) $i_c(O) := 4A$ c) $dvdt := \frac{4A}{C_3} = 4 \times 10^8 \cdot \frac{V}{s}$

d) $S := rlc(R_3, L_3, C_3, 0V, dvdt)$ $A1 := S_1 = 13333$

e) $A2 := S_2 = -13333$ $S^T = (1 \quad 13333 \quad -13333 \quad -10000 \quad -40000)$

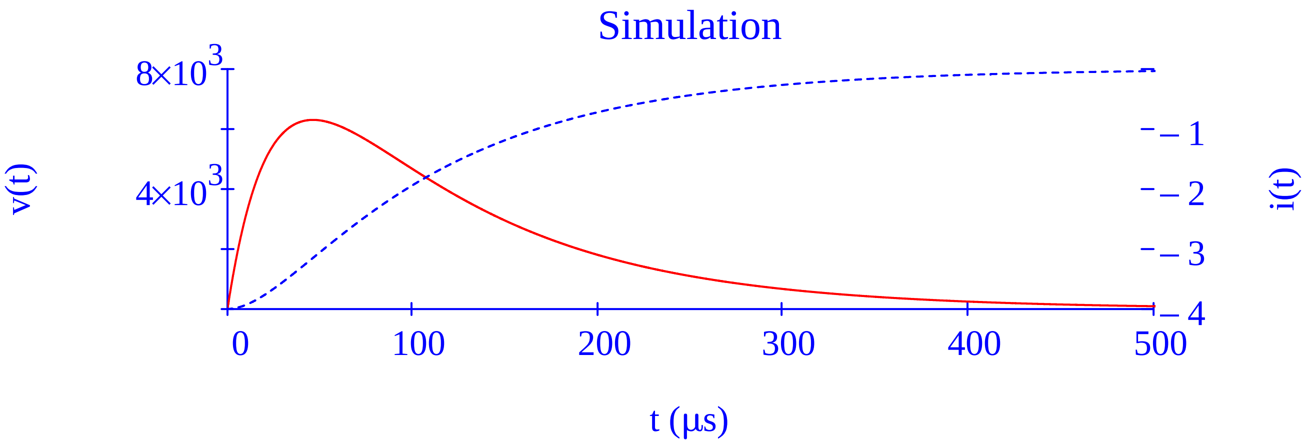
$S := (1 \quad 13333 \quad -13333 \quad -10000 \quad -40000)^T$

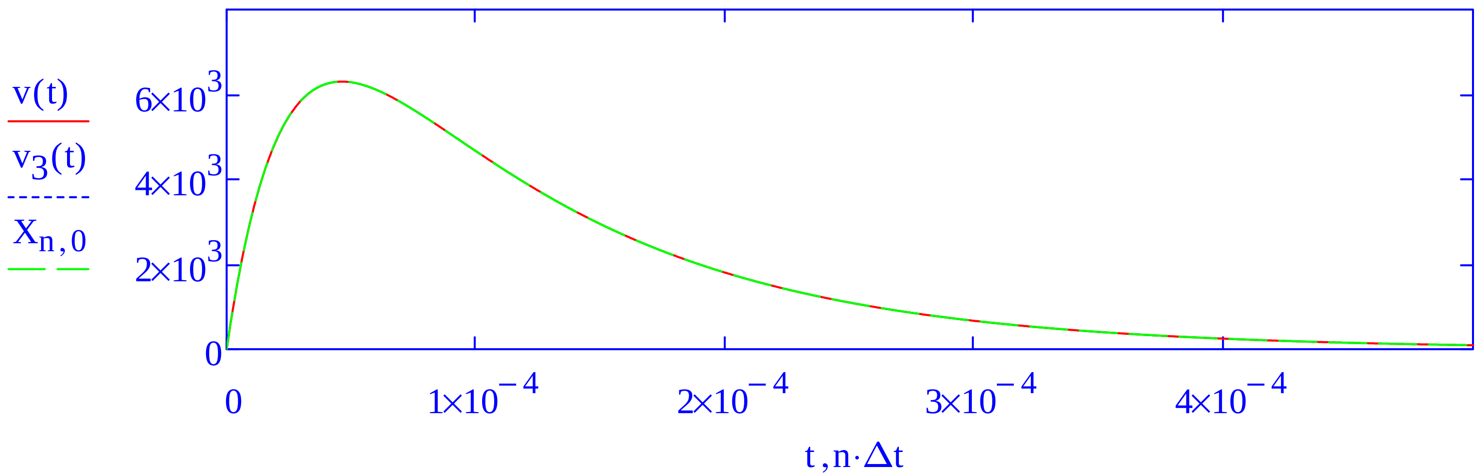
f) $v_3(t) := v_{rlc}(S, t)$

$$v_3(t) \rightarrow V \cdot \left(13333 \cdot e^{-\frac{10000 \cdot t}{s}} - 13333 \cdot e^{-\frac{40000 \cdot t}{s}} \right)$$

$$v(t) := 13333 \cdot \left(e^{-10000 \frac{t}{s}} - e^{-40000 \frac{t}{s}} \right) V$$

$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}\left(R_3, L_3, C_3, 0V, -4A, 0A\right)$$





Ex 8.4

$R_4 := 20k\Omega \quad L_4 := 8H \quad C_4 := 0.125\mu F$

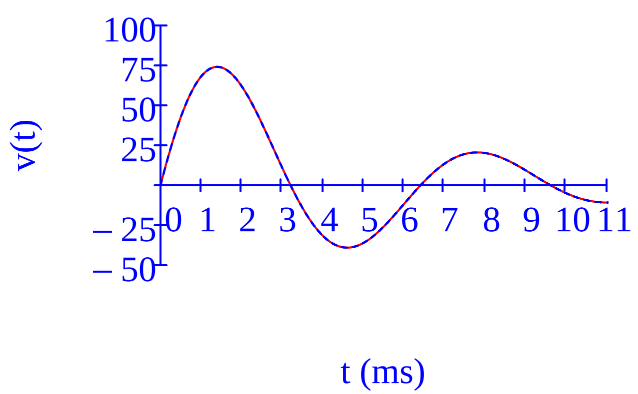
$$S := rlc\left(R_4, L_4, C_4, 0V, 98000\frac{V}{s}\right)$$

$S^T = (2 \;\; 0 \;\; 100.021 \;\; 200 \;\; 979.796) \qquad S := (2 \;\; 0 \;\; 100.021 \;\; 200 \;\; 979.796)^T$

$v(t) := v_{rlc}(S, t)$

$$v(t) \rightarrow 100.021 \cdot V \cdot \sin\left(\frac{979.796 \cdot t}{s}\right) \cdot e^{-\frac{200 \cdot t}{s}}$$

$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := simprlc(R_4, L_4, C_4, 0V, -12.25mA, 0A)$$



$$\alpha_4 := \alpha(R_4 \cdot C_4) = 200\frac{1}{s}$$

$$\omega_d(R, L, C) := \sqrt{\omega_0(L \cdot C)^2 - \alpha(R \cdot C)^2}$$

a) $s_1(R_4, L_4, C_4) = (-200 + 979.796j)\frac{1}{s}$

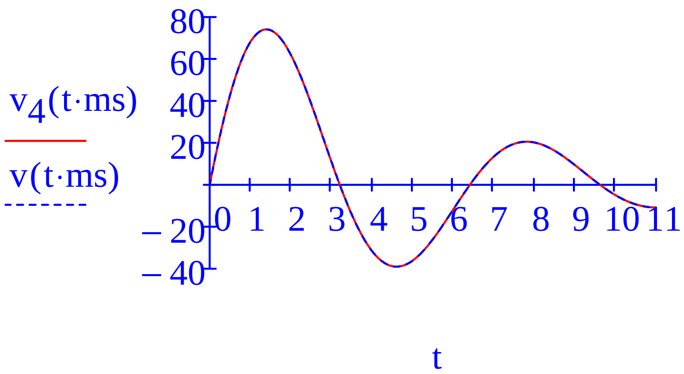
$s_2(R_4, L_4, C_4) = (-200 - 979.796j)\frac{1}{s}$

$$\omega_4 := \omega_d(R_4, L_4, C_4) = 979.796\frac{1}{s}$$

b) $dvdt := \frac{12.25mA}{C_4} = 9.8 \times 10^4 \cdot \frac{V}{s}$

c) $B_2 := \frac{dvdt}{\omega_4} = 100.021\,V$

d) $v_4(t) := B_2 \cdot e^{-\alpha_4 \cdot \frac{t}{s}} \cdot \sin\left(\omega_4 \cdot \frac{t}{s}\right) V$



$v_4(t \cdot ms)$
$v(t \cdot ms)$
80
60
40
20
− 20
− 40
0 1 2 3 4 5 6 7 8 9 10 11
t

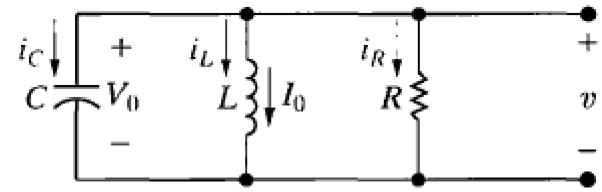
AP 8.4 A 10 mH inductor, a 1 μF capacitor, and a variable resistor are connected in parallel in the circuit shown. The resistor is adjusted so that the roots of the characteristic equation are -8000 ± j6000 rad/s. The initial voltage on the capacitor is 10 V, and the initial current in the inductor is 80 mA. Find

a) R;

b) $dv(0^+)/dt$;

c) B_1 and B_2 in the solution for v; and

d) $i_L(t)$.



$L_{84} := 10\text{mH} \qquad C_{84} := 1\mu\text{F}$

a) Given $s_1(R_x, L_{84}, C_{84}) = (-8000 + j\cdot 6000)\dfrac{\text{rad}}{\text{s}}$ $\quad R_{84} := \text{Find}(R_x) \rightarrow \dfrac{(80000 - 60000j)\cdot \text{mH}}{s^2 - [-(-960000000 - 28000000}$

$R_{84} = 62.5\,\Omega$

$s_1(R_{84}, L_{84}, C_{84}) = (-8 + 6j)\cdot\dfrac{\text{krad}}{\text{s}} \qquad s_2(R_{84}, L_{84}, C_{84}) = (-8 - 6j)\cdot\dfrac{\text{krad}}{\text{s}}$

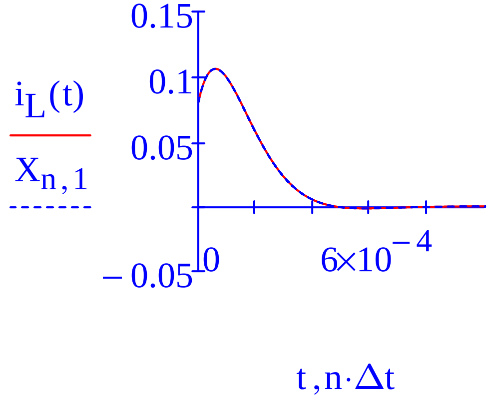
b) $\text{dvdt} := \dfrac{-80\text{mA} - \dfrac{10\text{V}}{R_{84}}}{C_{84}} = -0.24\cdot\dfrac{\text{V}}{\mu\text{s}}$

c) $B := \text{rlc}(R_{84}, L_{84}, C_{84}, 10\text{V}, \text{dvdt}) \qquad B_1 = 10 \qquad B_2 = -26.667$

$B^T = \begin{pmatrix} 2 & 10 & -26.667 & 8\times 10^3 & 6\times 10^3 \end{pmatrix}$

d) $v(t) := 10V \cdot e^{-8000 \cdot \frac{t}{s}} \cdot \cos\left(6000 \cdot \frac{t}{s}\right) - 26\frac{2}{3} \cdot V \cdot e^{-8000 \cdot \frac{t}{s}} \cdot \sin\left(6000 \cdot \frac{t}{s}\right)$

$$i_L(t) := \frac{1}{L_{84}} \cdot \int_0^t v(u)\,du + 80mA \qquad \begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}\left(R_{84}, L_{84}, C_{84}, 10V, 80mA, 0A\right)$$



Ex 8.5

$L_5 := 0.4H \quad C_5 := 10\mu F$

$mJ \equiv 10^{-3} J$

Given $\quad \text{criticallydamped}(R_4, L_4, C_4) = 1$

$$R_5 := \text{Find}(R_4) \rightarrow \begin{pmatrix} -\frac{4.0 \cdot H^{0.5}}{\mu F^{0.5}} & \frac{4.0 \cdot H^{0.5}}{\mu F^{0.5}} \end{pmatrix}$$

$R_5 = (-4000 \quad 4000)\,\Omega$

$R_4 := 4000\Omega$

$\alpha_{cd} := \alpha(R_4 \cdot C_4) = 1 \times 10^3 \frac{1}{s}$

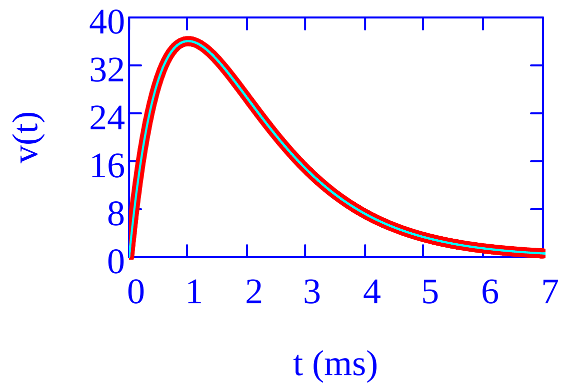
$v_0 := 0V \qquad dvdt := 98000 \frac{V}{s}$

$D := \text{rlc}(R_4, L_4, C_4, v_0, dvdt) \qquad D^T = (3 \quad 98000 \quad 0 \quad 1000 \quad 1)$

$D_2 := v_0 \qquad D_1 := dvdt + \alpha_{cd} \cdot D_2 \qquad D_1 = 98000 \cdot \frac{V}{s} \qquad D_2 = 0$

$v(t) := D_1 \cdot t \cdot e^{-\alpha_{cd} \cdot t} + D_2 \cdot e^{-\alpha_{cd} \cdot t}$

$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}(R_4, L_4, C_4, v_0, -12.25mA, 0A)$



AP 8.5 The resistor in the circuit in Assessment Problem 8.4 is adjusted for critical damping. The inductance and capacitance values are 0.4 H and 10 μF, respectively. The initial energy stored in the circuit is 25 mJ and is distributed equally between the inductor and capacitor. Find (a) R; (b) V_0; (c) I_0; (d) D_1 and D_2 in the solution for v; and (e) i_R, t > 0.

$L_5 := 0.4H \qquad C_5 := 10\mu F$

Given $\quad \text{criticallydamped}(R_x, L_5, C_5) = 1 \qquad R_5 := \text{Find}(R_x) \rightarrow \begin{pmatrix} -\dfrac{0.1 \cdot H^{0.5}}{\mu F^{0.5}} & \dfrac{0.1 \cdot H^{0.5}}{\mu F^{0.5}} \end{pmatrix}$

$R_5 = (-100 \quad 100)\,\Omega \qquad R_5 := 100\Omega$

$v_0 := \sqrt{\dfrac{25mJ}{C_5}} = 50\,V \qquad i_{L0} := \sqrt{\dfrac{25mJ}{L_5}} = 250 \cdot mA \qquad dvdt := \dfrac{-i_{L0} - \dfrac{v_0}{R_5}}{C_5} = -7.5 \times 10^4 \cdot \dfrac{V}{s}$

$D := \text{rlc}(R_5, L_5, C_5, v_0, dvdt) \qquad D_1 = -50000 \qquad D_2 = 50 \qquad D_3 = 500$

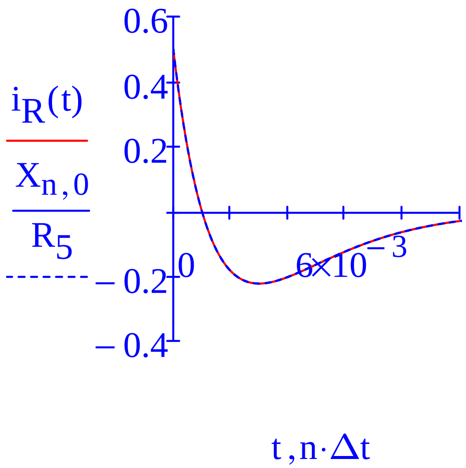
$D^T = \begin{pmatrix} 3 & -5 \times 10^4 & 50 & 500 & 1 \end{pmatrix} \qquad D := \begin{pmatrix} 3 & -5 \times 10^4 & 50 & 500 & 1 \end{pmatrix}^T$

$v(t) := v_{rlc}(D,t)$

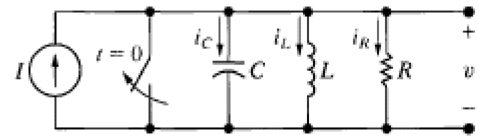
$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}\left(R_5, L_5, C_5, v_0, 250\text{mA}, 0\text{A}\right)$$

$$v(t) \rightarrow -V\cdot e^{-\frac{500\cdot t}{s}}\cdot\left(\frac{50000\cdot t}{s} - 50\right)$$

$$i_R(t) := \frac{v(t)}{R_5}\cdot\frac{A\cdot\Omega}{V} \text{ expand } \rightarrow \frac{A\cdot e^{-\frac{500\cdot t}{s}}}{2} - \frac{500\cdot A\cdot t\cdot e^{-\frac{500\cdot t}{s}}}{s}$$



AP 8.6 In the circuit shown, R = 500 Ω, L = 0.64 H, C = 1 μF, and I = -1 A. The initial voltage drop across the capacitor is 40 V and the initial inductor current is 0.5 A. Find (a) $i_R(0^+)$; (b) $i_c(0^+)$; (c) $di_L(0^+)/dt$; (d) s_1, s_2; (e) $i_L(t)$ for t > 0; and (f) v(t) for t > 0+.



$R_6 := 500\Omega$ $\quad L_6 := 0.64H$ $\quad C_6 := 1\mu F$ $\quad I := -1A$ $\quad v_{c0} := 40V$ $\quad i_{L0} := 0.5A$

$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := \text{simprlc}(R_6, L_6, C_6, v_{c0}, i_{L0}, I)$$

a) $$i_{R0} := \frac{v_{c0}}{R_6} = 80 \cdot mA$$

b) $$i_{c0} := I - i_{L0} - i_{R0} = -1.58\,A$$

c) $$di_{Ldt0} := \frac{v_{c0}}{L_6} = 62.5\,\frac{A}{s}$$

d) $$s_1(R_6, L_6, C_6) = (-1000 + 750j)\cdot\frac{rad}{s} \qquad s_2(R_6, L_6, C_6) = (-1000 - 750j)\cdot\frac{rad}{s}$$

e) $$B := \text{rlc}\left(R_6, L_6, C_6, v_{c0}, \frac{I - i_{L0} - \frac{v_{c0}}{R_6}}{C_6}\right)$$

$$B^T = (2 \quad 40 \quad -2053.33 \quad 1000 \quad 750)$$

$$B := (2 \quad 40 \quad -2053.33 \quad 1000 \quad 750)^T$$

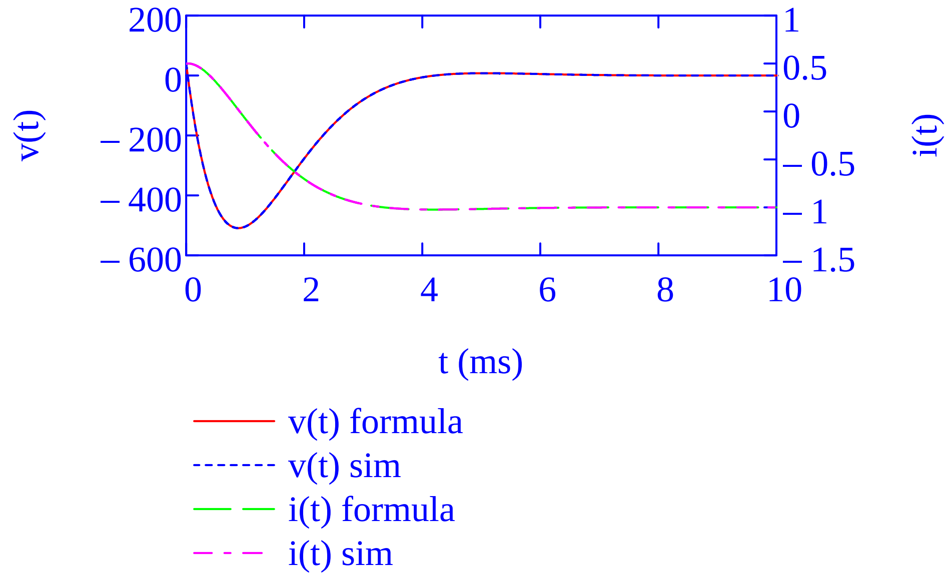
$$v(t) := v_{rlc}(B, t)$$

f) $v(t) \rightarrow V \cdot e^{-\frac{1000 \cdot t}{s}} \cdot \left(40 \cdot \cos\left(\frac{750 \cdot t}{s}\right) + -2053.33 \cdot \sin\left(\frac{750 \cdot t}{s}\right)\right)$

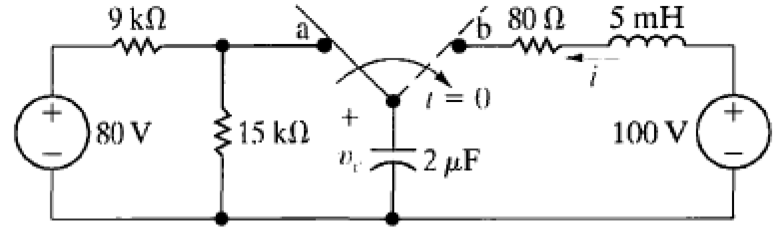
$B1 := -I + i_{L0} = 1.5\,A$

$62.5A = 750B2 - 1000 \cdot B1 \text{ solve}, B2 \rightarrow 2.0 \cdot A + 0.083333333333333333333 \cdot A$

$i(t) := I + e^{-1000 \cdot \frac{t}{s}} \cdot \left(1.5 \cos\left(750 \frac{t}{s}\right) + 2.0833 \cdot \sin\left(750 \cdot \frac{t}{s}\right)\right) \cdot A$



AP 8.7 The switch in the circuit shown has been in position a for a long time. At t = 0, it moves to position b. Find (a) $i(0^+)$; (b) $v_c(0^+)$; (c) $di(0^+)/dt$; (d) s_1, s_2; and (e) $i(t)$ for $t > 0$.



$$\text{simsrlc}(R_1, L_1, C_1, v_{c0}, i_{L0}, v_f) := \left|\begin{array}{l} i_{L_0} \leftarrow i_{L0} \\ v_{C_0} \leftarrow v_{c0} \\ f \leftarrow \dfrac{1}{2\pi\cdot\sqrt{L_1\cdot C_1}} \\ NN \leftarrow 2048\cdot 8 - 2 \\ \Delta t \leftarrow 2^{\left(\text{floor}\left(\log\left(\frac{4}{f\cdot NN\cdot s}, 2\right)\right)\right)}\cdot s \\ \text{for } n \in 0..NN \\ \quad \left| \begin{array}{l} v_{C_{n+1}} \leftarrow v_{C_n} + i_{L_n}\cdot\dfrac{\Delta t}{C_1} \\ i_{L_{n+1}} \leftarrow i_{L_n} + \dfrac{v_f - i_{L_n}\cdot R_1 - v_{C_n}}{L_1}\cdot\Delta t \end{array}\right. \\ \text{return } \begin{pmatrix} \text{augment}\left(\dfrac{v_C}{V}, \dfrac{i_L}{A}\right) \\ \dfrac{\Delta t}{s} \end{pmatrix} \end{array}\right.$$

$R_7 := 80\Omega \qquad L_7 := 5mH \qquad C_7 := 2\mu F \qquad v_f := 100V$

a) $i(O) := 0A$ b) $v_{c0} := \frac{15}{9+15}\cdot 80V = 50\,V$ c) $didt := \frac{v_f - v_{c0}}{L_7} = 10000\,\frac{A}{s}$

$R := R \qquad L := L$

$$s^2 + \frac{R}{L}s + \frac{1}{L\cdot C} = 0 \text{ solve}, s \rightarrow \begin{bmatrix} -\dfrac{R - \sqrt{-\frac{1}{C}\cdot\left(4\cdot L - C\cdot R^2\right)}}{2\cdot L} \\ -\dfrac{R + \sqrt{-\frac{4\cdot L - C\cdot R^2}{C}}}{2\cdot L} \end{bmatrix} \qquad roots(R, L, C) := \begin{bmatrix} 0 \\ -\dfrac{R - \sqrt{-\frac{1}{C}\cdot\left(4\cdot L - C\cdot R^2\right)}}{2\cdot L} \\ -\dfrac{R + \sqrt{-\frac{4\cdot L - C\cdot R^2}{C}}}{2\cdot L} \end{bmatrix}$$

d) $S := roots\left(R_7, L_7, C_7\right) \qquad S_1 = (-8000 + 6000j)\cdot\frac{rad}{s} \qquad S_2 = (-8000 - 6000j)\cdot\frac{rad}{s}$

$\alpha_s(R, L) := \frac{R}{2L} \qquad \alpha_7 := \alpha_s\left(R_7, L_7\right) = 8000\cdot\frac{rad}{s} \qquad \omega_7 := 6000\,\frac{rad}{s}$

$B_1 := i(0) = 0 \qquad e^{-\alpha_7\cdot t}\cdot\left(B_2\cdot\sin\left(\omega_7\cdot t\right)\right) \qquad B_2 := B_2$

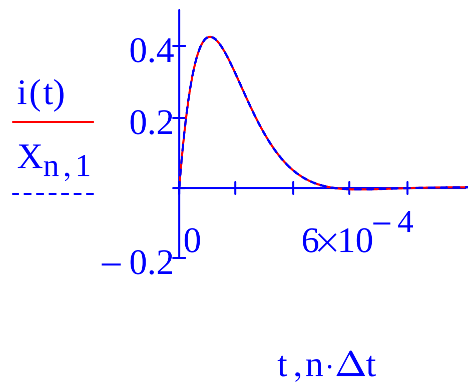
$$B_2\cdot\omega_7\cdot e^{-t\cdot\alpha_7}\cdot\cos\left(t\cdot\omega_7\right) - B_2\cdot\alpha_7\cdot e^{-t\cdot\alpha_7}\cdot\sin\left(t\cdot\omega_7\right) \text{ assume}, t = 0s \rightarrow \frac{6000\cdot B_2\cdot rad}{s}$$

$$\frac{6000\cdot B_2\cdot rad}{s} = 10000\,\frac{A}{s} \text{ solve}, B_2 \rightarrow \frac{5\cdot A}{3\cdot rad} \qquad B_2 := \frac{5}{3}A = 1.667\,A$$

$$i(t) := e^{-\alpha_7 \cdot t} \cdot \left(B_1 \cdot \cos\left(\omega_7 \cdot t\right) + B_2 \cdot \sin\left(\omega_7 \cdot t\right)\right)$$

$$i(t) \rightarrow 1.6666666666667 \cdot A \cdot e^{-\frac{8000 \cdot t}{s}} \cdot \sin\left(\frac{6000 \cdot rad \cdot t}{s}\right)$$

$$\begin{pmatrix} X \\ \Delta t \end{pmatrix} := simsrlc\left(R_7, L_7, C_7, v_{c0}, 0A, 100V\right)$$



AP 8.8 Find $v_c(t)$ for t > 0 for the circuit in Assessment Problem 8.7.

$$B_1 := 50V \qquad B_2 := B_2$$

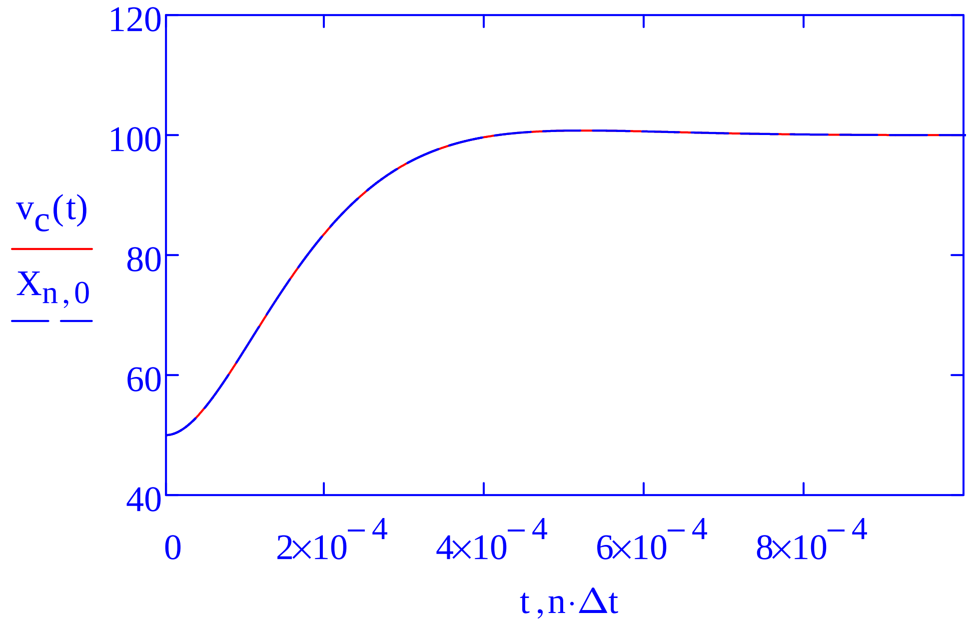
$$e^{-\alpha_7 \cdot t} \cdot \left(B_1 \cdot \cos\left(\omega_7 \cdot t\right) + B_2 \cdot \sin\left(\omega_7 \cdot t\right)\right)$$

$$e^{-t \cdot \alpha_7} \cdot \left(B_2 \cdot \omega_7 \cdot \cos\left(t \cdot \omega_7\right) - B_1 \cdot \omega_7 \cdot \sin\left(t \cdot \omega_7\right)\right) - \alpha_7 \cdot e^{-t \cdot \alpha_7} \cdot \left(B_1 \cdot \cos\left(t \cdot \omega_7\right) + B_2 \cdot \sin\left(t \cdot \omega_7\right)\right)$$

$$B_2 \cdot \omega_7 - B_1 \cdot \alpha_7 = 0 \frac{V}{s} \text{ solve}, B_2 \rightarrow \frac{200 \cdot V \cdot s}{3 \cdot s \cdot rad} \qquad B_2 := \frac{200}{3} V$$

$$v_c(t) := v_f - e^{-\alpha_7 \cdot t} \cdot \left(B_1 \cdot \cos\left(\omega_7 \cdot t\right) + B_2 \cdot \sin\left(\omega_7 \cdot t\right)\right)$$

$$v_c(t) \rightarrow 100 \cdot V - e^{-\frac{8000 \cdot t}{s}} \cdot \left(50 \cdot V \cdot \cos\left(\frac{6000 \cdot rad \cdot t}{s}\right) + \frac{200 \cdot V \cdot \sin\left(\frac{6000 \cdot rad \cdot t}{s}\right)}{3}\right)$$



120
100
80
60
40
$v_c(t)$
$X_{n,0}$
0
2×10^{-4}
4×10^{-4}
6×10^{-4}
8×10^{-4}
$t, n\cdot\Delta t$