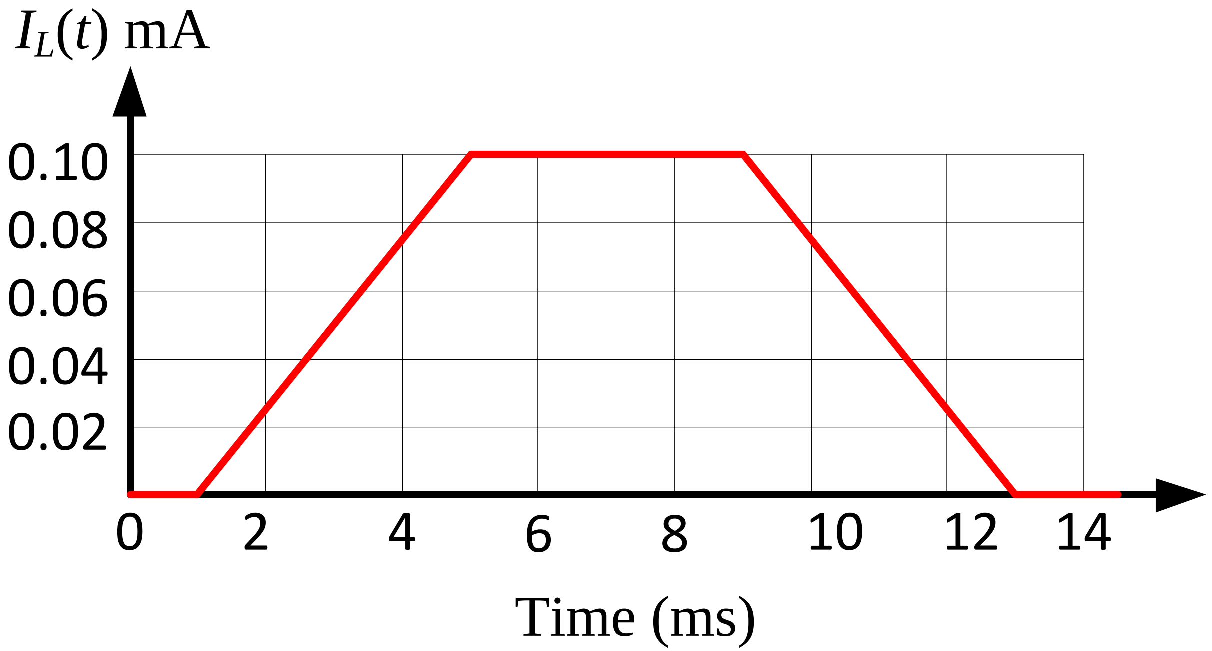
1.

For ideal inductor calculate the voltage across the inductor (L = 1000 mH) from knowledge of its current.

$$i_L(t)=\begin{cases} 0\ \text{mA} & t<1\ \text{ms} \\ -\dfrac{0.1}{4}+\dfrac{0.1}{4}t\quad \text{mA} & 1\le t\le 5\ \text{ms} \\ 0.1\ \text{mA} & 5\le t\le 9\ \text{ms} \\ 13\times\dfrac{0.1}{4}-\dfrac{0.1}{4}t\quad \text{mA} & 9\le t\le 13\ \text{ms} \\ 0\ \text{mA} & t>13\ \text{ms} \end{cases}$$



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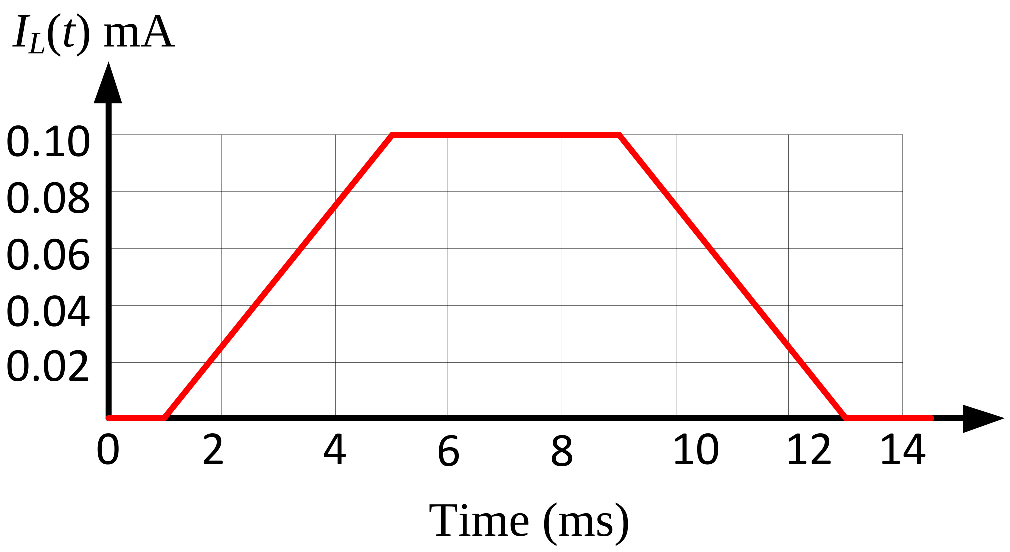
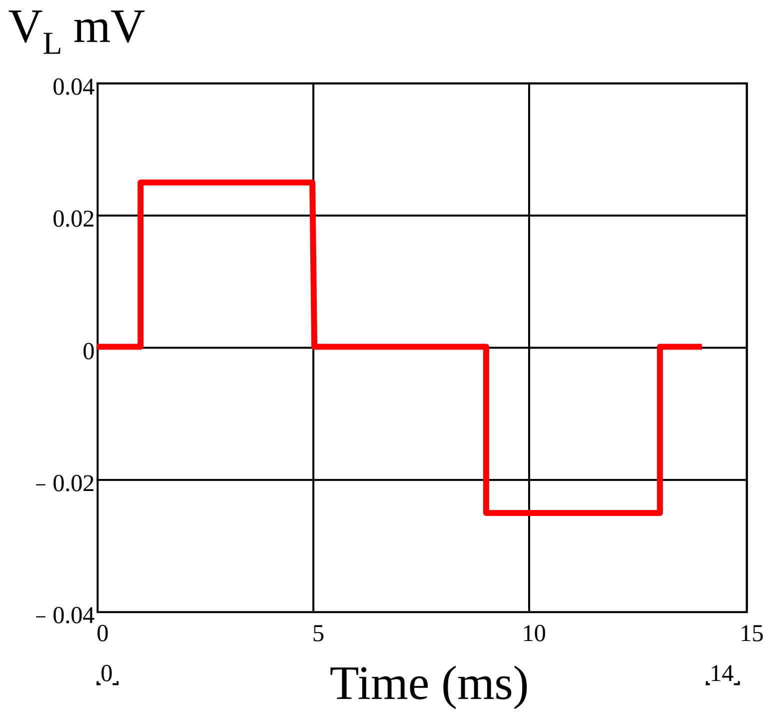


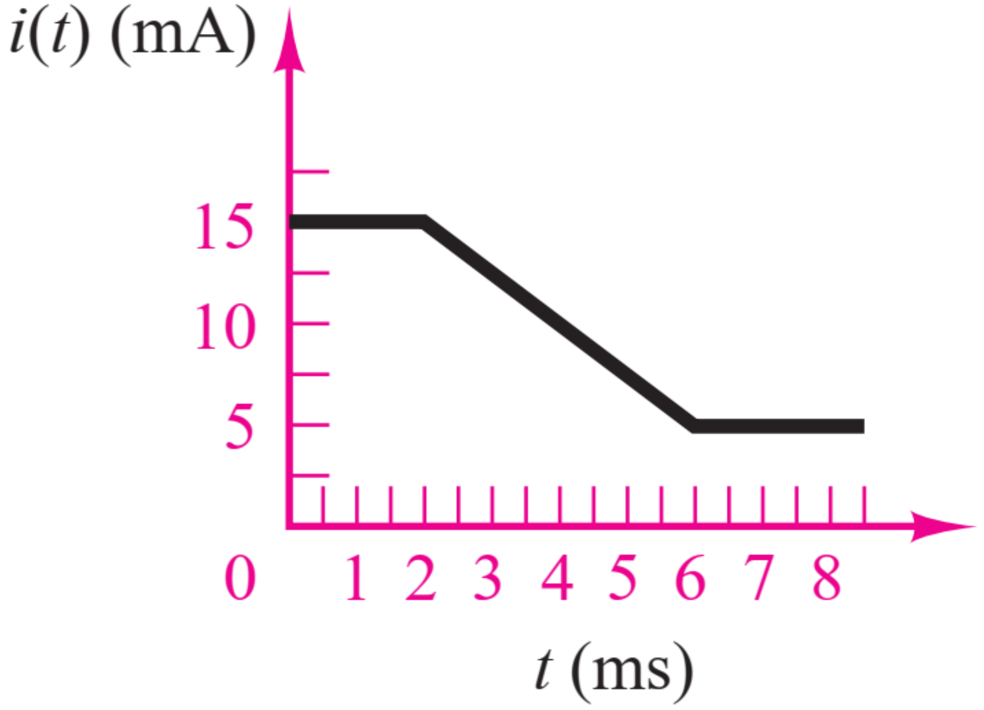
$$v_L(t)=L\frac{di_L}{dt}$$



Answer: $$V_L(t)=\begin{cases} 0 \text{ if } t\le 1 \text{ ms} \\ 0.025 \text{ if } 1<t\le 5 \text{ ms} \\ 0 \text{ if } 5<t\le 9 \text{ ms} \\ -0.025 \text{ if } 9<t\le 13 \text{ ms} \\ 0 \text{ otherwise} \end{cases}$$

2.

Calculate and plot the inductor energy and power for a 50-mH inductor subject to the current waveform shown below. What is the energy stored at t = 3 ms? Assume $i(-\infty) = 0$.



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Calculate and plot the inductor energy and power for a 50-mH inductor subject to the current waveform shown below. What is the energy stored at t = 3 ms? Assume $i(-\infty) = 0$.

$$I(t) := \begin{cases} 15 & \text{if } 0 \le t < 2 \\ \dfrac{-10}{4} \cdot t + 20 & \text{if } 2 \le t < 6 \\ 5 & \text{if } 6 \le t \end{cases}$$

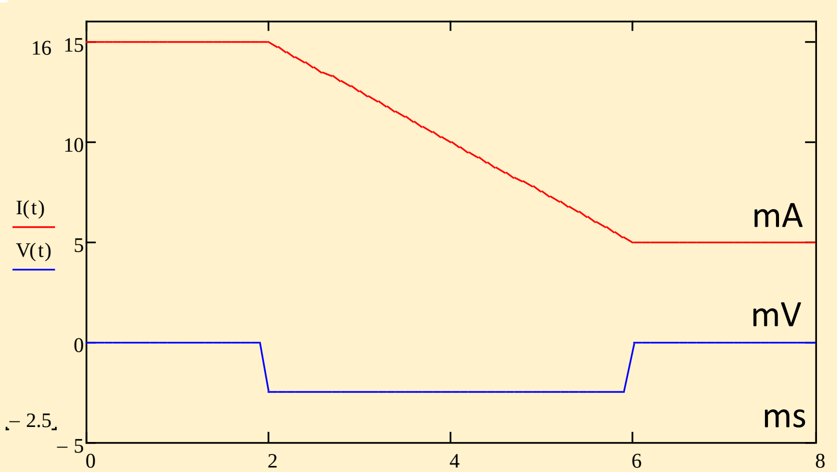
$$V(t) := \begin{cases} 0 & \text{if } 0 \le t < 2 \\ \dfrac{-10}{4} & \text{if } 2 \le t < 6 \\ 0 & \text{if } 6 \le t \end{cases}$$

W(t) = (1/2)·L ·I(t)²

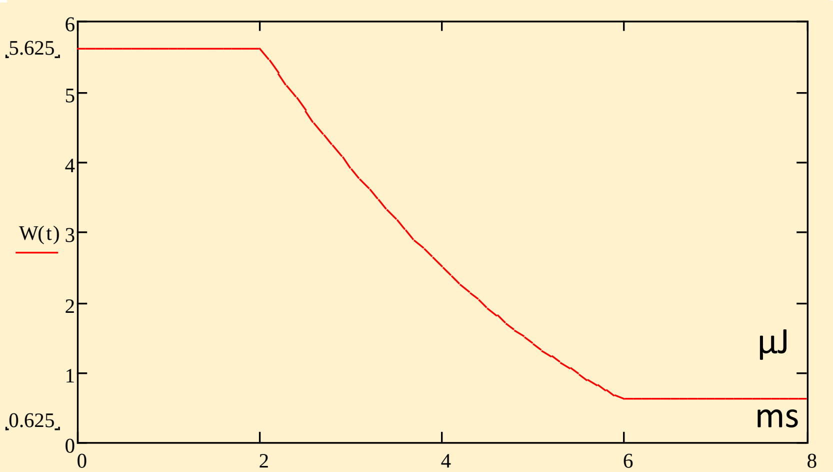
W(3 ms) = 3.91 μJ

P(t) = I(t) ·V(t)

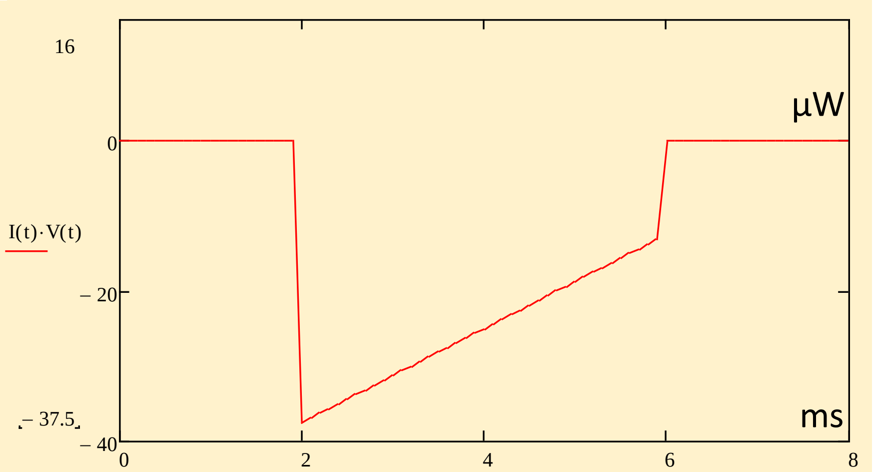
$$V(t) = L \cdot \left(\frac{d}{dt} I(t)\right)$$



$$W(t) = \frac{1}{2} \cdot 50 \cdot 10^{-3} \cdot I(t)^2$$



$$P(t) = I(t) \cdot V(t)$$



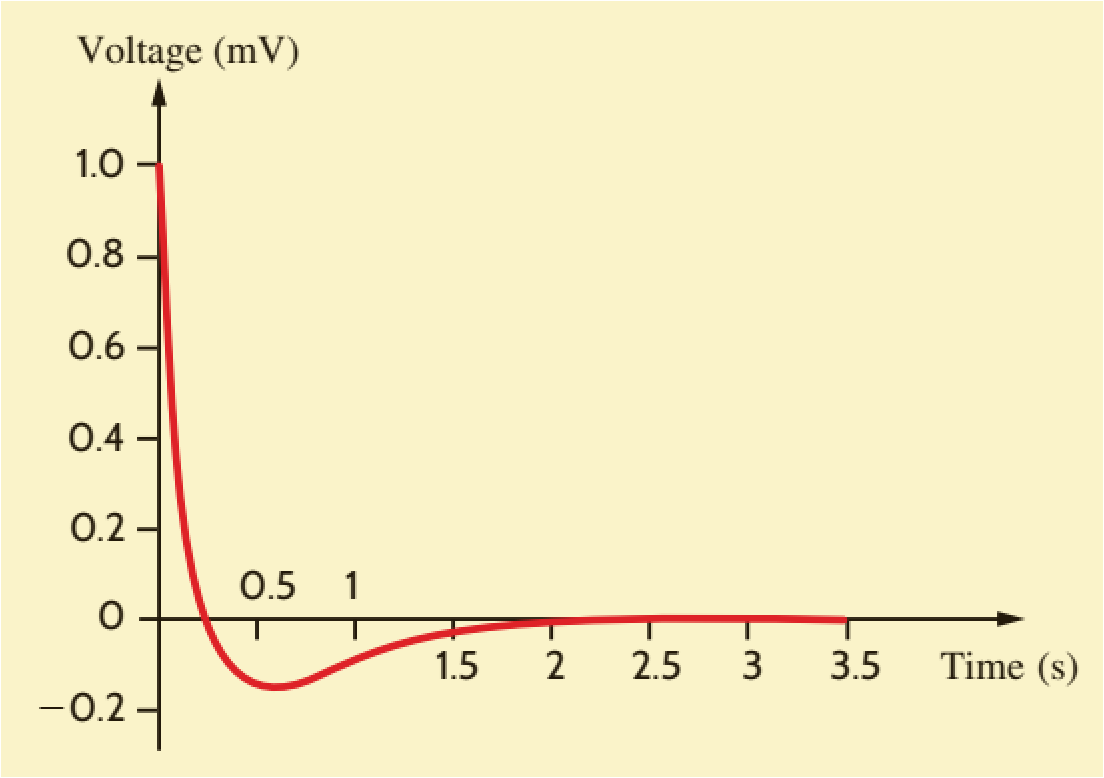
3.

The voltage across a 200-mH inductor is given by the expression

$$\upsilon(t) = (1 - 3t)e^{-3t}\,\text{mV} \qquad t \geq 0$$

$$\upsilon(t) = 0\ \text{mV} \qquad t < 0$$

Find the waveforms for the current, energy, and power



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Current (mA):

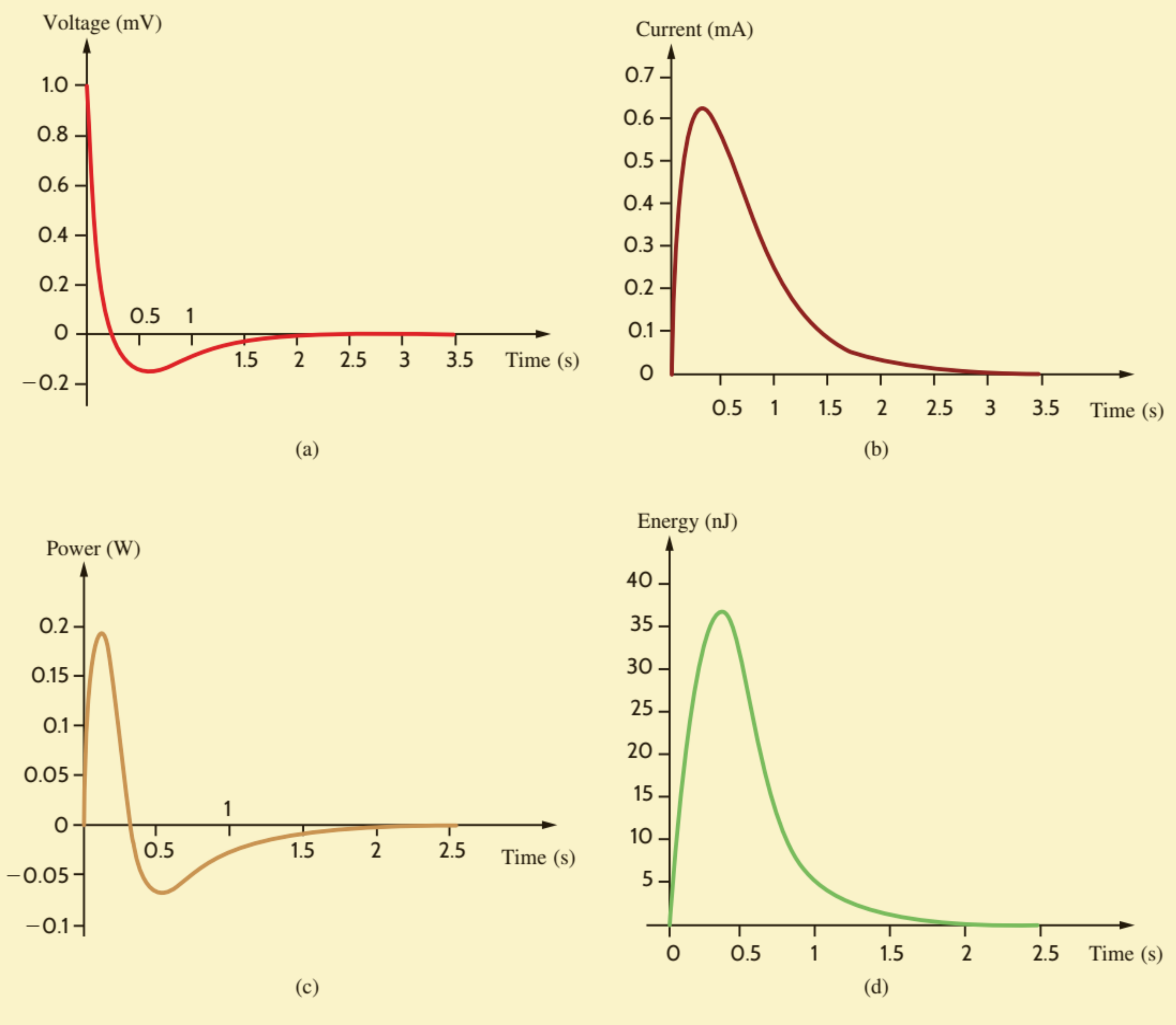
$$i(t) = \frac{1}{L}\cdot\int_0^t v(x)\,dx = \frac{10^3}{200}\cdot\int_0^t (1 - 3\cdot x)\cdot e^{-3\cdot x}\,dx = 5\cdot t\cdot e^{-3\cdot t}$$

Power (μW):

$$P(t) = i(t)\cdot v(t) = 5\cdot t\cdot(1 - 3\cdot t)\cdot e^{-6\cdot t}$$

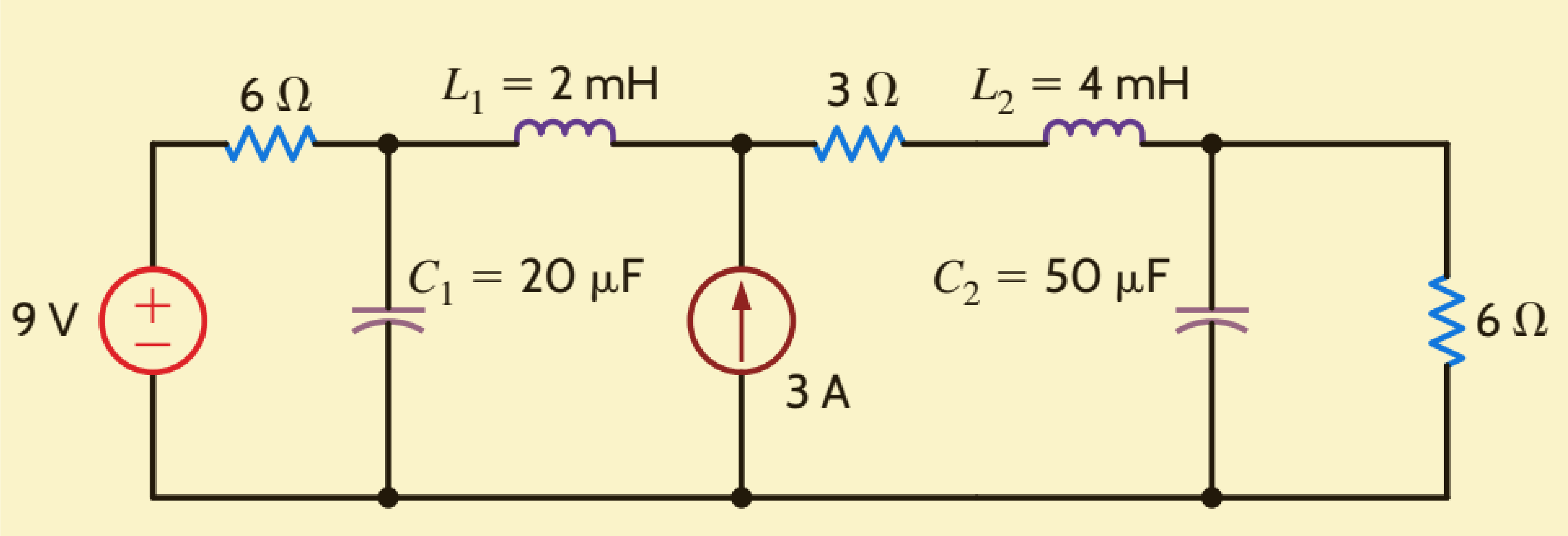
Energy (μJ):

$$W(t) = \frac{1}{2}\cdot L\cdot i(t)^2 = 2.5\cdot t^2\cdot e^{-6t}$$



4.

Find the total energy stored in the circuit



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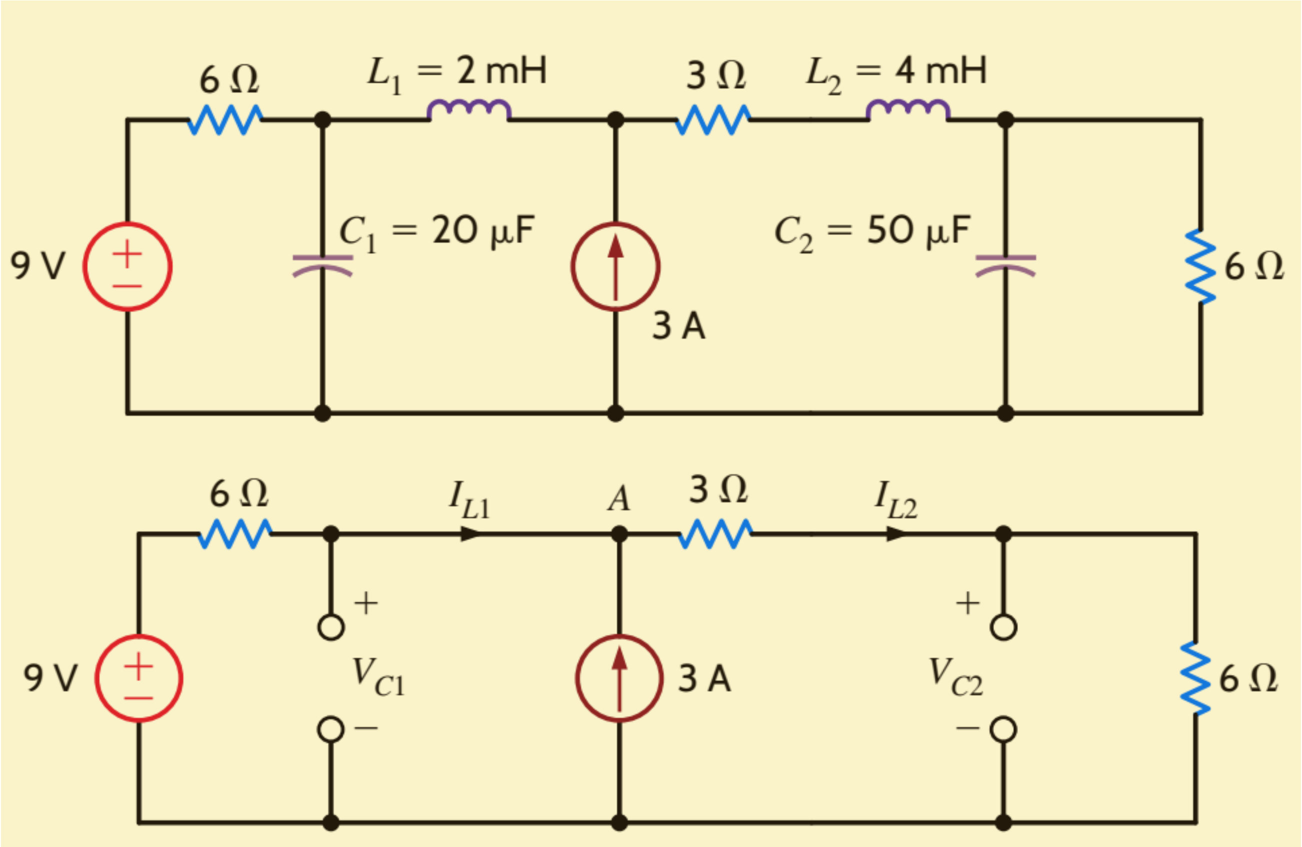


Currents:

$$\begin{cases} I_{L2} = I_{L1} + 3 \\ 6\, I_{L1} + 3\, I_{L2} + 6\, I_{L2} = 9 \end{cases}$$

Solution: $I_{L1} = -1.2\ A, \quad I_{L2} = 1.8\ A$

Voltages:

$$V_{C1} = -6I_{L1} + 9 = 16.2\ V$$

$$V_{C2} = 6I_{L1} = 10.8\ V$$

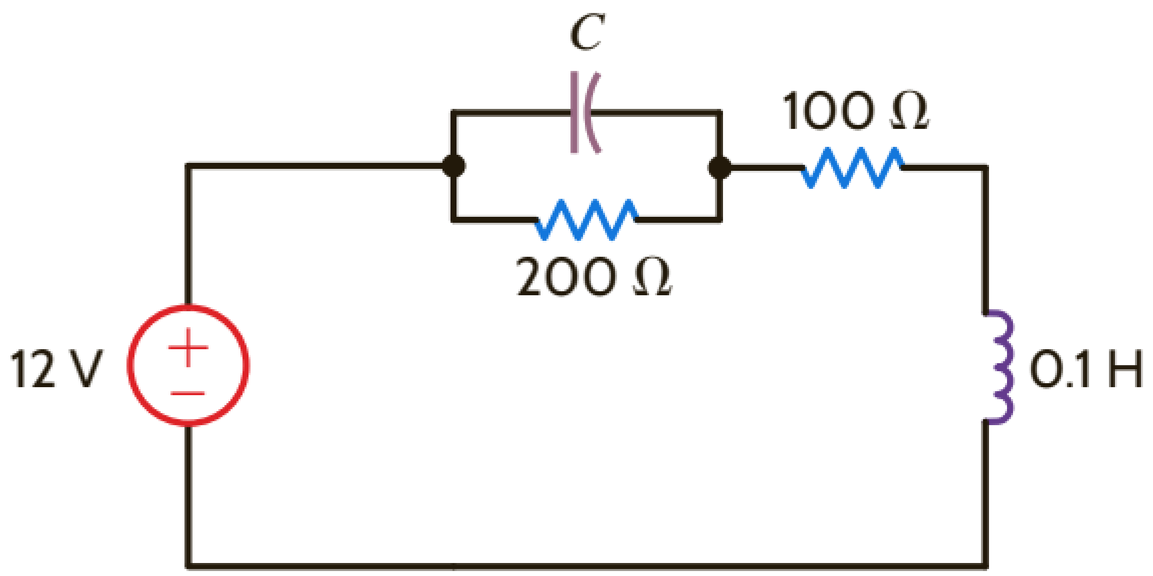
Energies:

$W_c = \frac{1}{2}CV^2$	$W_L = \frac{1}{2}LI^2$
$W_{c1} = 2.62\ mJ$	$W_{L1} = 1.44\ mJ$
$W_{c2} = 2.92\ mJ$	$W_{L2} = 6.48\ mJ$

The total stored energy is 13.46 mJ

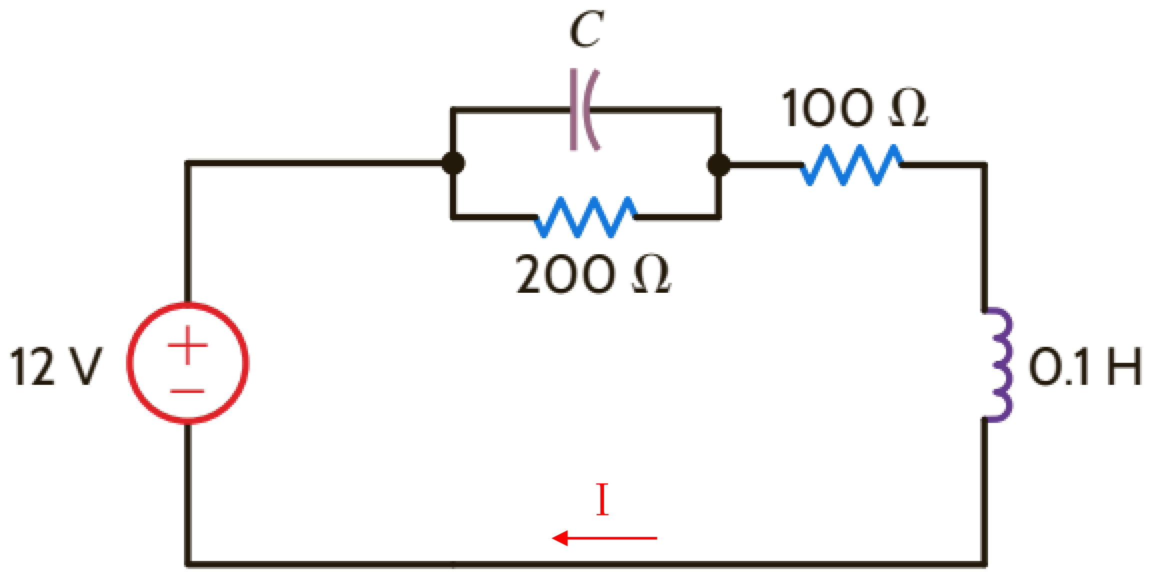
5.

Find the value of C if the energy stored in the capacitor equals the energy stored in the inductor.



5.

Find the value of C if the energy stored in the capacitor equals the energy stored in the inductor.



$I = \dfrac{12}{200 + 100} = 0.04$ /current in resistors and inductor

$W_L = \dfrac{1}{2} \cdot 0.1 \cdot I^2 = 8 \times 10^{-5}$ / energy in inductor

$V_C = I \cdot 200 = 8$ / voltage on capacitor

$W_C = \dfrac{1}{2} \cdot C \cdot \left(V_C\right)^2$ / energy in capacitor

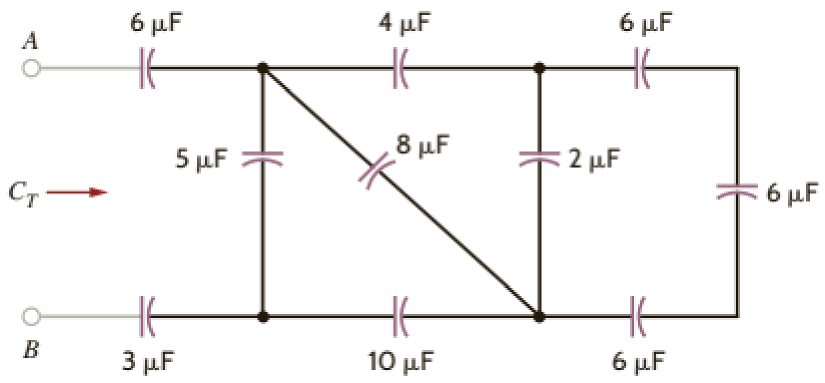
$W_L = W_C$

$C = \dfrac{2 \cdot W_L}{\left(V_C\right)^2} = 2.5 \times 10^{-6}$

Answer: 2.5 µF

6.

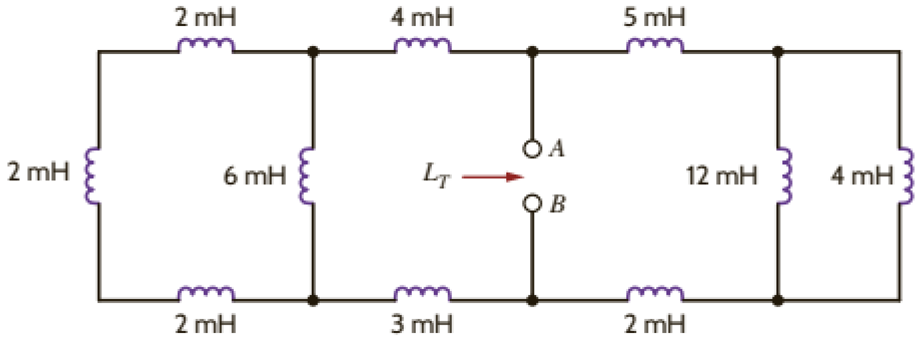
Compute the equivalent capacitance of the network



Answer: 5/3 μF

7.

Compute the equivalent inductance of the network



Answer: 5 mH