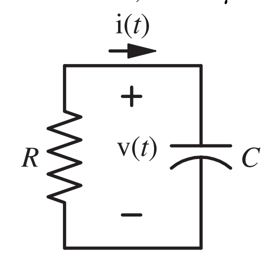
Solution of ECE 300 Test 3 S11

Please check your numerical algebra and arithmetic very carefully and be sure that Kirchhoff's and Ohm's laws and the defining equations for capacitors and inductors are satisfied, with the correct signs, everywhere and at all times.

1. In the *RC* circuit below, if $\mathrm{i}(t) = 2\mathrm{A}$ at time $t = 1$ s , what is the numerical rate of change (time derivative) of $\mathrm{v}(t)$ at the same time in V/s ?

$R = 12\Omega$, $C = 25\mu\mathrm{F}$



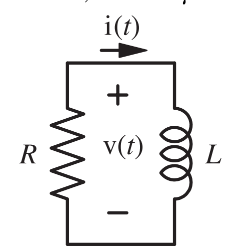
$$\mathrm{i}(t) = C\frac{d\,\mathrm{v}(t)}{dt} \Rightarrow \frac{d\,\mathrm{v}(t)}{dt} = \frac{\mathrm{i}(t)}{C} \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=1\mathrm{s}} = \frac{\mathrm{i}(1)}{C} = \frac{2A}{25\mu\mathrm{F}} = 80{,}000\ \mathrm{V/s}$$

2. (6 pts) In the RL circuit below, if $\mathrm{v}(t) = 18\mathrm{V}$ at time $t = 4s$, what are

(a) The numerical rate of change of $\mathrm{i}(t)$ at the same time in A/s?

(b) The numerical rate of change of $\mathrm{v}(t)$ at the same time in V/s?

$R = 1200\Omega$, $L = 250\mu\mathrm{H}$



$$\mathrm{v}(t) = L\frac{d\,\mathrm{i}(t)}{dt} \Rightarrow \frac{d\,\mathrm{i}(t)}{dt} = \frac{\mathrm{v}(t)}{L} \Rightarrow \left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=4\mathrm{s}} = \frac{\mathrm{v}(4)}{L} = \frac{18\mathrm{V}}{250\mu\mathrm{H}} = 72{,}000 \text{ A/s}$$

$$\mathrm{v}(t) = -R\,\mathrm{i}(t) \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right] = -R\left[\frac{d\,\mathrm{i}(t)}{dt}\right] \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=4\mathrm{s}} = -R\left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=4\mathrm{s}} = -1200\Omega \times 72{,}000 \text{ A/s} = -86{,}400{,}000 \text{ V/s}$$

3. If $i_s(t) = -1 + 3u(t)$, find the following numerical values. (Useful fact: $\left[\frac{d\,u(t)}{dt}\right]_{t=0^+} = 0$.)

(a) $v(0^+)$

(b) $i_L(0^+)$

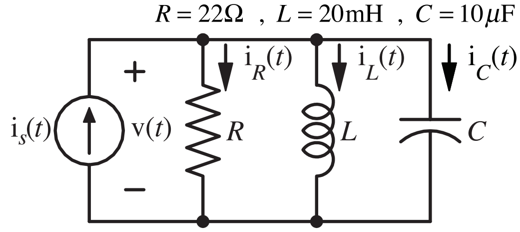
(c) $i_C(0^+)$

(d) $\left[\frac{d\,v(t)}{dt}\right]_{t=0^+}$

(e) $\left[\frac{d\,i_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\frac{d\,i_C(t)}{dt}\right]_{t=0^+}$

$R = 22\Omega$, $L = 20\text{mH}$, $C = 10\mu\text{F}$



Before time $t = 0$, $i_s(t) = -1\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -1\text{A}$, $i_C(t) = 0\text{A}$, $i_R(t) = 0\text{A}$.

At time $t = 0^+$, $i_s(t) = 2\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -1\text{A}$, $i_C(t) = 3\text{A}$, $i_R(t) = 0\text{A}$

$$\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{i_C(0^+)}{C} = \frac{3\text{A}}{10\mu\text{F}} = 300{,}000 \text{ V/s} \Rightarrow \frac{d\,i_R(t)}{dt} = \frac{1}{R}\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{300{,}000\text{V/s}}{22\Omega} = 13{,}636 \text{ A/s}$$

$$\left[\frac{d\,i_L(t)}{dt}\right]_{t=0^+} = \frac{v(0^+)}{L} = \frac{0\text{V}}{20\text{mH}} = 0 \text{ A/s}$$

$$i_s(t) = i_R(t) + i_L(t) + i_C(t) \Rightarrow \frac{d\,i_s(t)}{dt} = \frac{d\,i_R(t)}{dt} + \frac{d\,i_L(t)}{dt} + \frac{d\,i_C(t)}{dt} \Rightarrow \underbrace{\left[\frac{d\,i_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,i_L(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,i_C(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,i_C(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} = -13{,}636 \text{ A/s}$$

4. If $\mathrm{v}_s(t) = 8 - 12\,\mathrm{u}(t)$, find the following numerical values.

(a) $\mathrm{i}(0^+)$

(b) $\mathrm{v}_C(0^+)$

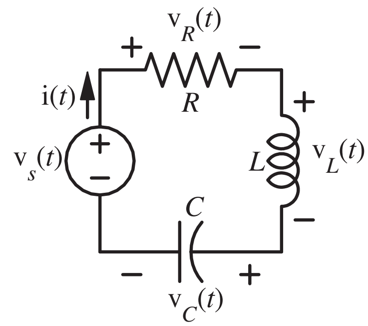
(c) $\mathrm{v}_L(0^+)$

(d) $\left[\dfrac{d\,\mathrm{i}(t)}{dt}\right]_{t=0^+}$

(e) $\left[\dfrac{d\,\mathrm{v}_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\dfrac{d\,\mathrm{v}_L(t)}{dt}\right]_{t=0^+}$

$R = 10\mathrm{k}\Omega$, $L = 4\mathrm{mH}$, $C = 280\mathrm{nF}$



Before time $t=0$, $\mathrm{v}_s(t) = 8\mathrm{V}$, $\mathrm{i}(t) = 0\mathrm{A}$, $\mathrm{v}_L(t) = 0\mathrm{V}$, $\mathrm{v}_C(t) = 8\mathrm{V}$, $\mathrm{v}_R(t) = 0\mathrm{V}$.

At time $t = 0^+$, $\mathrm{v}_s(t) = -4\mathrm{V}$, $\mathrm{i}(t) = 0\mathrm{V}$, $\mathrm{v}_L(t) = -12\mathrm{V}$, $\mathrm{v}_C(t) = 8\mathrm{V}$, $\mathrm{v}_R(t) = 0\mathrm{V}$

$$\left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=0^+} = \frac{\mathrm{v}_L(0^+)}{L} = \frac{-12\mathrm{V}}{4\mathrm{mH}} = -3{,}000\ \mathrm{A/s} \Rightarrow \frac{d\,\mathrm{v}_R(t)}{dt} = R\left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=0^+} = 10{,}000\Omega \times (-3{,}000\mathrm{A/s}) = -30{,}000{,}000\ \mathrm{V/s}$$

$$\left[\frac{d\,\mathrm{v}_C(t)}{dt}\right]_{t=0^+} = \frac{\mathrm{i}(0^+)}{C} = \frac{0\mathrm{A}}{280\mathrm{nF}} = 0\ \mathrm{V/s}$$

$$\mathrm{v}_s(t) = \mathrm{v}_R(t) + \mathrm{v}_L(t) + \mathrm{v}_C(t) \Rightarrow \frac{d\,\mathrm{v}_s(t)}{dt} = \frac{d\,\mathrm{v}_R(t)}{dt} + \frac{d\,\mathrm{v}_C(t)}{dt} + \frac{d\,\mathrm{v}_L(t)}{dt}$$

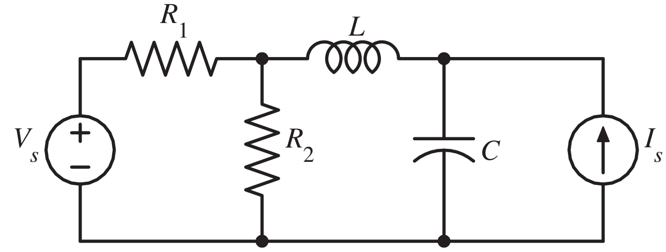
$$\underbrace{\left[\frac{d\,\mathrm{v}_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,\mathrm{v}_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,\mathrm{v}_C(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,\mathrm{v}_L(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,\mathrm{v}_L(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,\mathrm{v}_R(t)}{dt}\right]_{t=0+} = 30{,}000{,}000\ \mathrm{V/s}$$

5. Find the numerical values of α and ω_0 in these circuits.

(a)

$V_s = 34\text{V}$, $I_s = 1.5\text{A}$, $R_1 = 24\Omega$, $R_2 = 19\Omega$, $L = 28\text{mH}$, $C = 300\text{nF}$



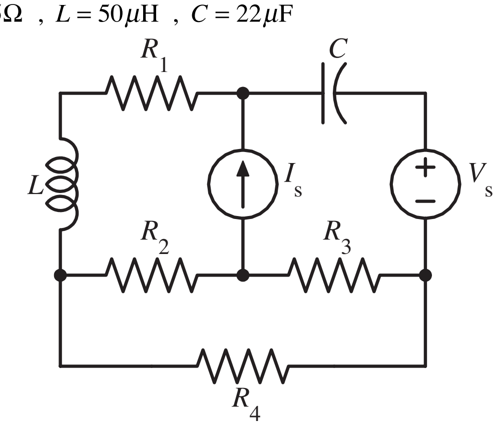
Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 \parallel R_2}{2L} = \frac{10.6047\Omega}{2 \times 28\text{mH}} = 189.3688\ /\text{s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{28\text{mH} \times 300\text{nF}}} = 10{,}911\ /\text{s}$$

(b)

$V_s = 11\text{V}$, $I_s = -2\text{A}$, $R_1 = 10\Omega$, $R_2 = 33\Omega$, $R_3 = 8\Omega$
$R_4 = 15\Omega$, $L = 50\mu\text{H}$, $C = 22\mu\text{F}$



Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 + (R_2 + R_3) \parallel R_4}{2L} = \frac{10\Omega + (33\Omega + 8\Omega) \parallel 15\Omega}{2 \times 50\mu\text{H}} = \frac{20.9821\Omega}{100\mu\text{H}} = 209{,}820\ /\text{s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{50\mu\text{H} \times 22\mu\text{F}}} = 30{,}151\ /\text{s}$$

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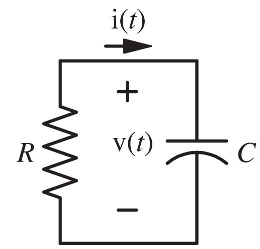
Please check your numerical algebra and arithmetic very carefully and be sure that Kirchhoff's and Ohm's laws and the defining equations for capacitors and inductors are satisfied, with the correct signs, everywhere and at all times.

1. In the *RC* circuit below, if $\mathrm{i}(t) = 2\mathrm{A}$ at time $t = 1$ s , what is the numerical rate of change (time derivative) of $\mathrm{v}(t)$ at the same time in V/s ?

$R = 12\Omega$, $C = 35\mu\mathrm{F}$



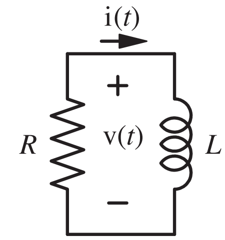
$$\mathrm{i}(t) = C\frac{d\,\mathrm{v}(t)}{dt} \Rightarrow \frac{d\,\mathrm{v}(t)}{dt} = \frac{\mathrm{i}(t)}{C} \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=1\mathrm{s}} = \frac{\mathrm{i}(1)}{C} = \frac{2A}{35\mu\mathrm{F}} = 57{,}100\ \mathrm{V/s}$$

2. (6 pts) In the *RL* circuit below, if $v(t) = 18\text{V}$ at time $t = 4s$, what are

(a) The numerical rate of change of $i(t)$ at the same time in A/s?

(b) The numerical rate of change of $v(t)$ at the same time in V/s?

$R = 1200\Omega$, $L = 350\mu\text{H}$



$$v(t) = L\frac{d\,i(t)}{dt} \Rightarrow \frac{d\,i(t)}{dt} = \frac{v(t)}{L} \Rightarrow \left[\frac{d\,i(t)}{dt}\right]_{t=4\text{s}} = \frac{v(4)}{L} = \frac{18\text{V}}{350\mu\text{H}} = 51{,}429 \text{ A/s}$$

$$v(t) = -R\,i(t) \Rightarrow \left[\frac{d\,v(t)}{dt}\right] = -R\left[\frac{d\,i(t)}{dt}\right] \Rightarrow \left[\frac{d\,v(t)}{dt}\right]_{t=4\text{s}} = -R\left[\frac{d\,i(t)}{dt}\right]_{t=4\text{s}} = -1200\Omega \times 51{,}400 \text{ A/s} = -61{,}680{,}000 \text{ V/s}$$

3. If $i_s(t) = -2 + 5\,u(t)$, find the following numerical values. (Useful fact: $\left[\frac{d\,u(t)}{dt}\right]_{t=0^+} = 0$.)

(a) $v(0^+)$

(b) $i_L(0^+)$

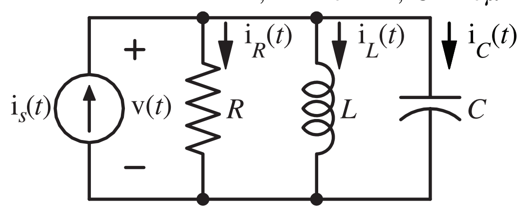
(c) $i_C(0^+)$

(d) $\left[\frac{d\,v(t)}{dt}\right]_{t=0^+}$

(e) $\left[\frac{d\,i_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\frac{d\,i_C(t)}{dt}\right]_{t=0^+}$

$R = 22\Omega$, $L = 20\text{mH}$, $C = 10\mu\text{F}$



Before time $t = 0$, $i_s(t) = -2\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -2\text{A}$, $i_C(t) = 0\text{A}$, $i_R(t) = 0\text{A}$.

At time $t = 0^+$, $i_s(t) = 3\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -2\text{A}$, $i_C(t) = 5\text{A}$, $i_R(t) = 0\text{A}$

$$\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{i_C(0^+)}{C} = \frac{5\text{A}}{10\mu\text{F}} = 500{,}000 \text{ V/s} \Rightarrow \frac{d\,i_R(t)}{dt} = \frac{1}{R}\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{500{,}000\text{V/s}}{22\Omega} = 22{,}727 \text{ A/s}$$

$$\left[\frac{d\,i_L(t)}{dt}\right]_{t=0^+} = \frac{v(0^+)}{L} = \frac{0\text{V}}{20\text{mH}} = 0 \text{ A/s}$$

$$i_s(t) = i_R(t) + i_L(t) + i_C(t) \Rightarrow \frac{d\,i_s(t)}{dt} = \frac{d\,i_R(t)}{dt} + \frac{d\,i_L(t)}{dt} + \frac{d\,i_C(t)}{dt} \Rightarrow \underbrace{\left[\frac{d\,i_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,i_L(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,i_C(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,i_C(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} = -22{,}727 \text{ A/s}$$

4. If $v_s(t) = 6 - 15\,u(t)$, find the following numerical values.

(a) $i(0^+)$

(b) $v_C(0^+)$

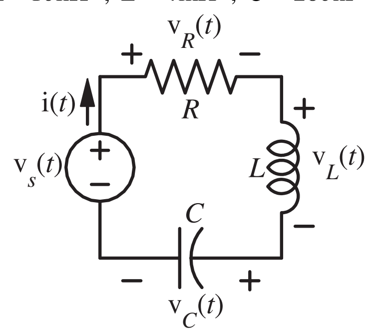
(c) $v_L(0^+)$

(d) $\left[\dfrac{d\,i(t)}{dt}\right]_{t=0^+}$

(e) $\left[\dfrac{d\,v_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\dfrac{d\,v_L(t)}{dt}\right]_{t=0^+}$

$R = 10\text{k}\Omega$, $L = 4\text{mH}$, $C = 280\text{nF}$



Before time $t = 0$, $v_s(t) = 6\text{V}$, $i(t) = 0\text{A}$, $v_L(t) = 0\text{V}$, $v_C(t) = 6\text{V}$, $v_R(t) = 0\text{V}$.

At time $t = 0^+$, $v_s(t) = -9\text{V}$, $i(t) = 0\text{V}$, $v_L(t) = -15\text{V}$, $v_C(t) = 6\text{V}$, $v_R(t) = 0\text{V}$

$$\left[\frac{d\,i(t)}{dt}\right]_{t=0^+} = \frac{v_L(0^+)}{L} = \frac{-15\text{V}}{4\text{mH}} = -3{,}750\ \text{A/s} \Rightarrow \frac{d\,v_R(t)}{dt} = R\left[\frac{d\,i(t)}{dt}\right]_{t=0^+} = 10{,}000\Omega \times (-3{,}750\text{A/s}) = -37{,}500{,}000\ \text{V/s}$$

$$\left[\frac{d\,v_C(t)}{dt}\right]_{t=0^+} = \frac{i(0^+)}{C} = \frac{0\text{A}}{280\text{nF}} = 0\ \text{V/s}$$

$$v_s(t) = v_R(t) + v_L(t) + v_C(t) \Rightarrow \frac{d\,v_s(t)}{dt} = \frac{d\,v_R(t)}{dt} + \frac{d\,v_C(t)}{dt} + \frac{d\,v_L(t)}{dt}$$

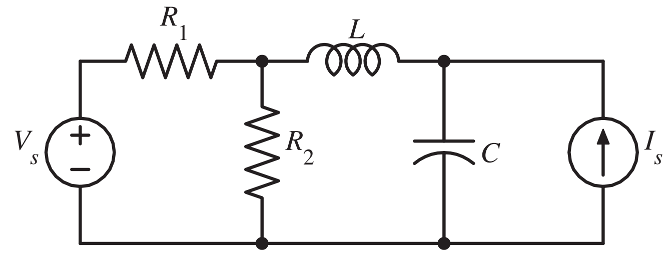
$$\underbrace{\left[\frac{d\,v_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,v_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,v_C(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,v_L(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,v_L(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,v_R(t)}{dt}\right]_{t=0+} = 37{,}500{,}000\ \text{V/s}$$

5. Find the numerical values of α and ω_0 in these circuits.

(a)

$V_s = 34\text{V}$, $I_s = 1.5\text{A}$, $R_1 = 24\Omega$, $R_2 = 19\Omega$, $L = 38\text{mH}$, $C = 300\text{nF}$



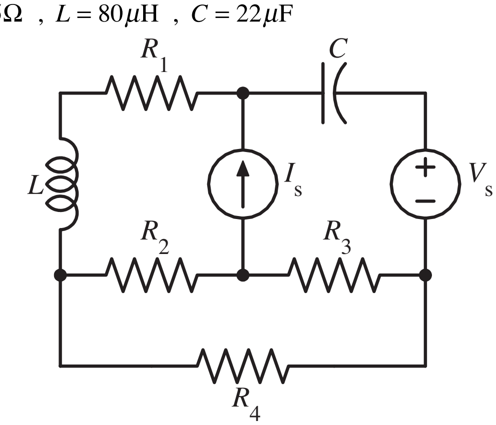
Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 \parallel R_2}{2L} = \frac{10.6047\Omega}{2 \times 38\text{mH}} = 139.5 \text{ /s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{38\text{mH} \times 300\text{nF}}} = 9,366 \text{ /s}$$

(b)

$V_s = 11\text{V}$, $I_s = -2\text{A}$, $R_1 = 10\Omega$, $R_2 = 33\Omega$, $R_3 = 8\Omega$
$R_4 = 15\Omega$, $L = 80\mu\text{H}$, $C = 22\mu\text{F}$



Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 + (R_2 + R_3) \parallel R_4}{2L} = \frac{10\Omega + (33\Omega + 8\Omega) \parallel 15\Omega}{2 \times 80\mu\text{H}} = \frac{20.9821\Omega}{160\mu\text{H}} = 131,100 \text{ /s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{80\mu\text{H} \times 22\mu\text{F}}} = 23,837 \text{ /s}$$

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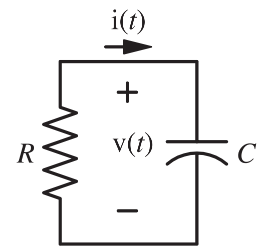
1. In the *RC* circuit below, if $\mathrm{i}(t) = 2\mathrm{A}$ at time $t = 1$ s, what is the numerical rate of change (time derivative) of $\mathrm{v}(t)$ at the same time in V/s ?

$R = 12\Omega$, $C = 125\mu\mathrm{F}$



$$\mathrm{i}(t) = C\frac{d\,\mathrm{v}(t)}{dt} \Rightarrow \frac{d\,\mathrm{v}(t)}{dt} = \frac{\mathrm{i}(t)}{C} \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=1\mathrm{s}} = \frac{\mathrm{i}(1)}{C} = \frac{2A}{125\mu\mathrm{F}} = 16{,}000 \text{ V/s}$$

2. (6 pts) In the RL circuit below, if $\mathrm{v}(t) = 18\text{V}$ at time $t = 4s$, what are

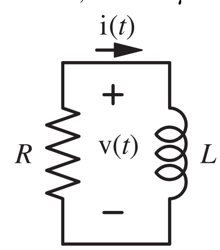
(a) The numerical rate of change of $\mathrm{i}(t)$ at the same time in A/s?

$$\left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=4\text{s}} = \underline{\hspace{3cm}} \text{ A/s}$$

(b) The numerical rate of change of $\mathrm{v}(t)$ at the same time in V/s?

$$\left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=4\text{s}} = \underline{\hspace{3cm}} \text{ V/s}$$

$R = 1200\Omega$, $L = 750\mu\text{H}$



$$\mathrm{v}(t) = L\frac{d\,\mathrm{i}(t)}{dt} \Rightarrow \frac{d\,\mathrm{i}(t)}{dt} = \frac{\mathrm{v}(t)}{L} \Rightarrow \left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=4\text{s}} = \frac{\mathrm{v}(4)}{L} = \frac{18\text{V}}{750\mu\text{H}} = 24{,}000 \text{ A/s}$$

$$\mathrm{v}(t) = -R\,\mathrm{i}(t) \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right] = -R\left[\frac{d\,\mathrm{i}(t)}{dt}\right] \Rightarrow \left[\frac{d\,\mathrm{v}(t)}{dt}\right]_{t=4\text{s}} = -R\left[\frac{d\,\mathrm{i}(t)}{dt}\right]_{t=4\text{s}} = -1200\Omega \times 24{,}000 \text{ A/s} = -28{,}800{,}000 \text{ V/s}$$

3. If $i_s(t) = -4 + 9\,u(t)$, find the following numerical values. (Useful fact: $\left[\frac{d\,u(t)}{dt}\right]_{t=0^+} = 0$.)

(a) $v(0^+)$

(b) $i_L(0^+)$

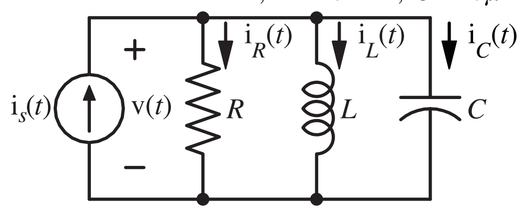
(c) $i_C(0^+)$

(d) $\left[\frac{d\,v(t)}{dt}\right]_{t=0^+}$

(e) $\left[\frac{d\,i_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\frac{d\,i_C(t)}{dt}\right]_{t=0^+}$

$R = 22\Omega$, $L = 20\text{mH}$, $C = 10\mu\text{F}$



Before time $t = 0$, $i_s(t) = -4\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -4\text{A}$, $i_C(t) = 0\text{A}$, $i_R(t) = 0\text{A}$.

At time $t = 0^+$, $i_s(t) = 5\text{A}$, $v(t) = 0\text{V}$, $i_L(t) = -4\text{A}$, $i_C(t) = 9\text{A}$, $i_R(t) = 0\text{A}$

$$\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{i_C(0^+)}{C} = \frac{9\text{A}}{10\mu\text{F}} = 900{,}000 \text{ V/s} \Rightarrow \frac{d\,i_R(t)}{dt} = \frac{1}{R}\left[\frac{d\,v(t)}{dt}\right]_{t=0^+} = \frac{900{,}000\text{V/s}}{22\Omega} = 40{,}909 \text{ A/s}$$

$$\left[\frac{d\,i_L(t)}{dt}\right]_{t=0^+} = \frac{v(0^+)}{L} = \frac{0\text{V}}{20\text{mH}} = 0 \text{ A/s}$$

$$i_s(t) = i_R(t) + i_L(t) + i_C(t) \Rightarrow \frac{d\,i_s(t)}{dt} = \frac{d\,i_R(t)}{dt} + \frac{d\,i_L(t)}{dt} + \frac{d\,i_C(t)}{dt} \Rightarrow \underbrace{\left[\frac{d\,i_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,i_L(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,i_C(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,i_C(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,i_R(t)}{dt}\right]_{t=0+} = -40{,}909 \text{ A/s}$$

4. If $v_s(t) = 3 - 7\,u(t)$, find the following numerical values.

(a) $i(0^+)$

(b) $v_C(0^+)$

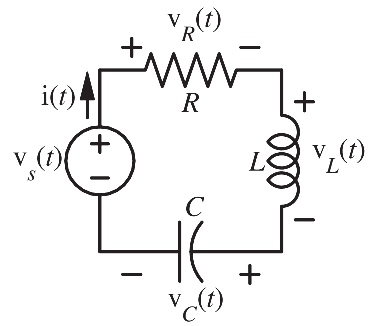
(c) $v_L(0^+)$

(d) $\left[\frac{d\,i(t)}{dt}\right]_{t=0^+}$

(e) $\left[\frac{d\,v_R(t)}{dt}\right]_{t=0^+}$

(f) $\left[\frac{d\,v_L(t)}{dt}\right]_{t=0^+}$

$R = 10\text{k}\Omega$, $L = 4\text{mH}$, $C = 280\text{nF}$



Before time $t = 0$, $v_s(t) = 3\text{V}$, $i(t) = 0\text{A}$, $v_L(t) = 0\text{V}$, $v_C(t) = 3\text{V}$, $v_R(t) = 0\text{V}$.

At time $t = 0^+$, $v_s(t) = -4\text{V}$, $i(t) = 0\text{V}$, $v_L(t) = -7\text{V}$, $v_C(t) = 3\text{V}$, $v_R(t) = 0\text{V}$

$$\left[\frac{d\,i(t)}{dt}\right]_{t=0^+} = \frac{v_L(0^+)}{L} = \frac{-7\text{V}}{4\text{mH}} = -1{,}750 \text{ A/s} \Rightarrow \frac{d\,v_R(t)}{dt} = R\left[\frac{d\,i(t)}{dt}\right]_{t=0^+} = 10{,}000\Omega \times (-1{,}750\text{A/s}) = -17{,}500{,}000 \text{ V/s}$$

$$\left[\frac{d\,v_C(t)}{dt}\right]_{t=0^+} = \frac{i(0^+)}{C} = \frac{0\text{A}}{280\text{nF}} = 0 \text{ V/s}$$

$$v_s(t) = v_R(t) + v_L(t) + v_C(t) \Rightarrow \frac{d\,v_s(t)}{dt} = \frac{d\,v_R(t)}{dt} + \frac{d\,v_C(t)}{dt} + \frac{d\,v_L(t)}{dt}$$

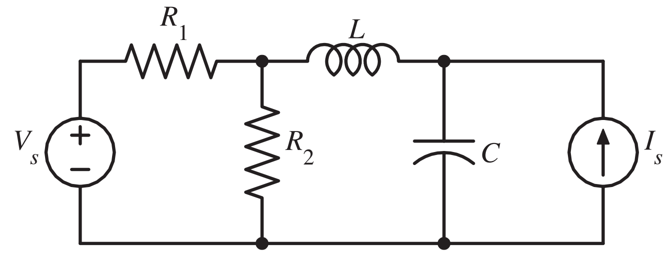
$$\underbrace{\left[\frac{d\,v_s(t)}{dt}\right]_{t=0+}}_{=0} = \left[\frac{d\,v_R(t)}{dt}\right]_{t=0+} + \underbrace{\left[\frac{d\,v_C(t)}{dt}\right]_{t=0+}}_{=0} + \left[\frac{d\,v_L(t)}{dt}\right]_{t=0+}$$

$$\left[\frac{d\,v_L(t)}{dt}\right]_{t=0+} = -\left[\frac{d\,v_R(t)}{dt}\right]_{t=0+} = 17{,}500{,}000 \text{ V/s}$$

5. Find the numerical values of α and ω_0 in these circuits.

(a)

$V_s = 34\text{V}$, $I_s = 1.5\text{A}$, $R_1 = 24\Omega$, $R_2 = 19\Omega$, $L = 78\text{mH}$, $C = 300\text{nF}$



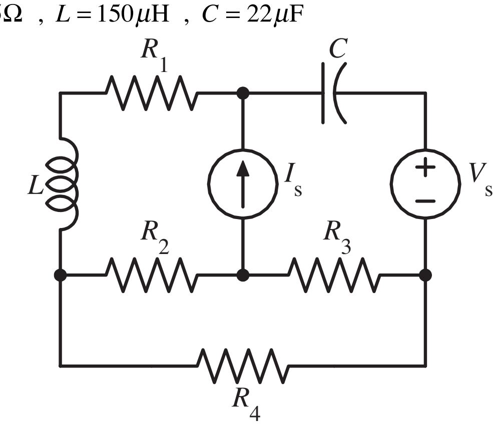
Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 \parallel R_2}{2L} = \frac{10.6047\Omega}{2 \times 78\text{mH}} = 67.9788 \text{ /s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{78\text{mH} \times 300\text{nF}}} = 6{,}537 \text{ /s}$$

(b)

$V_s = 11\text{V}$, $I_s = -2\text{A}$, $R_1 = 10\Omega$, $R_2 = 33\Omega$, $R_3 = 8\Omega$
$R_4 = 15\Omega$, $L = 150\mu\text{H}$, $C = 22\mu\text{F}$



Series RLC. Therefore

$$\alpha = \frac{R_{eq}}{2L} = \frac{R_1 + (R_2 + R_3) \parallel R_4}{2L} = \frac{10\Omega + (33\Omega + 8\Omega) \parallel 15\Omega}{2 \times 150\mu\text{H}} = \frac{20.9821\Omega}{300\mu\text{H}} = 69{,}940 \text{ /s}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{150\mu\text{H} \times 22\mu\text{F}}} = 17{,}408 \text{ /s}$$