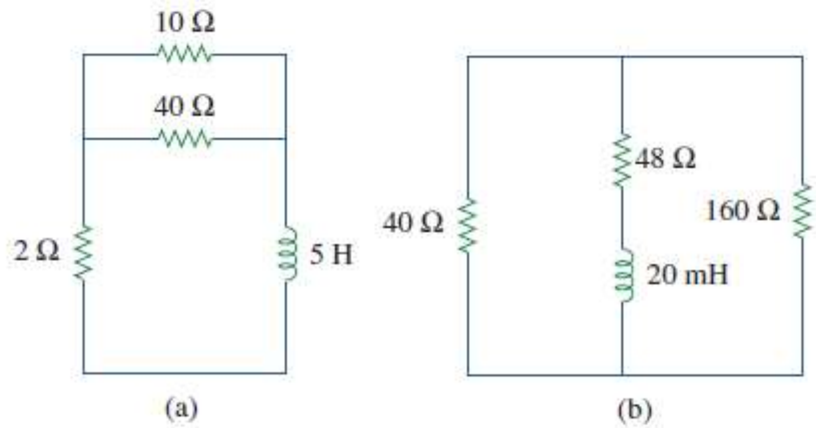
Electric Circuits II – Tutorial 02 - Source Free RL circuit, Singularity functions

#	Student ID	Student Name	Grade (10)
-			

<table>
<tr><td>Q1</td><td>

7.15 Find the time constant for each of the circuits in Fig. 7.95.



</td></tr>
<tr><td>Sol 1</td><td>

(a) $R_{Th} = 2 + 10//40 = 10\Omega,\quad \tau = \frac{L}{R_{Th}} = 5/10 = \underline{0.5s}$

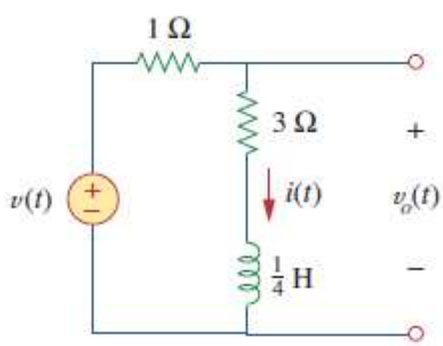
(b) $R_{Th} = 40//160 + 48 = 40\Omega,\quad \tau = \frac{L}{R_{Th}} = (20x10^{-3})/80 = \underline{0.25\,ms}$

(a) **10 Ω, 500 ms** (b) **40 Ω, 250 μs**

</td></tr>
</table>

<table>
<tr><td>Q2</td><td>

Consider the circuit of Fig. 7.97. Find $v_o(t)$ if $i(0) = 6$ A and $v(t) = 0$.



</td></tr>
</table>

Sol 2

$$i(t) = i(0)e^{-t/\tau}, \qquad \tau = \frac{L}{R_{eq}} = \frac{1/4}{4} = \frac{1}{16}$$

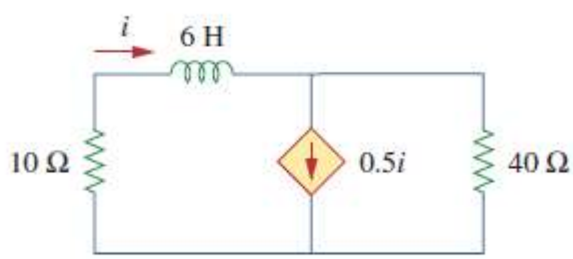
$$i(t) = 6e^{-16t}$$

$$v_o(t) = 3i + L\frac{di}{dt} = 18e^{-16t} + (1/4)(-16)6e^{-16t}$$

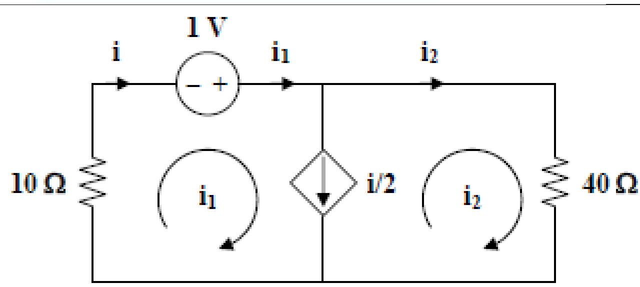
$$\mathbf{v_o(t) = -6e^{-16t}u(t)\ V}$$

Q3

In the circuit of Fig. 7.99, find $i(t)$ for $t > 0$ if $i(0) = 6$ A.



Sol 3



To find R_{th} we replace the inductor by a 1-V voltage source as shown above.

$$10i_1 - 1 + 40i_2 = 0$$

But $\quad i = i_2 + i/2 \quad$ and $\quad i = i_1$

i.e. $\quad i_1 = 2i_2 = i$

$$10i - 1 + 20i = 0 \longrightarrow i = \frac{1}{30}$$

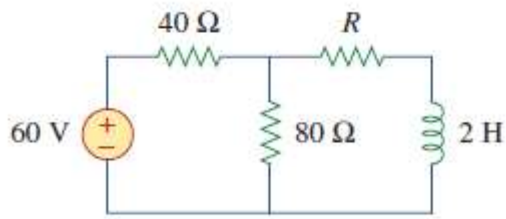
$$R_{th} = \frac{1}{i} = 30\,\Omega$$

$$\tau = \frac{L}{R_{th}} = \frac{6}{30} = 0.2\text{ s}$$

$$i(t) = 6e^{-5t}u(t)\ A$$

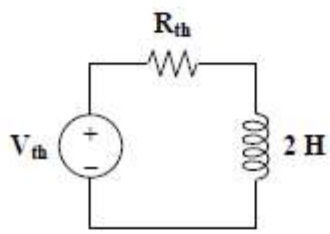
Q4

In the circuit of Fig. 7.101, find the value of R for which the steady-state energy stored in the inductor will be 1 J.



Sol 4

The circuit can be replaced by its Thevenin equivalent shown below.



$$V_{th} = \frac{80}{80+40}(60) = 40\text{ V}$$

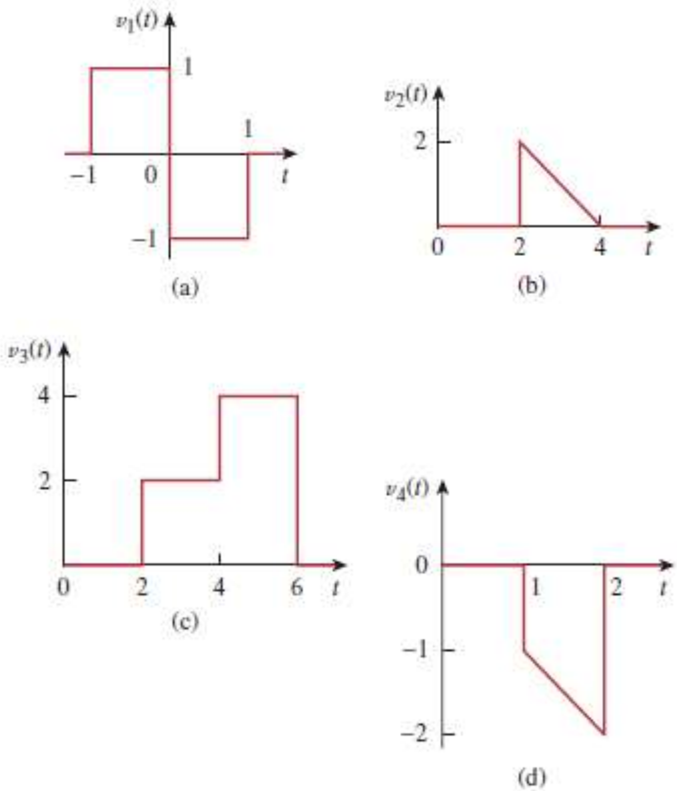
$$R_{th} = 40 \,||\, 80 + R = \frac{80}{3} + R$$

$$I = i(0) = i(\infty) = \frac{V_{th}}{R_{th}} = \frac{40}{80/3 + R}$$

$$w = \frac{1}{2}LI^2 = \frac{1}{2}(2)\left(\frac{40}{R + 80/3}\right)^2 = 1$$

$$\frac{40}{R + 80/3} = 1 \longrightarrow R = \frac{40}{3}$$

$$R = 13.333\ \Omega$$

Q5	**7.26** Express the signals in Fig. 7.104 in terms of singularity functions. 
Sol 5	(a) $v_1(t) = u(t+1) - u(t) + [u(t-1) - u(t)]$ $v_1(t) = \mathbf{u(t+1) - 2u(t) + u(t-1)}$ (b) $v_2(t) = (4-t)[u(t-2) - u(t-4)]$ $v_2(t) = -(t-4)u(t-2) + (t-4)u(t-4)$ $v_2(t) = \mathbf{2u(t-2) - r(t-2) + r(t-4)}$ (c) $v_3(t) = 2[u(t-2) - u(t-4)] + 4[u(t-4) - u(t-6)]$ $v_3(t) = \mathbf{2u(t-2) + 2u(t-4) - 4u(t-6)}$ (d) $v_4(t) = -t[u(t-1) - u(t-2)] = -t\,u(t-1) + t\,u(t-2)$ $v_4(t) = (-t+1-1)u(t-1) + (t-2+2)u(t-2)$ $v_4(t) = \mathbf{-r(t-1) - u(t-1) + r(t-2) + 2u(t-2)}$