Solution 16.1

The current in an *RLC* circuit is described by

Table 15.1:

- $\frac{d^2f}{dt^2} \xleftrightarrow{\mathcal{L}} s^2F(s) - sf(0^-) - f'(0^-)$
- $\frac{df}{dt} \xleftrightarrow{\mathcal{L}} sF(s) - f(0^-)$

$$\frac{d^2i}{dt^2} + 10\frac{di}{dt} + 25i = 0$$

If $i(0) = 7$ A and $di(0)/dt = 0$, find $i(t)$ for $t > 0$.

Solution

Step 1. Transform the equation into the s-domain and solve for I(s).

$s^2I(s) - (di(0^-)/dt) - si(0^-) + 10sI(s) - 10i(0^-) + 25\,I(s) = 0$

$(s^2+10s+25)I(s) + [-(di(0^-)/dt) - si(0^-) - 10i(0^-)] = 0$ $\quad \frac{di(0^-)}{dt} = 0 \;\;;\;\; i(0^-) = 7A$

$(s^2+10s+25)I(s) + [-7s-70] = 0$ or $(s^2+10s+25)I(s) = 7(s+10)$ or

$I(s) = 7(s+10)/\,(s^2+10s+25)$

Step 2. Perform a partial fraction expansion and then solve for i(t) in the time domain.

$s^2 + 10s + 25 = 0$, thus $s_{1,2} = \dfrac{-10 \pm \sqrt{10-10}}{2} = -5$, repeated roots.

$I(s) = 7(s+10)/(s+5)^2 = A/(s+5) + B/(s+5)^2 = (As+A5+B)/(s+5)^2$ or $\quad B = 7(-5+10) = 35$

multiply out:

$7s + 70 = As + 5A + B$

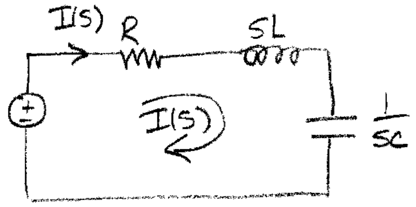
Equate powers of s: s^1: $A = 7$ and $5A+B = 70$ or $B = 70 - 35 = 35$ or

$I(s) = 7/(s+5) + 35/(s+5)^2$ or

$A=7\,;\; B=35$

using Table 15.2: $\quad$ **$i(t) = [(7+35t)e^{-5t}]u(t)$ A**

Whites EE 221 – Circuits II 1/1



Solution 16.4

If $R = 20\ \Omega$, $L = 0.6$ H, what value of C will make an *RLC* series circuit:

By KVL: $RI(s) + sLI(s) + \frac{I(s)}{sC} = V(s)$

or $s^2 L I(s) + sRI(s) + \frac{I(s)}{C} = sV(s)$

$s^2 I(s) + s\frac{R}{L} I(s) + \frac{I(s)}{LC} = \frac{s}{L} V(s)$

(a) overdamped,
(b) critically damped,
(c) underdamped?

$\Rightarrow I(s) = \dfrac{\frac{s}{L} V(s)}{s^2 + s\frac{R}{L} + \frac{1}{LC}}$ $\quad a_1 = 1,\ b_1 = \frac{R}{L},\ c_1 = \frac{1}{LC}$

Solution

Step 1. Since we are working with a series RLC circuit, we can express our values in terms of I(s) and the s equation that multiplies it in the s-domain. From here we can easily find the values that produce over damped, critically damped, and underdamped conditions.

Equating the mesh equation we get, RI(s) + LsI(s) + (1/C)I(s)/s – V(s) = 0 or

(0.6s + 20 + 1/(Cs))I(s) = V(s) or [s^2+(20/0.6)+(1/(0.6Cs)]I(s) = V(s)/0.6 or

[s^s+(20/0.6)s+1/(0.6C)]I(s) = sV(s)/0.6 $\quad s_{1,2} = \frac{-b_1 \pm \sqrt{b_1^2 - 4a_1c_1}}{2a_1} = \frac{-\frac{R}{L} \pm \sqrt{\left(\frac{R}{L}\right)^2 - \frac{4}{LC}}}{2}$

The roots for the denominator are $s_{1,2} = \dfrac{-(20/0.6) \pm \sqrt{(400/0.36) - 4/(0.6C)}}{2}$.

Step 2. To find the values of our roots that produces overdamped, critically damped, and underdamped conditions, we note that when s_1 and s_2 values that produces these values,

See Section 8.4:

- overdamped is when s_1 and s_2 are real with no complex values
- critically damped is when $s_1 = s_2$
- underdamped is when both s_1 and s_2 have complex roots and $s_1 = s_2^*$

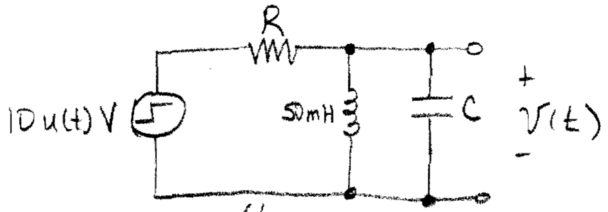
Now all we need to do is to solve for these conditions.

(a) Overdamped is when [4/(0.6C)] is less than 400/0.36 or C > 4x0.36/(400x0.6) = $6\text{x}10^{-3}$, or **C > 6 mF** $\quad \left(\frac{R}{L}\right)^2 > \frac{4}{LC} \Rightarrow C > \frac{4}{L}\cdot\left(\frac{L}{R}\right)^2 = \frac{4L}{R^2}$

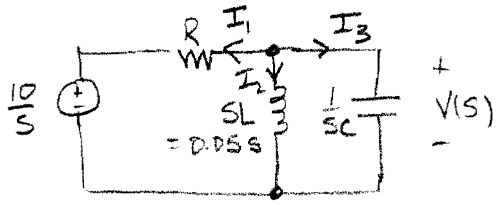
(b) Critically damped is when [4/(0.6C)] is equal to 400/0.36 or C = 4x0.36/(400x0.6) = $6\text{x}10^{-3}$ = **6 mF** $\quad \left(\frac{R}{L}\right)^2 = \frac{4}{LC} \Rightarrow C = \frac{4}{L}\cdot\left(\frac{L}{R}\right)^2 = \frac{4L}{R^2}$

(c) Underdamped is when [4/(0.6C)] is greater than 400/0.36 or C < 4x0.36/(400x0.6) = $6\text{x}10^{-3}$ or **C < 6mF** $\quad \left(\frac{R}{L}\right)^2 < \frac{4}{LC} \Rightarrow C < \frac{4L}{R^2}$

Whites EE 221 - Circuits II 1/1



s domain



Solution 16.11

The step response of a parallel RLC circuit is

$$v = 10 + 20e^{-300t}(\cos 400t - 2\sin 400t)\ \text{V},\ \ t \geq 0$$

when the inductor is 50 mH. Find R and C.

Solution

Step 1. There are different ways to approach this problem so, we will convert everything into the s-domain and then solve for the unknowns. We should also note that the steady-state voltage is 10 volts, then the circuit is a step input voltage across a parallel combination of a capacitor and an inductor all in series with an output resistor.

(KCL)

The nodal equation for this circuit is given by,

$$\overbrace{[(V-10/s)/R]}^{I_1} + \overbrace{[(V-0)/(0.05s)]}^{I_2} + \overbrace{[(V-0)/(1/sC)]}^{I_3} = 0 \text{ or}$$

$$[(1/R)+(1/(0.05s))+sC]V = 10/(Rs) = [(20R+RCs^2+s)/(Rs)]V \text{ or}$$

$$V = [10/(Rs)][Rs/(RCs^2+s+20R)] = 10/[(RCs)(s^2+(1/(RC))s+(20/C))]$$

Step 2. From the value of v(t) we can determine the value of the roots of the polynomial $(s^2+(1/(RC))s+(20/C)) = (s+300+j400)(s+300-j400)$ thus, $20/C = 300^2+400^2 = 90{,}000 + 160{,}000 = 250{,}000$ or

$$C = 20/250{,}000 = \mathbf{80\ \mu F}$$

• $\frac{1}{LC} = 250{,}000 \Rightarrow C = (2.5\times10^5 \cdot 50\times10^{-3})^{-1}$

$\underline{C = 80\,\mu F}$

and $1/(RC) = 600$ or

$$R = 1/(600\text{x}80\text{x}10^{-6}) = \mathbf{20.83\ \Omega}.$$

• $\frac{1}{RC} = 600 \Rightarrow R = (600 \cdot 80\times10^{-6})^{-1}$

$\underline{R = 20.83\,\Omega}$

KCL: $\frac{V - \frac{10}{s}}{R} + \frac{V}{sL} + \frac{V}{1/sC} = 0$ or $V\left(\frac{1}{R} + \frac{1}{sL} + sC\right) = \frac{10}{sR}$

$\therefore V = \frac{\frac{10}{sR}}{\frac{1}{R} + \frac{1}{sL} + sC} \cdot \frac{sLR}{sLR} = \frac{10 \cdot L}{s^2RLC + sL + R} \cdot \frac{\frac{1}{RLC}}{\frac{1}{RLC}}$ Standard form

$V = \frac{\frac{10}{RC}}{s^2 + \frac{s}{RC} + \frac{1}{LC}}$

From Table 15.2:

$\mathcal{L}\{e^{-300t}\cos 400t\} = \frac{s+300}{(s+300)^2 + (400)^2}$

$(s+300)^2 + 400^2 = s^2 + 600s + 300^2 + 400^2$

Equate.

$\frac{1}{RC} = 600$

$\frac{1}{LC} = 300^2 + 400^2$

Whites EE 221 - Circuits II

multiply out: $\frac{7.5s^2}{(s+2)\left[(s+\frac{1}{2})^2+\frac{7}{4}\right]} = \frac{A}{s+2} + \frac{Bs+C}{(s+\frac{1}{2})^2+\frac{7}{4}} =$

$\therefore 7.5s^2 = A\left[(s+\frac{1}{2})^2+\frac{7}{4}\right] + (Bs+C)(s+2) = A(s^2+s+2) + Bs^2 + B2s + Cs + 2C$

Solution 16.17

s^2: $7.5 = A + B \Rightarrow \underline{B = 7.5 - A = 0}$

s^0: $2A + 2C = 0 = \underline{C = -A = -7.5}$

If $i_s(t) = 7.5e^{-2t}u(t)$ A in the circuit shown in Fig. 16.40, find the value of $i_o(t)$.

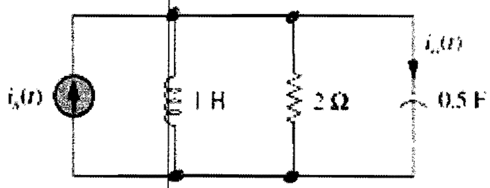
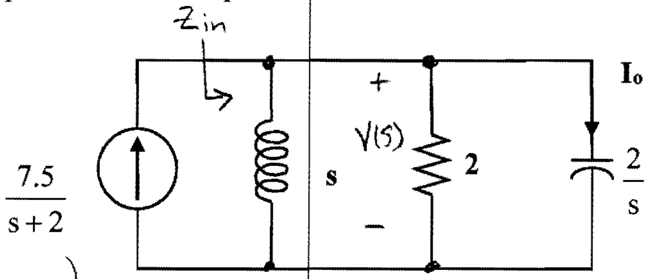


Figure 16.40 For Prob. 16.17.

Solution

We need to determine the initial conditions which in this case are all equal to zero since there are no sources before t = 0. Next we convert the circuit into the s-domain. We can write a nodal equation and then calculate $I_o = V/(2/s)$. We then perform a partial fraction expansion and convert back into the time domain.



$V(S) = Z_{in}(S) \cdot I_s(S)$

$$V_{(S)} = \frac{7.5}{s+2}\left(\frac{1}{\frac{1}{s}+\frac{1}{2}+\frac{s}{2}}\right) = \frac{7.5}{s+2}\left(\frac{2s}{s^2+s+2}\right) = \frac{15s}{(s+2)(s+0.5+j1.3229)(s+0.5-j1.3229)}$$

complex roots

or $I_o(s) = \frac{V(S)}{2/s} = \frac{s}{2} \cdot \frac{7.5}{s+2} \cdot \frac{2s}{s^2+s+2}$

$= 7.5 \cdot \frac{s^2}{s+2} \cdot \frac{1}{(s+\frac{1}{2})^2+\frac{7}{4}}$

$$I_o = \frac{Vs}{2} = \frac{7.5s^2}{(s+2)(s+0.5+j1.3229)(s+0.5-j1.3229)}$$

$\overset{PFE}{=} \frac{A}{s+2} + \frac{Bs+D}{(s+\frac{1}{2})^2+\frac{7}{4}}$

$$= \frac{7.5}{s+2} + \frac{\frac{7.5(-0.5-j1.3229)^2}{(1.5-j1.3229)(-j2.646)}}{s+0.5+j1.3229} + \frac{\frac{7.5(-0.5+j1.3229)^2}{(1.5+j1.3229)(+j2.646)}}{s+0.5-j1.3229}$$

$\Rightarrow A = \frac{7.5 \cdot (-2)^2}{(-2+\frac{1}{2})^2+\frac{7}{4}}$

$$\underline{i_o(t) = 7.5\left(e^{-2t} + 0.3779e^{-90°}e^{-t/2}e^{-j1.3229t} + 0.3779e^{90°}e^{-t/2}e^{j1.3229t}\right)u(t)\ A}$$

$A = 7.5$

$\Leftarrow B = 0,\ C = -A.$

or $\therefore I(S) = \frac{7.5}{s+2} - \frac{7.5}{(s+\frac{1}{2})^2+\frac{7}{4}}$

$= \frac{7.5}{s+2} - 7.5 \cdot \frac{2}{\sqrt{7}} \cdot \frac{(\frac{\sqrt{7}}{2})}{(s+\frac{1}{2})^2+(\frac{\sqrt{7}}{2})^2}$

$$\underline{= 7.5\left(e^{-2t} - 0.7559e^{-0.5t}\sin 1.3229t\right)u(t)\ A}$$

$\mathcal{L}^{-1}$

$$\text{or } i_o(t) = 7.5\left(e^{-2t} - \frac{2}{\sqrt{7}}e^{-0.5t}\sin\left(\frac{\sqrt{7}}{2}t\right)\right)u(t)A$$

Solution 16.18

Find v(t), t>0 in the circuit of Fig. 16.41. Let $v_s = 12$ V.

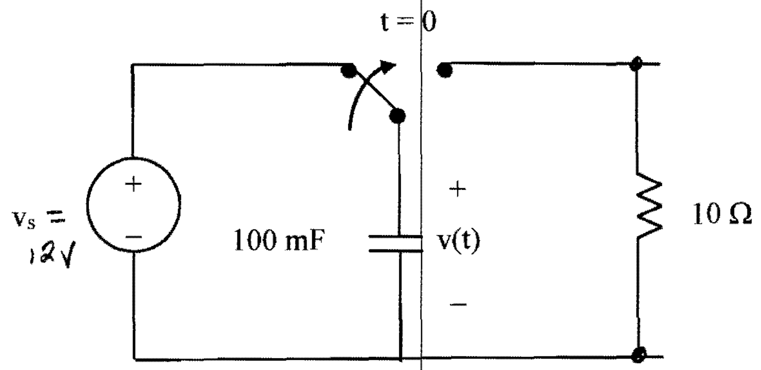


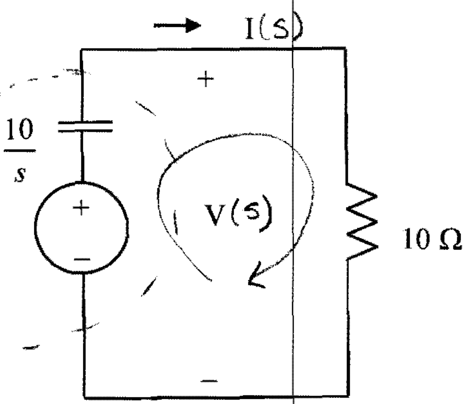
Figure 16.41
For Prob. 16.18.

Solution

For t<0, $v(0) = v_s = 12$ V.
For t>0, the circuit in the s-domain is as shown below.

See Fig 16.2 (c)
Equivalent ckt
model for C w/
initial conditions

$\frac{v(0)}{s}$ = 12/s



KVL: $\frac{12}{s} = I(s)\cdot\frac{10}{s} + 10\cdot I(s)$

$\Rightarrow I(s) = \frac{12/s}{10/s + 10}\cdot\frac{\frac{s}{10}}{\frac{s}{10}}$

$= \frac{1.2}{s+1}$

$\therefore V(s) = 10\cdot I(s) = \frac{12}{s+1}$

$v(t) = \mathcal{L}^{-1}\{V(s)\} = 12e^{-t}u(t)$ V

$$100mF = 0.1F \quad\longrightarrow\quad \frac{1}{sC} = \frac{10}{s} \quad \text{and}$$

I = (12/s)/[10+(10/s)] = 1.2/(s+1) and V = 10I which gives us

v(t) = **[12e^{-t}]u(t)** V.

Solution 16.19

The switch in Fig. 16.42 moves from position A to position B at t=0 (please note that the switch must connect to point B before it breaks the connection at A, a "make before break switch"). Find v(t) for t >0.

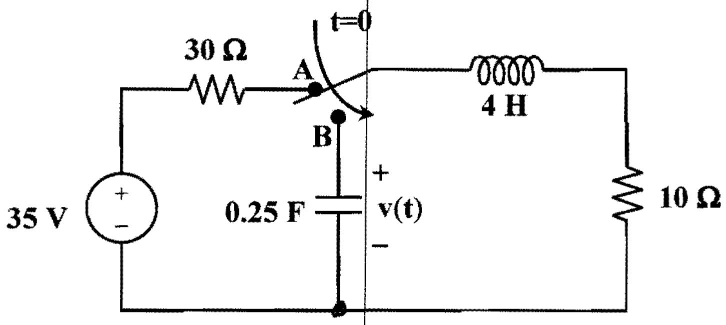


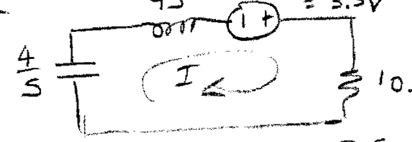
Figure 16.42 For Prob. 16.19.

Solution

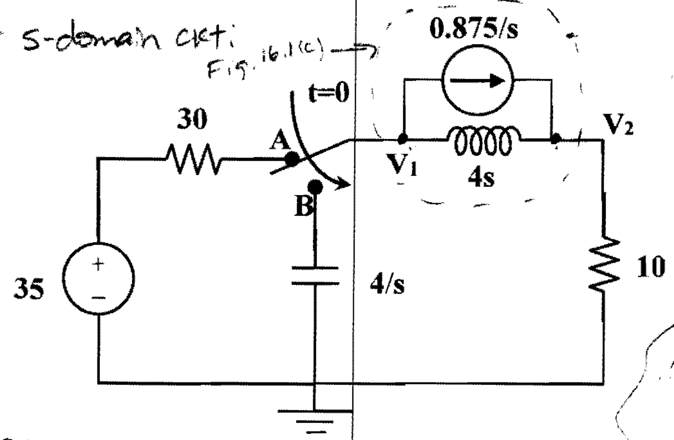
Step 1. First find all the initial conditions and then transform into the s-domain. Since the capacitor is not connected to a circuit, we do not know its initial condition so we can assume it is zero $\boxed{v(0) = 0}$. We can find $i_L(0)$ by letting the inductor be a short and $i_L(0) = 35/40 = 0.875$ amp.

Fig. 16.1(b)

or



Equivalent s-domain ckt: Fig. 16.1(c)



KVL: $\frac{4}{s}\cdot I + 4sI + 10I = 3.5$

or $(4 + 4s^2 + 10s)I = 3.5s$

$I = \frac{3.5s}{4(s^2+2.5s+1)}$

$\therefore V = \frac{4}{s}\cdot I = \frac{14}{4(s+\frac{1}{2})(s+2)}$

$\therefore V = \frac{3.5}{(s+\frac{1}{2})(s+2)} = \frac{A}{s+\frac{1}{2}} + \frac{B}{s+2}$

$\Rightarrow A = \frac{3.5}{1.5} = 2.333$; $B = \frac{3.5}{-1.5} = -A$

$\therefore v(t) = [-2.333e^{-t/2} + 2.333e^{-2t}]u(t)$ V

KCL after t=0:

$[(V_1-0)/(4/s)] + [(V_1-V_2)/(4s)] + (0.875/s) = 0$ and $[(V_2-V_1)/(4s)] + (-0.875/s) + [(V_2-0)/10] = 0$ where $V = V_1$. Next, add these together, $[sV_1/4] + [V_2/10] = 0$ or $V_2 = -2.5sV_1$. Now we can solve for V_1 and V_2.

Step 2. $[(s/4)+(1/(4s))+(2.5s/(4s))]V_1 = -0.875/s$
$= [(s^2+2.5s+1)/(4s)]V_1$ or $V_1 = -0.875(4)/(s^2+2.5s+1) = -3.5/[(s+0.5)(s+2)]$
$= [-2.3333/(s+0.5)]+[2.3333/(s+2)]$ or

$v(t) = [-2.333e^{-t/2}+2.333e^{-2t}]u(t)$ **volts.**

Solution 16.64

The switch in Fig. 16.87 moves from position 1 to position 2 at $t = 0$. Find $v(t)$, for all $t > 0$.

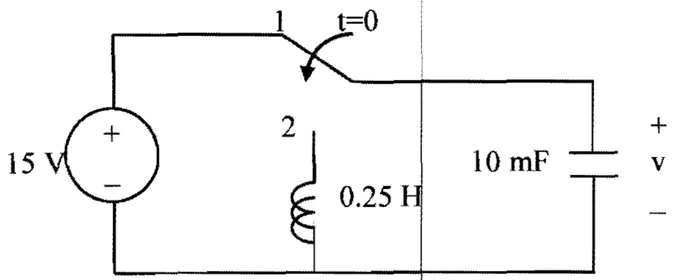
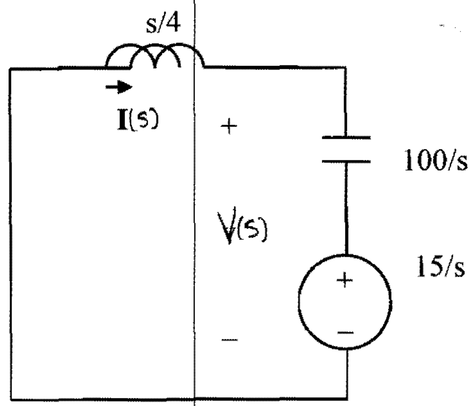


Figure 16.87
For Prob. 16.64.

Solution

When the switch is position 1, $v(0)=15$ V, and $i_L(0) = 0$. When the switch is in position 2, we have the equivalent s-domain circuit as shown below, using Fig. 16.2(b)



$$I(s) = -\frac{15/s}{\frac{s}{4}+\frac{100}{s}}\cdot\frac{4s}{4s} = \frac{-60}{s^2+400}$$

$$V(s) = -\frac{s}{4}\cdot I(s) = \frac{15s}{s^2+400}$$

$$V(s) = \frac{15s}{s^2+(20)^2}$$

using Table 15.2:

$$\underline{v(t)} = \mathcal{L}^{-1}\{V(s)\} = \underline{15\cos(20t)\,u(t)\text{ V}}$$

$I = -(15/s)/[0.25s+(100/s)] = -60/(s^2+400)$ and $V = -0.25sI$ (or $(100/s)I + 15/s$).

$I = 15s/(s^2+400)$ which leads to,

$$\underline{v(t) = [15\cos(20t)]u(t)\text{ V}}$$

Solution 16.71

For the ideal transformer circuit in Fig. 16.94, determine $i_o(t)$.

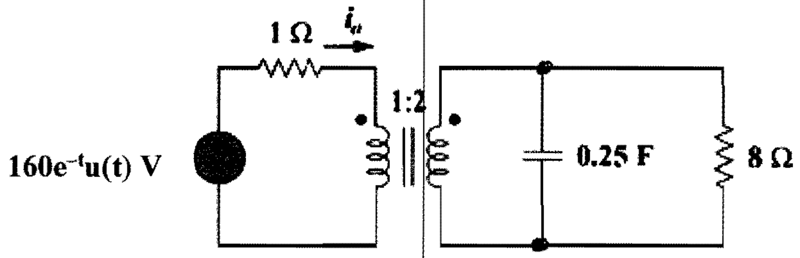
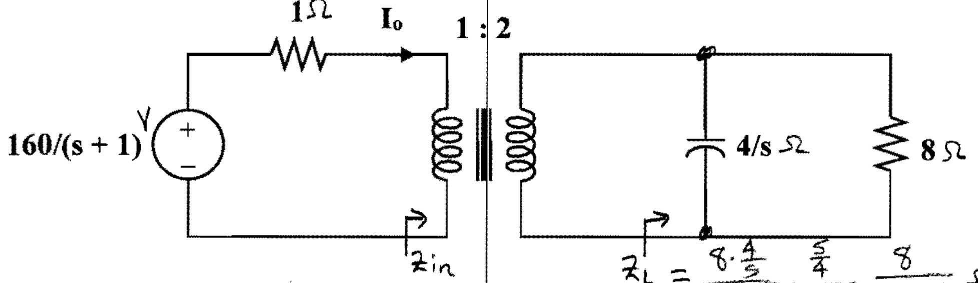


Figure 16.94
For Prob. 16.71.

Solution

Consider the following circuit. Equivalent s-domain circuit w/ zero initial conditions:



$$Z_L = \frac{8\cdot\frac{4}{s}}{8+\frac{4}{s}}\cdot\frac{\frac{s}{4}}{\frac{s}{4}} = \frac{8}{2s+1}\ \Omega$$

$$Z_L = 8 \,||\, \frac{4}{s} = \frac{(8)(4/s)}{8+4/s} = \frac{8}{2s+1}$$

When this is reflected to the primary side,

$$Z_{in} = 1 + \frac{Z_L}{n^2}, \quad n = \frac{2}{1} = 2$$

$$Z_{in} = 1 + \frac{2}{2s+1} = \frac{2s+3}{2s+1}$$

$$I_o = \frac{160}{s+1}\cdot\frac{1}{Z_{in}} = \frac{160}{s+1}\cdot\frac{2s+1}{2s+3}\cdot\frac{\frac{1}{2}}{\frac{1}{2}}$$

$$I_o = \frac{160s+80}{(s+1)(s+1.5)} = \frac{A}{s+1} + \frac{B}{s+1.5}$$

$$A = \frac{-160+80}{0.5} = \frac{-80}{0.5} = -160$$

$$B = \frac{160(-1.5)+80}{-0.5} = 320$$

A = –160 and B = 320.

$\therefore \quad I_o(s) = \frac{-160}{s+1} + \frac{320}{s+1.5}$

using Table 15.2 :

$\underline{i_o(t) = 160[2e^{-1.5t} - e^{-t}]u(t) \text{ A.}}$

Solution 16.83

(a) $H(s) = \frac{V_o}{V_s} = \frac{R}{R + sL} = \frac{R/L}{s + R/L}$

$\mathbf{h(t) = \frac{R}{L} e^{-Rt/L}\ u(t)}$

(b) $v_s(t) = u(t) \longrightarrow V_s(s) = 1/s$

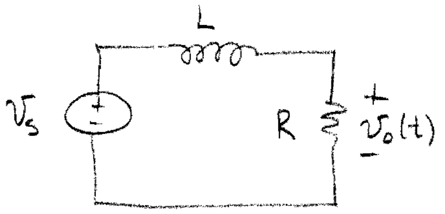
$V_o = \frac{R/L}{s + R/L} V_s = \frac{R/L}{s(s + R/L)} = \frac{A}{s} + \frac{B}{s + R/L}$

$A = 1, \qquad B = -1$

$V_o = \frac{1}{s} - \frac{1}{s + R/L}$

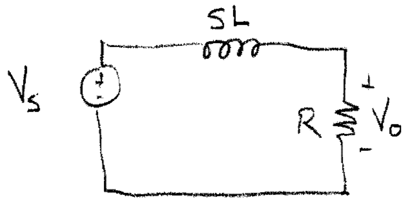
$v_o(t) = u(t) - e^{-Rt/L}\, u(t) = \mathbf{(1 - e^{-Rt/L})\, u(t)}$

(a)



$\Downarrow$

Equivalent s domain ckt



By voltage division:

$V_o = \frac{R}{R+sL} \cdot V_s$

$\therefore H(s) \equiv \frac{V_o}{V_s} = \frac{R}{R+sL} \cdot \frac{\frac{1}{L}}{\frac{1}{L}}$

or in standard form

$H(s) = \frac{R/L}{s + R/L}$

$\underline{\underline{h(t)}} = \mathcal{L}^{-1}\{H(s)\} = \underline{\frac{R}{L} e^{-\frac{R}{L}t} u(t)}$

(b) Since $V_o(s) = H(s)\, V(s)$, we first determine $V(s)$

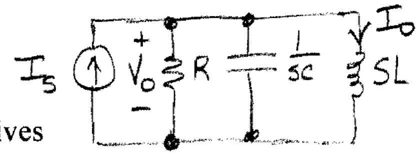
With $v_s(t) = u(t) \overset{\mathcal{L}}{\Rightarrow} V_s = \frac{1}{s}$

$\therefore V_o(s) = \frac{R/L}{s + R/L} \cdot \frac{1}{s} \underset{\substack{\uparrow \\ \text{PFE}}}{=} \frac{A}{s} + \frac{B}{s + R/L} \qquad A = \frac{R/L}{R/L} = 1\ ;\ B = \frac{R/L}{-R/L} = -1$

$\therefore V_o(s) = \frac{1}{s} - \frac{1}{s + R/L}$

$\underline{\underline{v_o(t)}} = \mathcal{L}^{-1}\{V_o(s)\} = u(t) - e^{-\frac{R}{L}t} u(t) = \underline{\left(1 - e^{-\frac{R}{L}t}\right) u(t)\ \text{V}}$

Equivalent s-domain ckt w/ zero initial conditions:



Solution 16.96

If V_o is the voltage across R, applying KCL at the non-reference node gives

$$I_s = \frac{V_o}{R} + sC\,V_o + \frac{V_o}{sL} = \left(\frac{1}{R} + sC + \frac{1}{sL}\right)V_o$$

$$V_o = \frac{I_s}{\frac{1}{R} + sC + \frac{1}{sL}} = \frac{sRL\,I_s}{sL + R + s^2RLC}$$

$$I_o = \frac{V_o}{sL\cancel{R}} = \frac{R\,\cancel{sL}\,I_s}{s^2RLC + sL + R}$$

$$H(s) = \frac{I_o}{I_s} = \frac{\cancel{sC}R}{s^2RLC + sL + R} = \frac{s/\cancel{R}^{L}C}{s^2 + s/RC + 1/LC}$$

The roots

$$s_{1,2} = \frac{-1}{2RC} \pm \sqrt{\frac{1}{(2RC)^2} - \frac{1}{LC}}$$

both lie in the left half plane since R, L, and C are positive quantities.

Thus, **the circuit is stable.**

$$I_o = \frac{V_o}{SL} = \frac{RI_s}{SL + R + S^2RLC}$$

$$H(s) = \frac{I_o}{I_s} = \frac{R}{S^2RLC + SL + R} \cdot \frac{\frac{1}{RLC}}{\frac{1}{RLC}}$$

$$H(s) = \frac{1/LC}{s^2 + s/RC + 1/LC}$$

Roots $$S_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$S_{1,2} = \frac{-\frac{1}{RC} \pm \sqrt{\left(\frac{1}{RC}\right)^2 - 4/LC}}{2}$$

$$= -\frac{1}{2RC} \pm \sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}$$

- $S_1 = -\frac{1}{2RC} + \underbrace{\sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}}$
  - ✓ if this is real then $< \frac{1}{2RC}$ $\Rightarrow S_1 < 0$.
  - ✓ if this is imag then $Re\{S_1\} = -\frac{1}{2RC} < 0$
- $S_2 = -\frac{1}{2RC} - \underbrace{\sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}}$
  - ✓ If this is real then $S_2 < 0$
  - ✓ If this is imag, then $Re\{S_2\} = -\frac{1}{2RC} < 0$

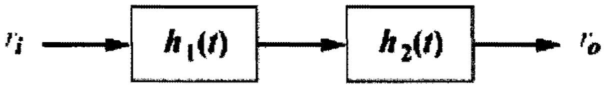
∴ both roots in the LHP. ⇒ stable.

Solution 16.97

A system is formed by cascading two systems as shown in Fig. 16.106. Given that the impulse responses of the systems are,

$h_1(t) = 21e^{-t}\, u(t), \qquad h_2(t) = e^{-4t}\, u(t)$

(a) Obtain the impulse response of the overall system.
(b) Check if the overall system is stable.



in the s domain

Figure 16.106
For Prob. 16.97.

$V_i(s) \to \boxed{H_1(s)} \to \boxed{H_2(s)} \to V_o(s)$

Solution

(a) $H_1(s) = \dfrac{21}{s+1}, \qquad H_2(s) = \dfrac{1}{s+4}$

$H(s) = H_1(s)H_2(s) = \dfrac{21}{(s+1)(s+4)}$ = [A/(s+1)] + [B/(s+4)] where

$A = \frac{21}{3} = 7$
$B = \frac{21}{-3} = -7$

A = 21/3 = 7 and B = 21/(–3) therefore, $H(s) = \frac{7}{s+1} - \frac{7}{s+4}$

$h(t) = \mathcal{L}^{-1}\{H(s)\} \Rightarrow$ **$h(t) = 7[e^{-t} - e^{-4t}]u(t)$.**

(b) Since the poles of H(s) all lie in the left half s-plane, **the system is stable**.

$s_1 = -1$
$s_2 = -4$