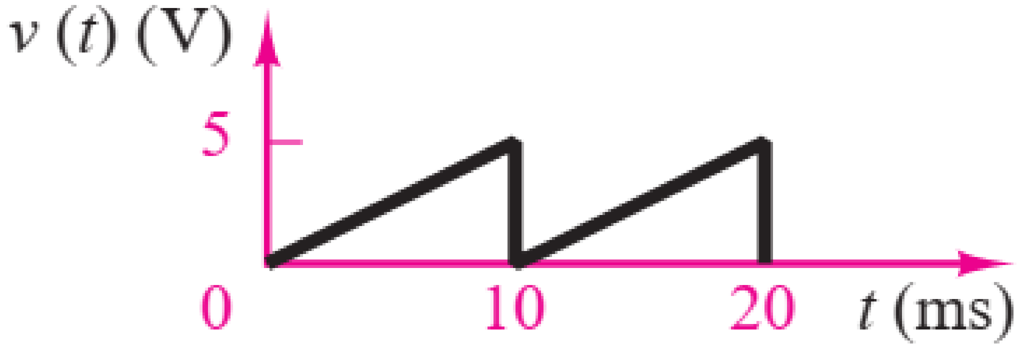
1.

$$x_{\text{rms}} = \sqrt{\frac{1}{T}\int_0^T x^2(t')\,dt'}$$ Root-mean-square value

Find the rms value of the waves shown in the figure:



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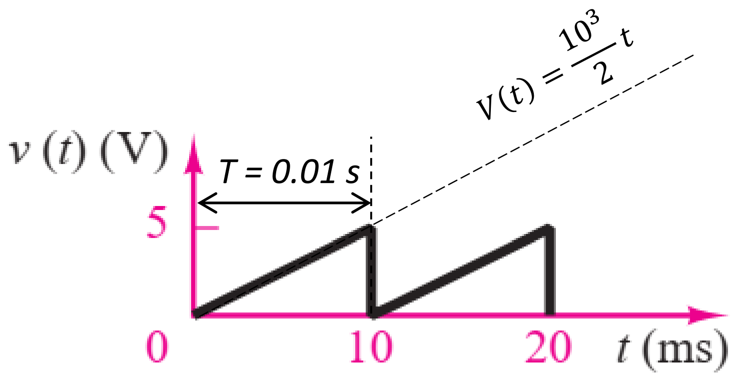
$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t')\,dt'}$$ Root-mean-square value

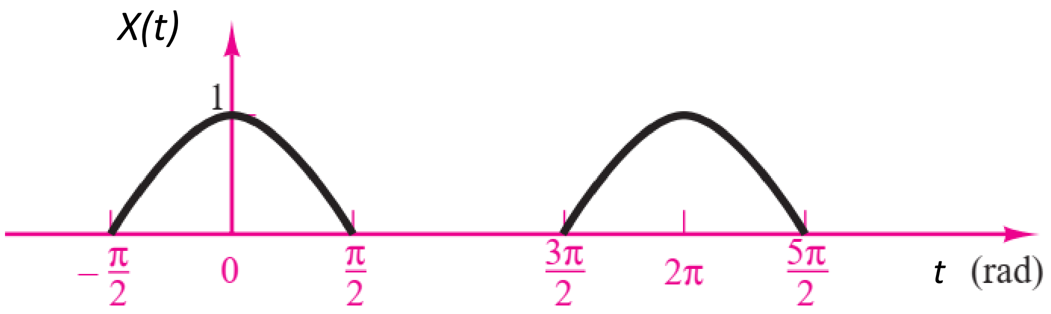


Answer: $$\left[\frac{1}{0.01}\cdot\int_0^{0.01}\left(\frac{10^3}{2}\cdot t\right)^2 dt\right]^{\frac{1}{2}} = 2.887\ V$$

1.

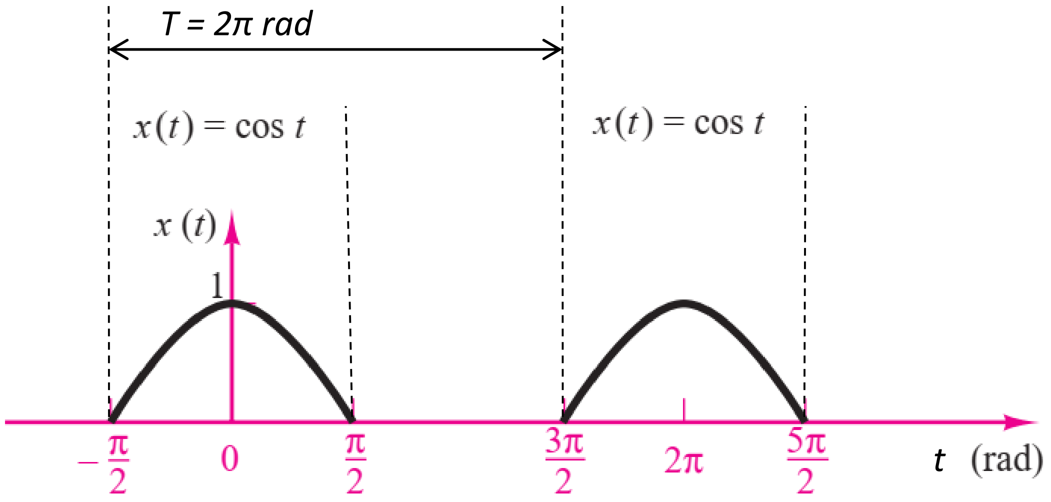
$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t')\,dt'} \qquad \text{Root-mean-square value}$$

Find the rms value of the waves shown in the figure:



1.

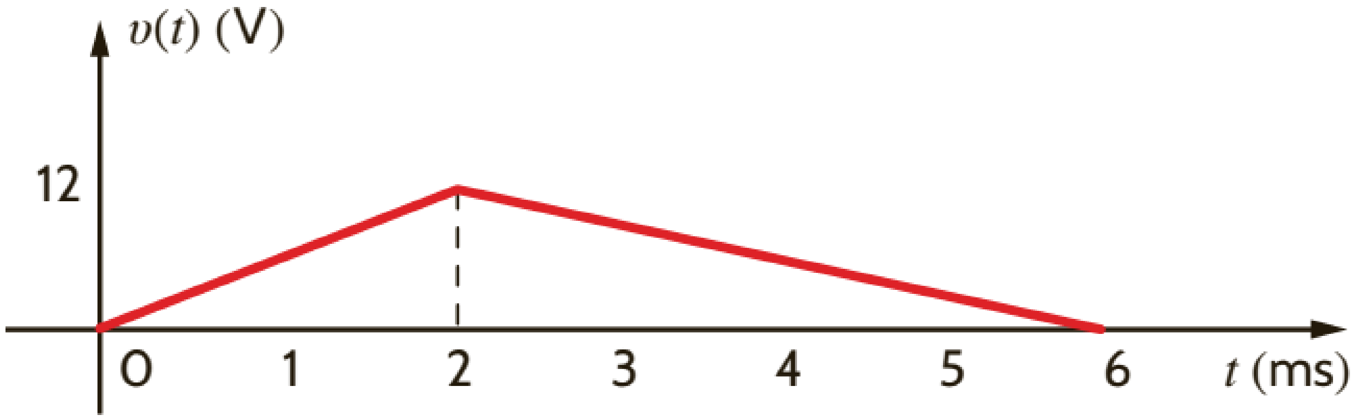
$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t')\,dt'}$$ Root-mean-square value



Answer: $$\left(\frac{1}{2\cdot\pi}\cdot\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}}\cos(t)^2\,dt\right)^{\frac{1}{2}} = 0.5 \quad V$$

2.

The voltage across a 2-μF capacitor is shown in plot below. Determine the waveform for the capacitor current and compute the energy stored in the electric field of the capacitor at t = 2 ms.



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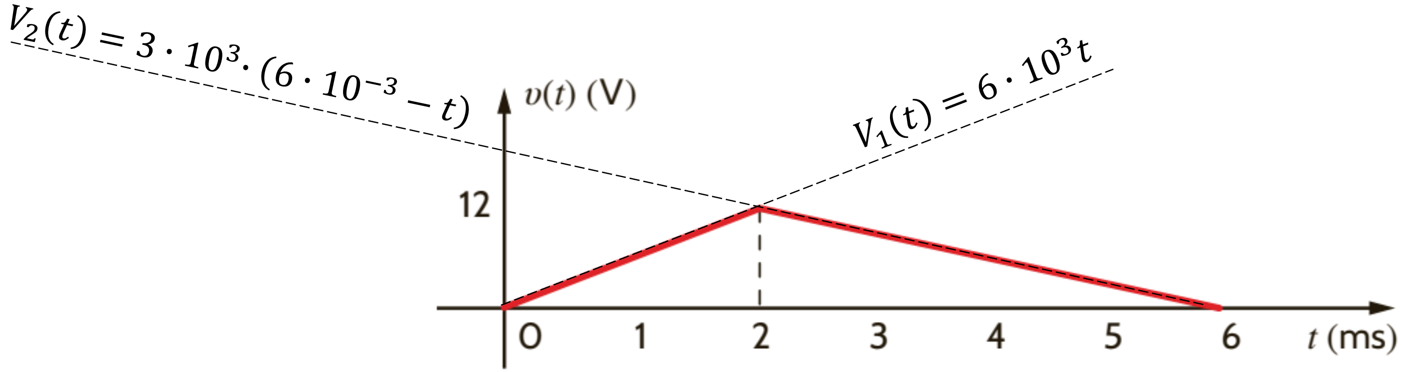
The voltage across a 2-μF capacitor is shown in plot below. Determine the waveform for the capacitor current and compute the energy stored in the electric field of the capacitor at t = 2 ms.

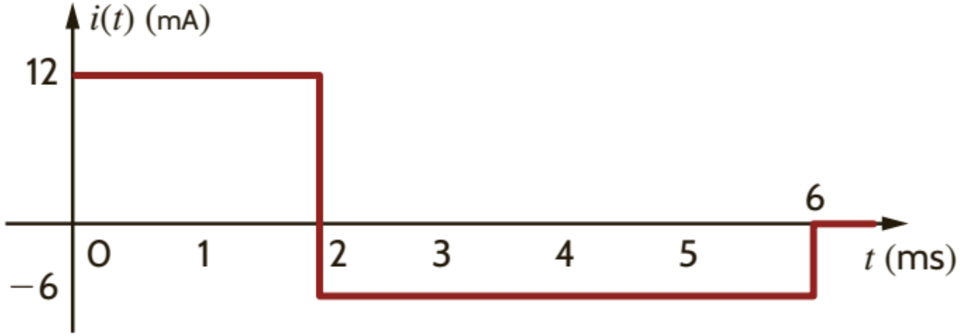


$$i(t) = C\frac{dV}{dt}$$

$$\begin{cases} i_1(t) = 2 \cdot 10^{-6} \cdot 6 \cdot 10^3 \text{ A} \\ i_2(t) = -2 \cdot 10^{-6} \cdot 3 \cdot 10^3 \text{ A} \end{cases}$$

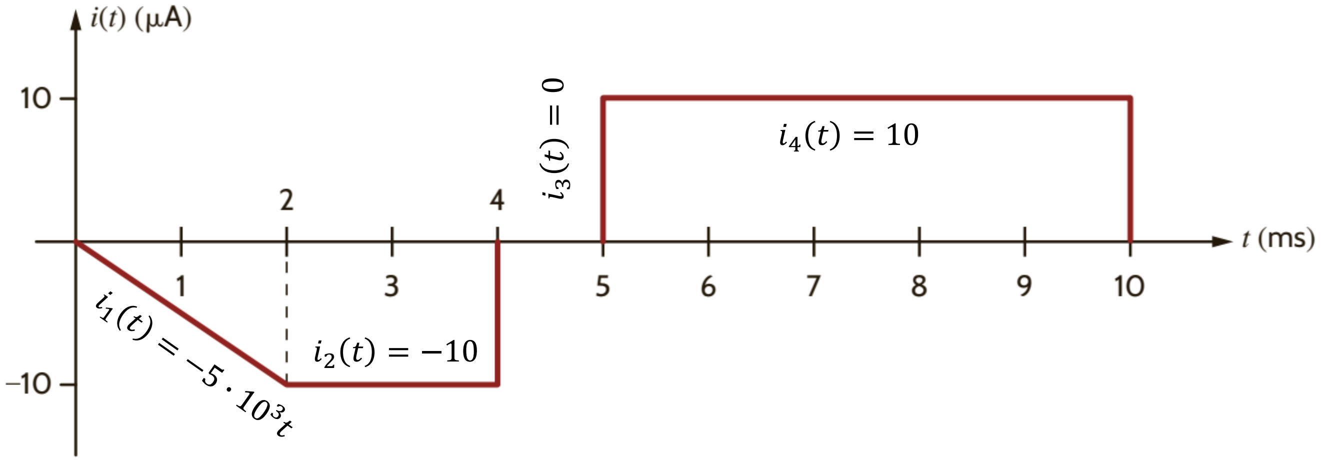
$$W(T) = \int_0^T I \cdot V dt = \int_0^T C \cdot \left(\frac{d}{dt}V\right) \cdot V dt = \int_0^T C \cdot V dV = \frac{C \cdot \left(V(T)^2 - V(0)^2\right)}{2} = \frac{C \cdot V(T)^2}{2} \longrightarrow W(T = 2\,ms) = \frac{2 \cdot 10^{-6} \cdot 12^2}{2}$$

Answer:

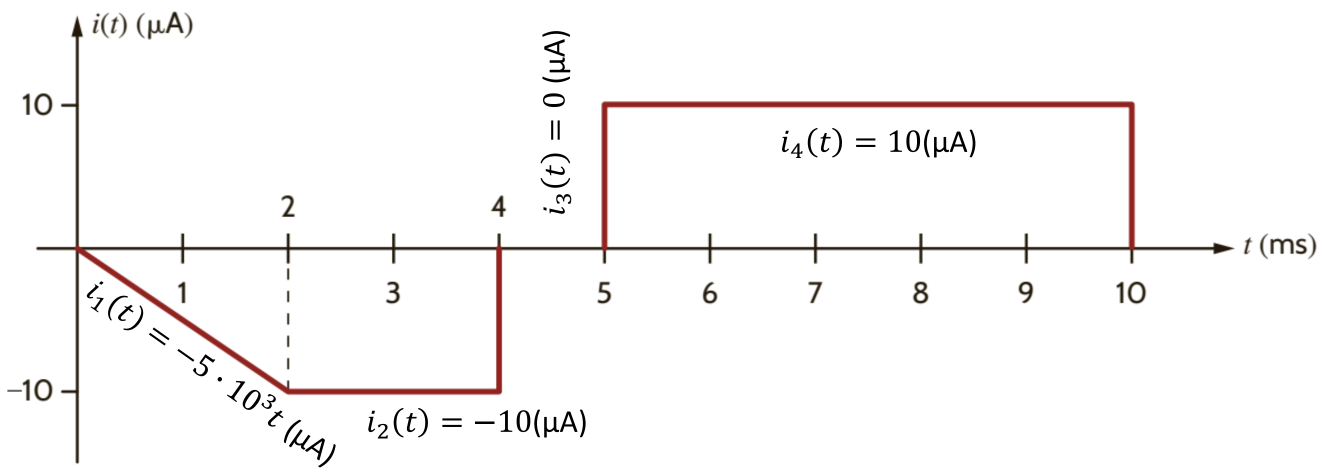


; $W(T = 2\,ms) = 144\ \mu J$

3. The waveform for the current in a 1-nF capacitor is presented below. If the capacitor has an initial voltage of -5 V, determine the waveform for the capacitor voltage. How much energy is stored in the capacitor at t = 6 ms?



3. The waveform for the current in a 1-nF capacitor is presented below. If the capacitor has an initial voltage of -5 V, determine the waveform for the capacitor voltage. How much energy is stored in the capacitor at t = 6 ms?



$$i(t) = C\frac{dV}{dt}$$

$$V(t) = \frac{1}{C}\int_{t_i}^{t} i(t')dt' + V_0$$

$$\begin{cases} V_1(t) = \dfrac{1}{1\cdot 10^{-9}}\displaystyle\int_0^t i_1(t')dt' - 5 = -2.5\cdot 10^6 \cdot t^2 - 5 \\ V_2(t) = \dfrac{-10^{-5}}{1\cdot 10^{-9}}\displaystyle\int_{2\cdot 10^{-3}}^{t} dt' - 15 = 5 - 10^4 t \\ V_3(t) = V_2(t = 4\ ms) = -35\ V \\ V_4(t) = \dfrac{-10^{-5}}{1\cdot 10^{-9}}\displaystyle\int_{5\cdot 10^{-3}}^{t} dt' - 35 = 10^4 t - 85 \end{cases}$$

$$V_1(t = 2\ ms) = -15\ V$$

$$V_2(t = 4\ ms) = -35\ V$$

$$V_4(t = 10\ ms) = 15\ V$$

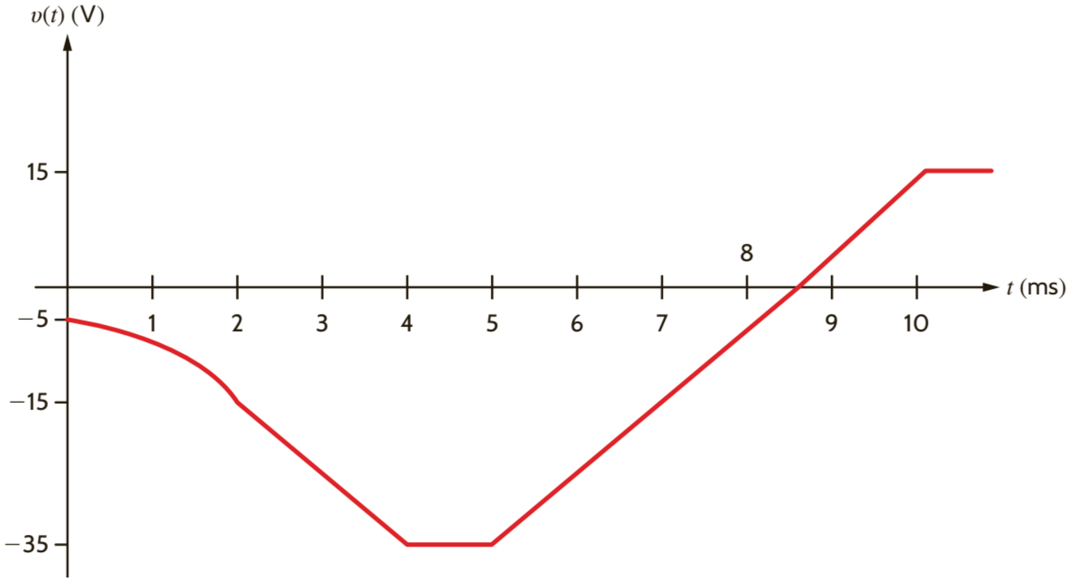
3. The waveform for the current in a 1-nF capacitor is presented below. If the capacitor has an initial voltage of -5 V, determine the waveform for the capacitor voltage. How much energy is stored in the capacitor at *t* = 6 ms?

$$V_1(t) = \frac{1}{1\cdot 10^{-9}}\int_0^t i_1(t')dt' - 5 = -2.5\cdot 10^6\cdot t^2 - 5$$

$$V_2(t) = \frac{-10^{-5}}{1\cdot 10^{-9}}\int_{2\cdot 10^{-3}}^t i_2(t')dt' - 15 = 5 - 10^4 t$$

$$V_3(t) = V_2(t = 4\,ms) = -35\,V$$

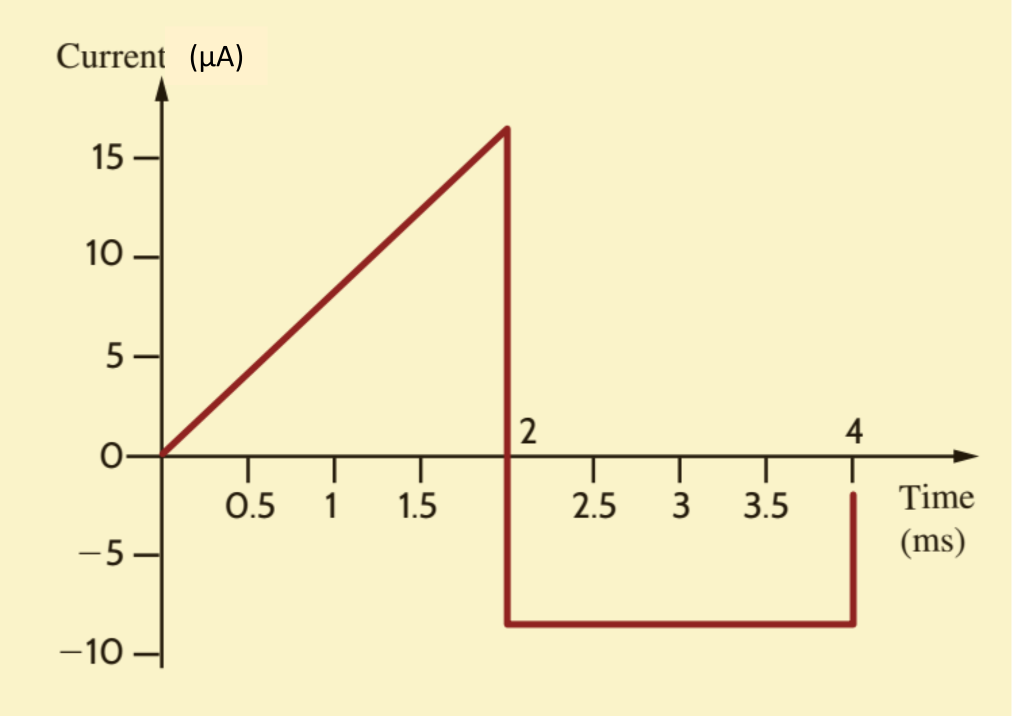
$$V_4(t) = \frac{-10^{-5}}{1\cdot 10^{-9}}\int_{5\cdot 10^{-3}}^t i_4(t')dt' - 35 = 10^4 t - 85$$



Answer: $$W(6\,ms) = \frac{CV_4(6\,ms)^2}{2} = 312.5\,nJ$$

4.

The current in an initially uncharged 4-µF capacitor is shown in figure below. Plot the waveforms for the voltage, power, and energy and compute the energy stored in the electric field of the capacitor at t = 2 ms.



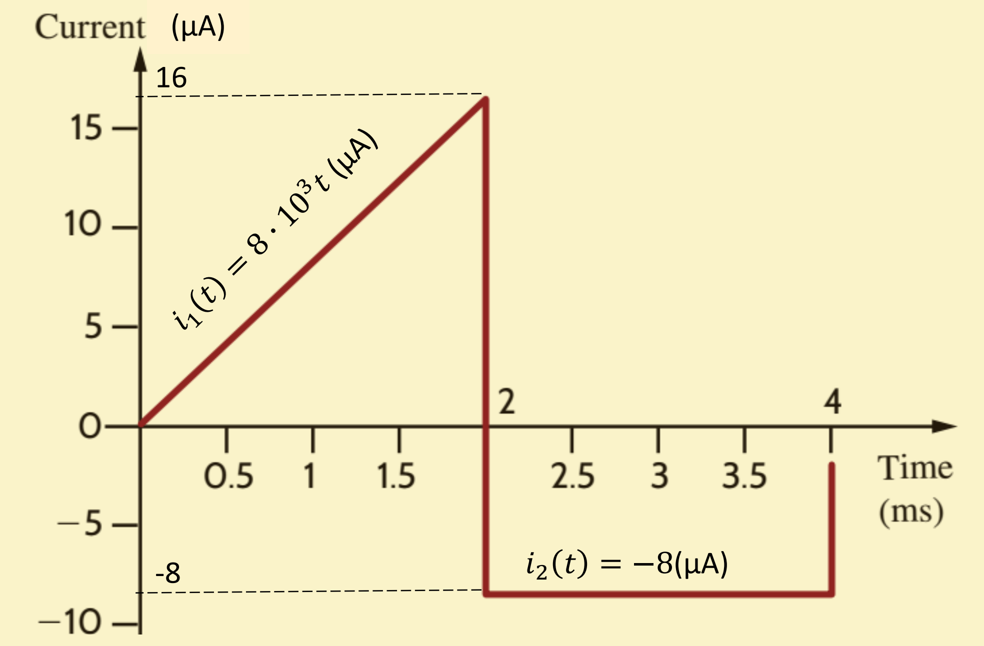
4.

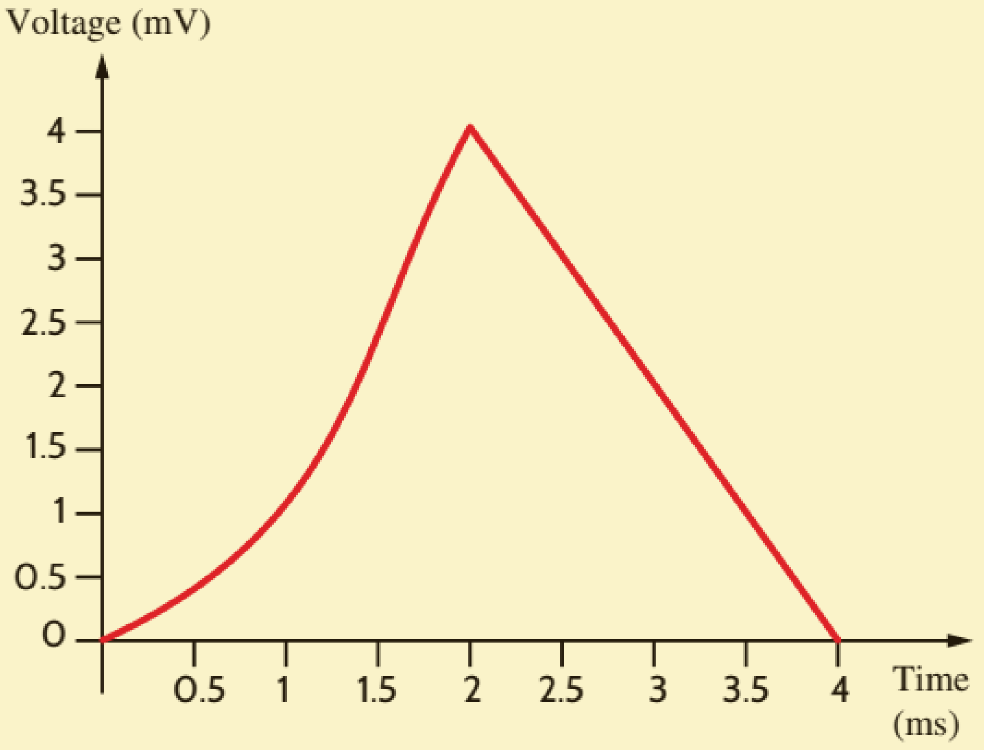
Voltage

$$V(t) = \frac{1}{C}\int_{t_i}^{t} i(t')dt' + V_0$$

$$V_1(t) = \frac{1}{4\cdot 10^{-6}}\int_0^t i_1(t')dt' + 0 = 10^3 \cdot t^2 \qquad V_1(2\ ms) = 4\ mV$$

$$V_2(t) = \frac{1}{4\cdot 10^{-6}}\int_{2\ ms}^t i_2(t')dt' + V_1(2\ ms) = \frac{1}{125} - 2t \qquad V_2(4\ ms) = 0\ mV$$





4.

Voltage

$$V(t) = \frac{1}{C}\int_{t_i}^{t} i(t')dt' + V_0$$

$$V_1(t) = \frac{1}{4\cdot 10^{-6}}\int_0^t i_1(t')dt' + 0 = 10^3 \cdot t^2 \qquad V_1(2\,ms) = 4\,mV$$

$$V_2(t) = \frac{1}{4\cdot 10^{-6}}\int_{2\,ms}^t i_2(t')dt' + V_1(2\,ms) = \frac{1}{125} - 2t \qquad V_2(4\,ms) = 0\,mV$$

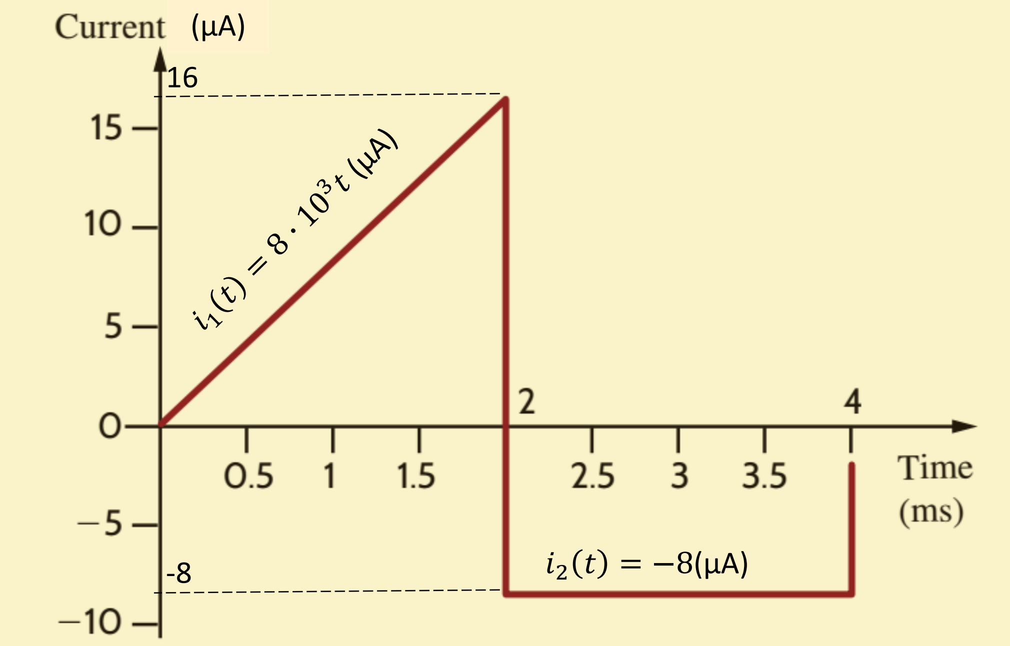
Power

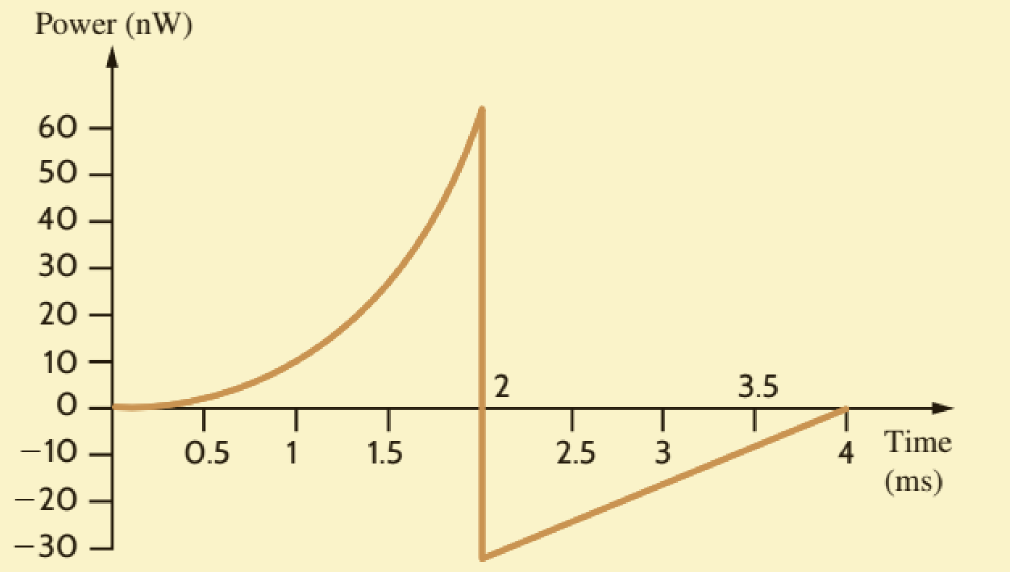
$$P(t) = \mathrm{V}(t)i(t)$$

$$P_1(t) = V_1(t)i_1(t) = 8\cdot t^3 \qquad P_1(2\,ms) = 64\text{ nW}$$

$$P_2(t) = V_2(t)i_2(t) = -8\cdot 10^{-6}\cdot\left(\frac{1}{125} - 2t\right) \qquad P_2(2\,ms) = -32\text{ nW}$$

$$P_2(4\,ms) = 0\text{ nW}$$





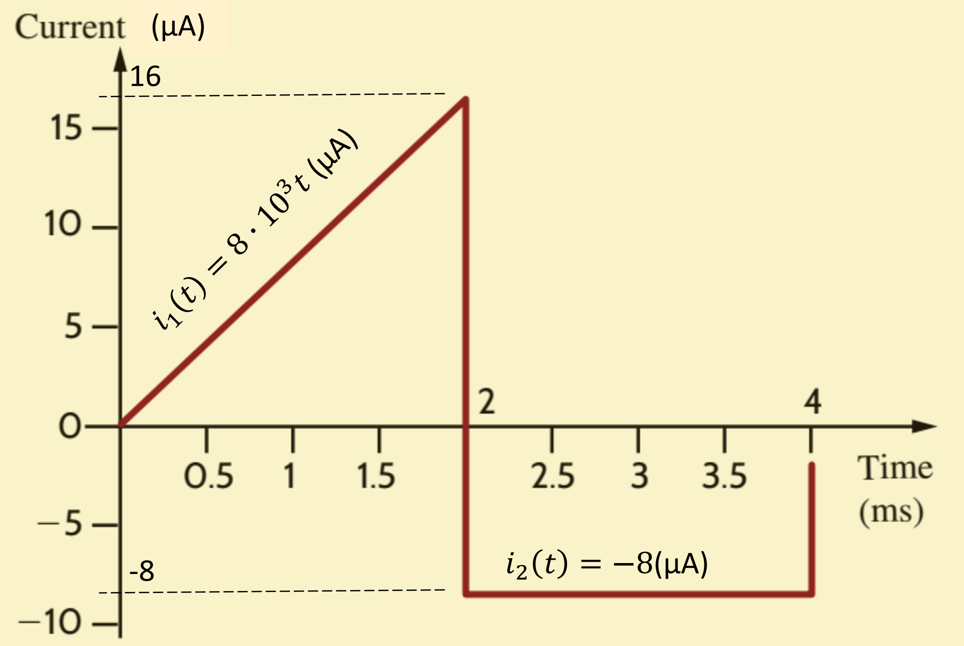
4.

Voltage

$$V(t) = \frac{1}{C}\int_{t_i}^{t} i(t')dt' + V_0$$

$$V_1(t) = \frac{1}{4\cdot 10^{-6}}\int_0^t i_1(t')dt' + 0 = 10^3\cdot t^2 \qquad V_1(2\,ms) = 4\,mV$$

$$V_2(t) = \frac{1}{4\cdot 10^{-6}}\int_{2\,ms}^t i_2(t')dt' + V_1(2\,ms) = \frac{1}{125} - 2t \qquad V_2(4\,ms) = 0\,mV$$

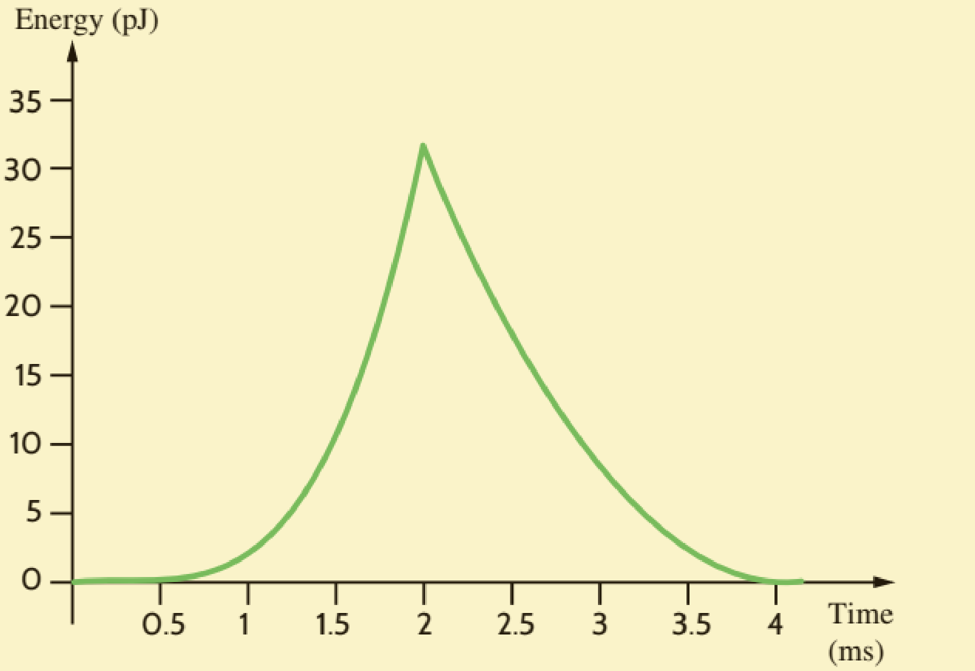


Energy

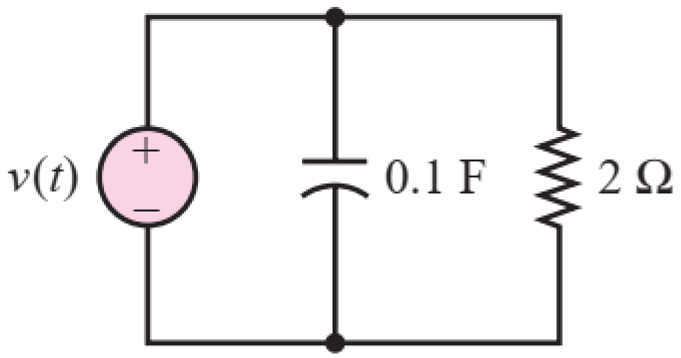
$$W(t) = \frac{CV(t)^2}{2}$$

$$W_1(t) = \frac{CV_1(t)^2}{2} = 2\cdot t^4 \qquad W_1(2\,ms) = 32\,pJ$$

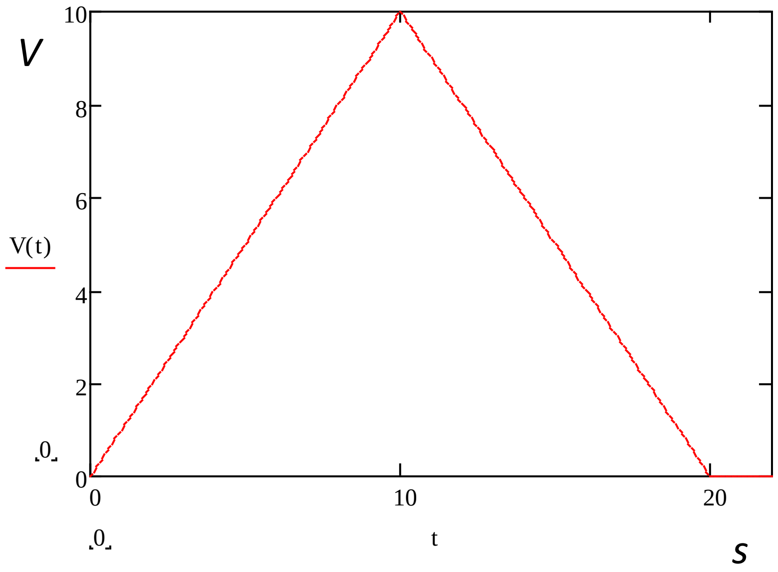
$$W_2(t) = \frac{CV_2(t)^2}{2} = 2\cdot 10^{-6}\left(\frac{1}{125} - 2t\right)^2 \qquad W_2(4\,ms) = 0\,pJ$$



5.



$$v(t) = \begin{cases} 0 & \text{for } -\infty < t < 0 \\ t & \text{for } 0 \le t < 10 \text{ s} \\ 20 - t & \text{for } 10 \le t < 20 \text{ s} \\ 0 & \text{for } 20 \text{ s} \le t < \infty \end{cases}$$



Find

a. The energy stored in the capacitor for all time

b. The energy delivered by the source for all time

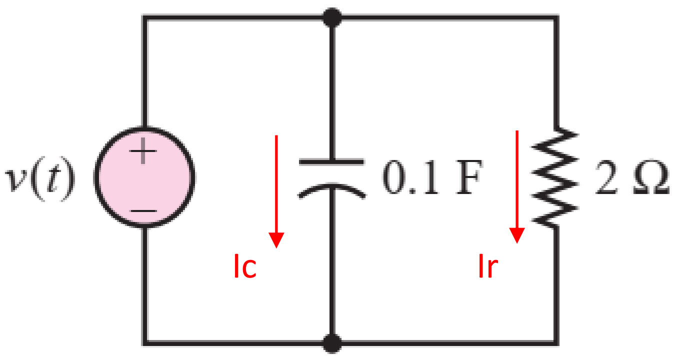
5.

Energy stored in the capacitor:

$Vc(t) = V(t)$

$$Wc(T) = \int_0^T Ic\cdot Vc\,dt = \int_0^T C\cdot\left(\frac{d}{dt}Vc\right)\cdot Vc\,dt = \int_0^T C\cdot Vc\,dVc = \frac{C\cdot\left(Vc(T)^2 - Vc(0)^2\right)}{2} = \frac{C\cdot Vc(T)^2}{2}$$

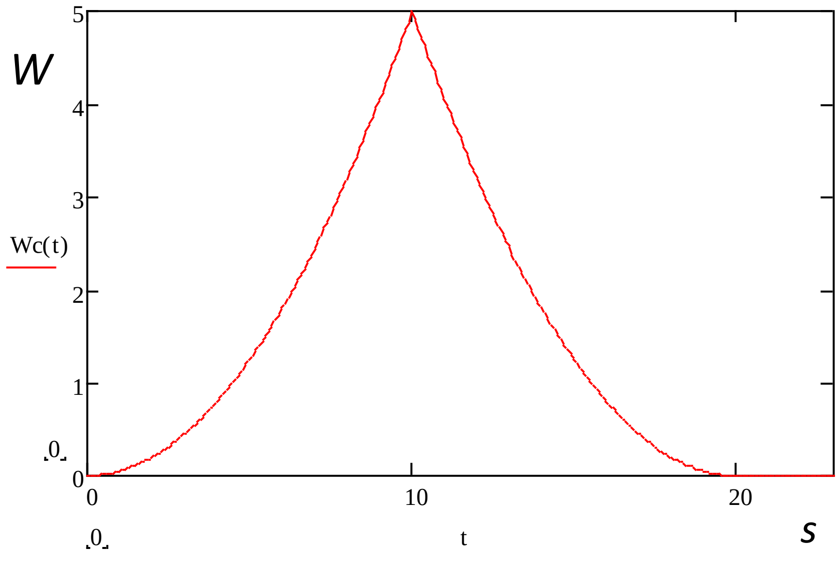
$$Ic = C\cdot\left(\frac{d}{dt}Vc\right)$$

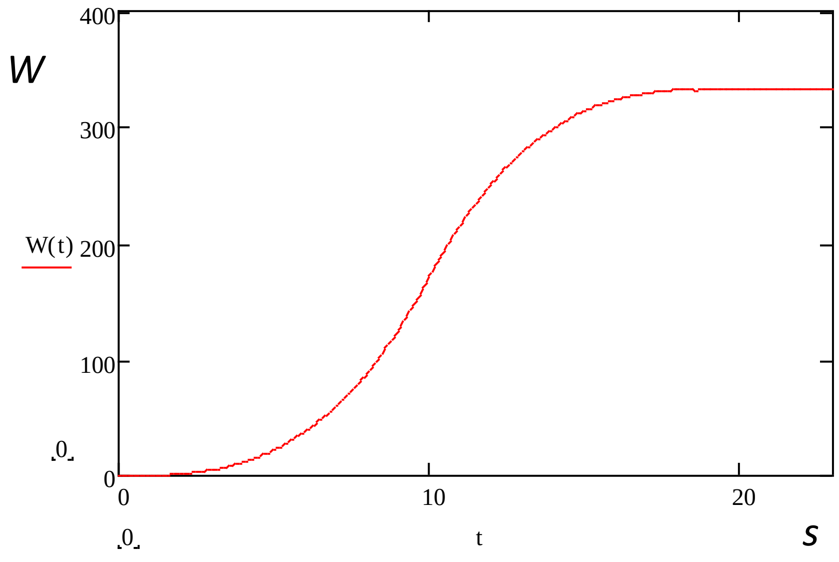


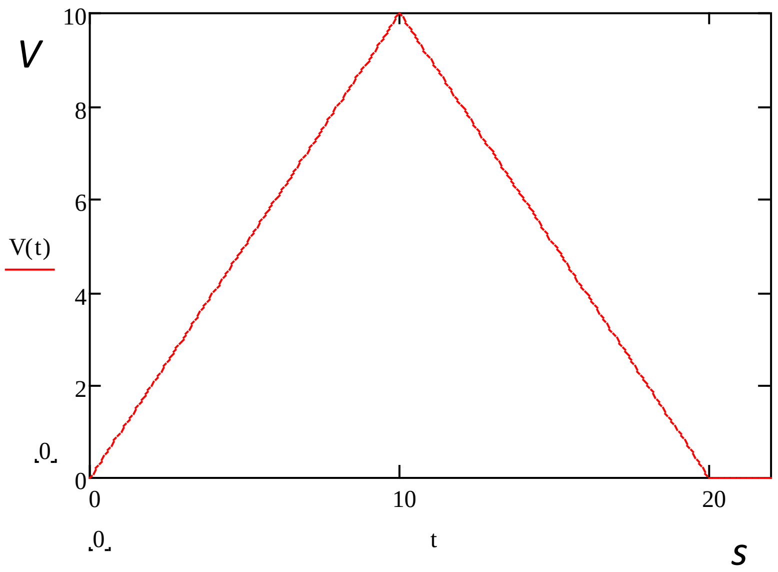
Energy delivered by the source:

$$W(T) = \left[\int_0^T I\cdot V\,dt = \int_0^T (Ic + Ir)\cdot V\,dt = \frac{C\cdot V(T)^2}{2} + \int_0^T \frac{V(t)^2}{R}\,dt\right]$$

$$v(t) = \begin{cases} 0 & \text{for } -\infty < t < 0 \\ t & \text{for } 0 \le t < 10\text{ s} \\ 20 - t & \text{for } 10 \le t < 20\text{ s} \\ 0 & \text{for } 20\text{ s} \le t < \infty \end{cases}$$



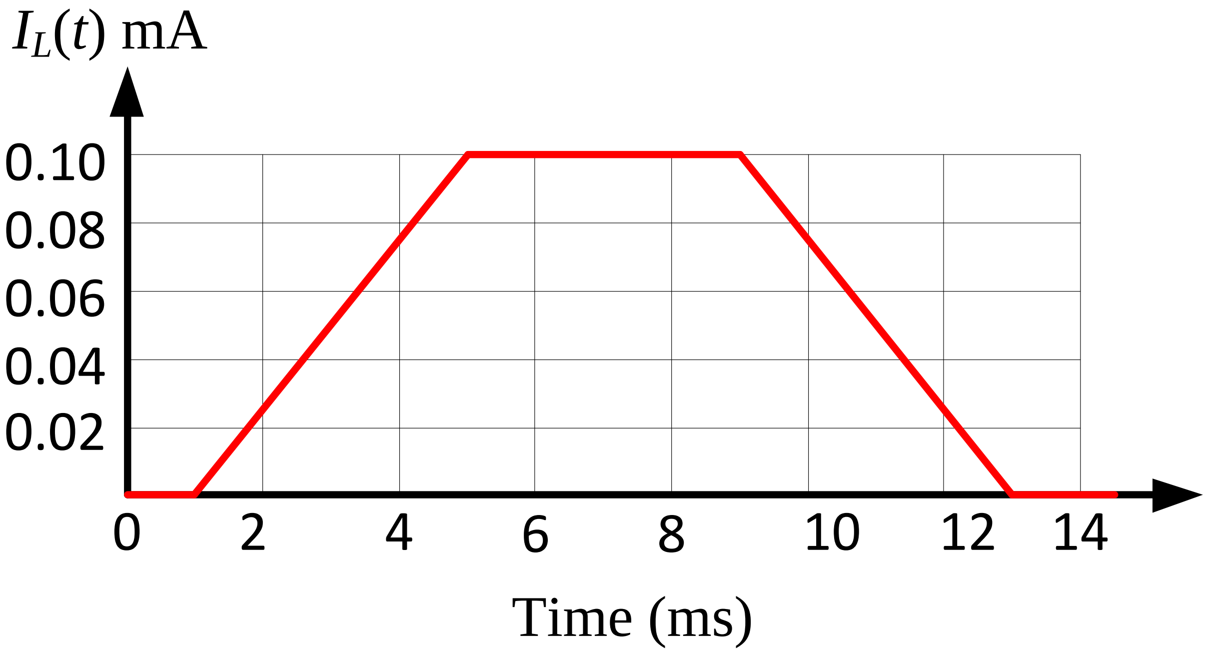




1.

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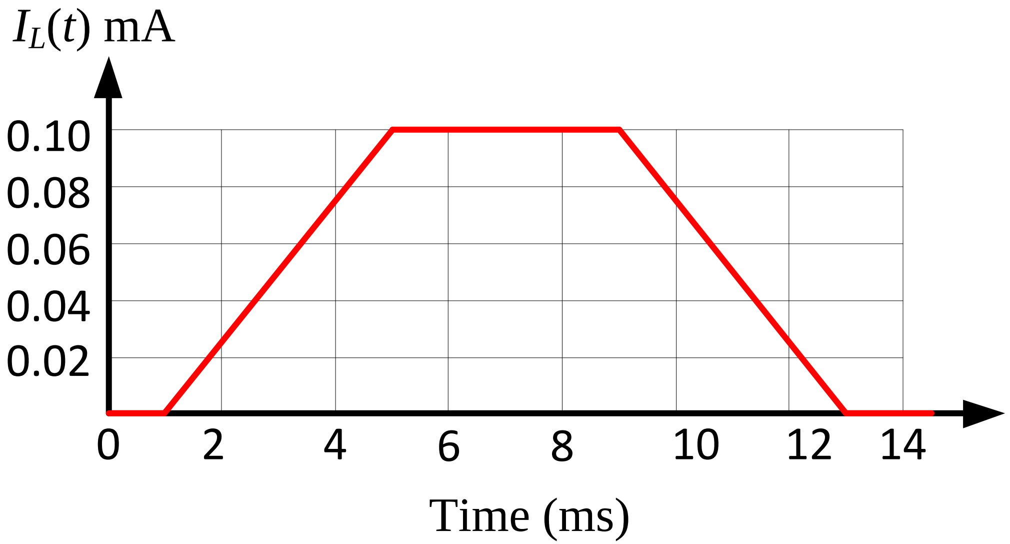
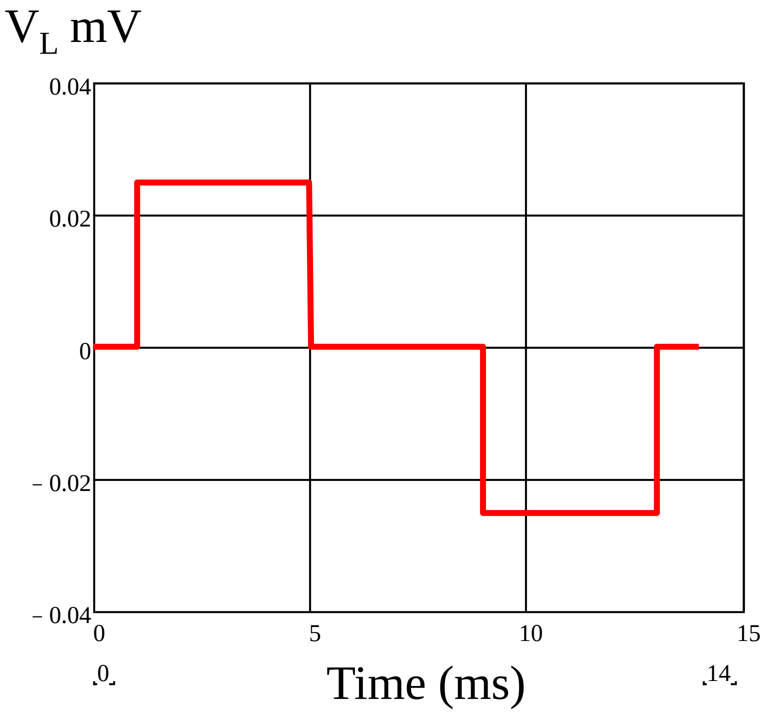
$$i_L(t) = \begin{cases} 0 \text{ mA} & t < 1 \text{ ms} \\ -\dfrac{0.1}{4} + \dfrac{0.1}{4}t \quad \text{mA} & 1 \le t \le 5 \text{ ms} \\ 0.1 \text{ mA} & 5 \le t \le 9 \text{ ms} \\ 13 \times \dfrac{0.1}{4} - \dfrac{0.1}{4}t \quad \text{mA} & 9 \le t \le 13 \text{ ms} \\ 0 \text{ mA} & t > 13 \text{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



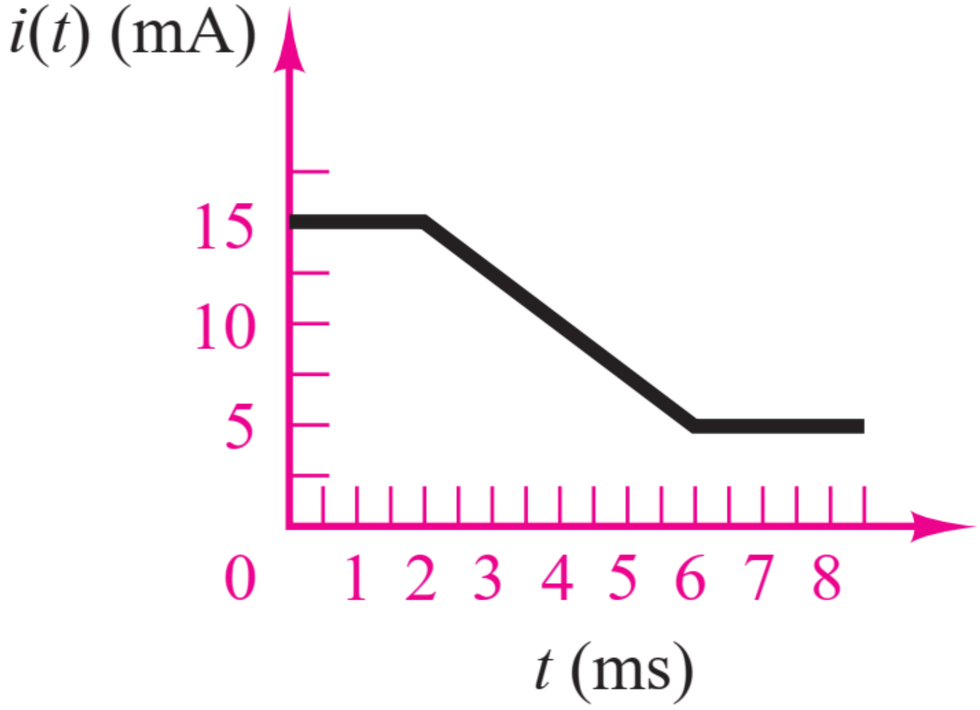
$$v_L(t) = L\frac{di_L}{dt}$$

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



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.



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(-∞)* = 0.

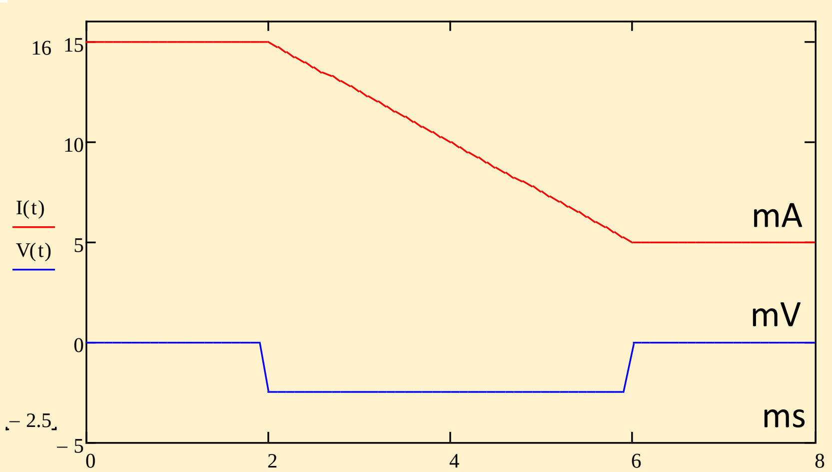
$$I(t) := \begin{cases} 15 & \text{if } 0 \le t < 2 \\ \frac{-10}{4} \cdot t + 20 & \text{if } 2 \le t < 6 \\ 5 & \text{if } 6 \le t \end{cases} \quad \Rightarrow \quad V(t) := \begin{cases} 0 & \text{if } 0 \le t < 2 \\ \frac{-10}{4} & \text{if } 2 \le t < 6 \\ 0 & \text{if } 6 \le t \end{cases}$$

$\Rightarrow$ $W(t) = (1/2) \cdot L \cdot I(t)^2$

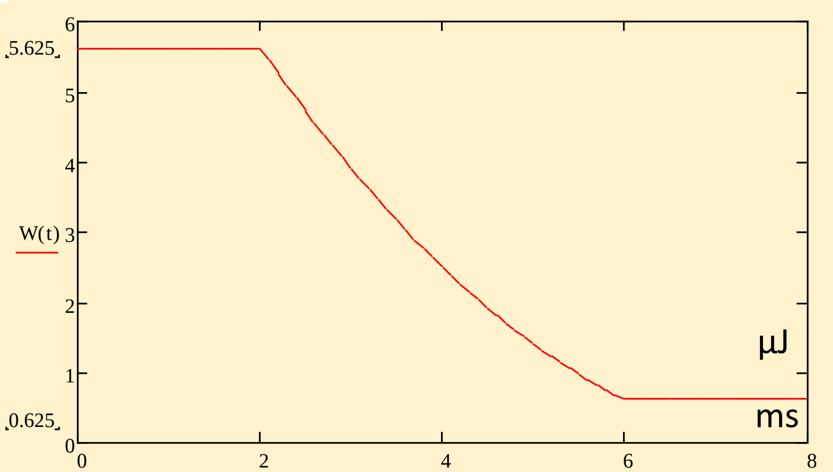
$W(3\text{ ms}) = 3.91\ \mu J$

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

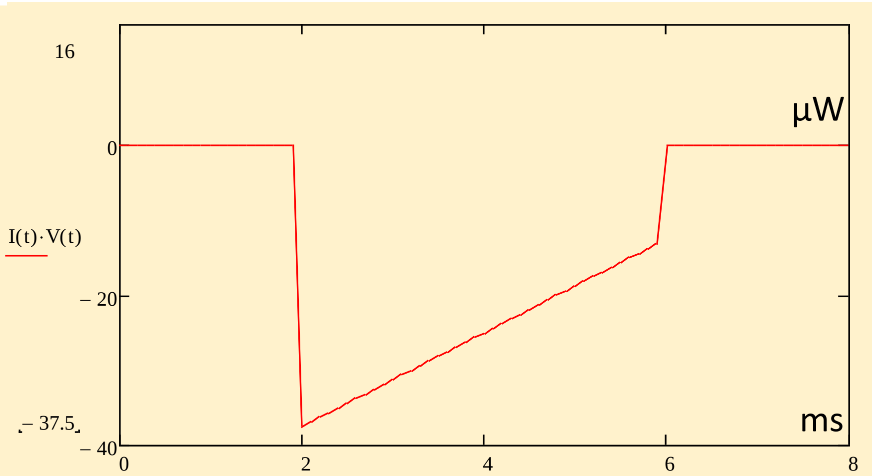
$$V(t) = L \cdot \left(\frac{d}{dt} I(t)\right)$$



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



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



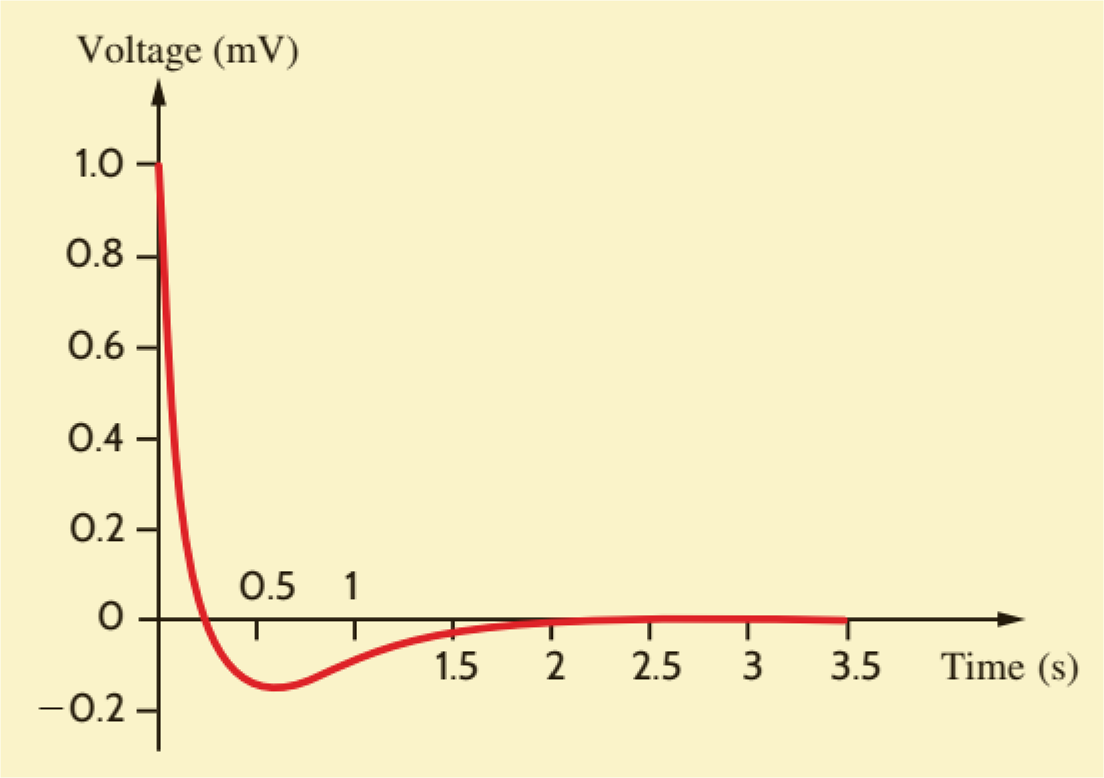
3.

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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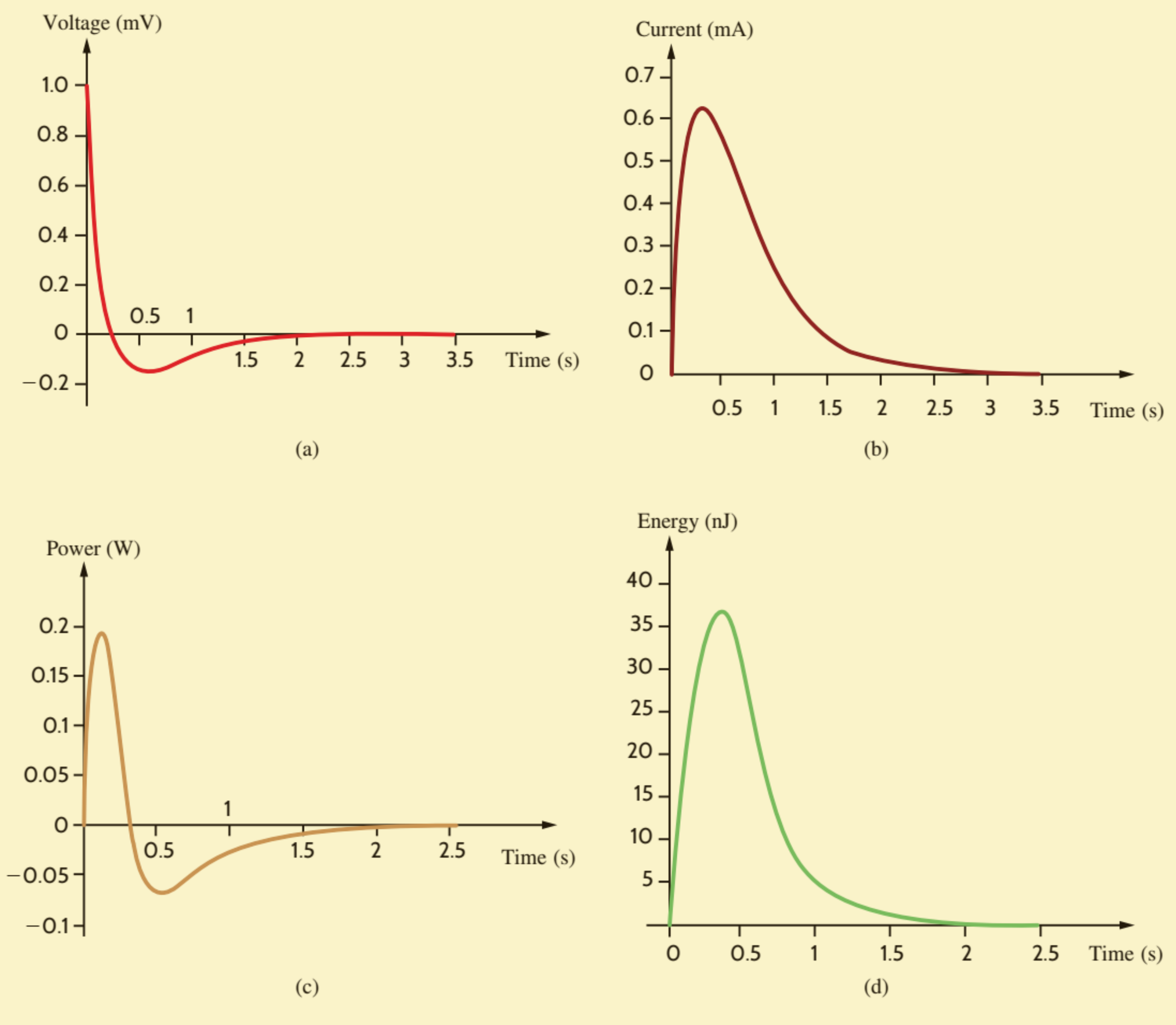


Current (mA):

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

Power (μW):

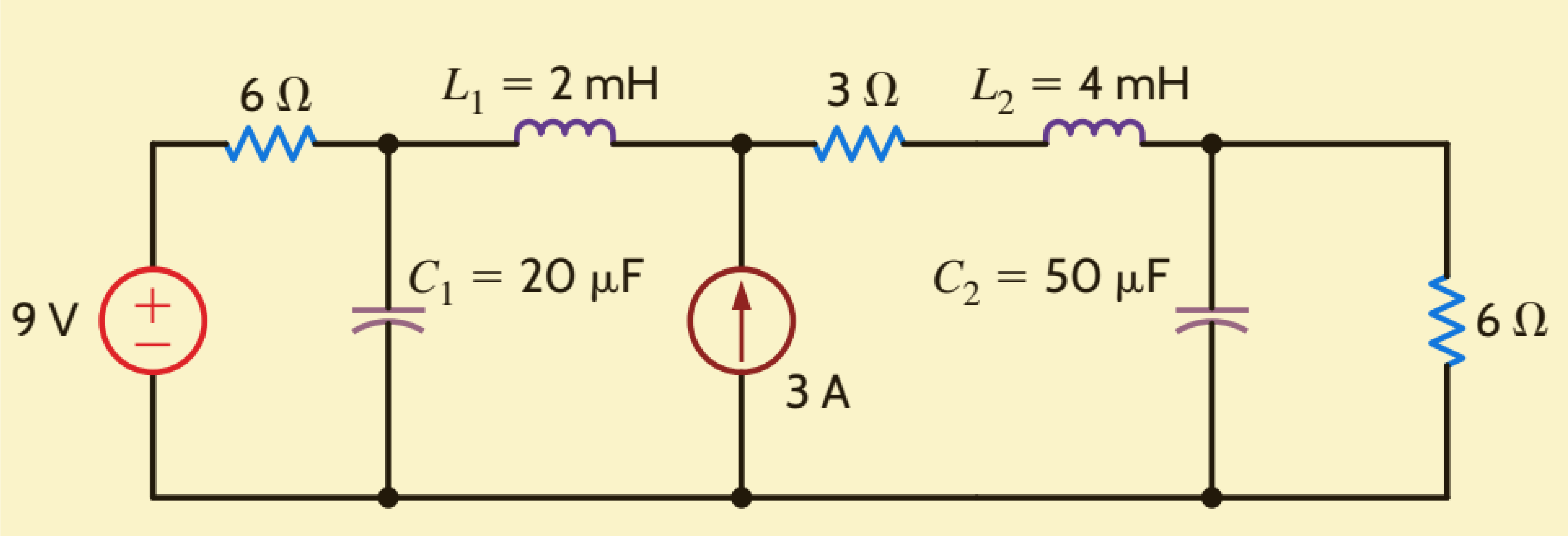
$$P(t) = i(t)\cdot v(t) = 5\cdot t\cdot(1 - 3\cdot t)\cdot e^{-6\cdot t}$$

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



4.

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:

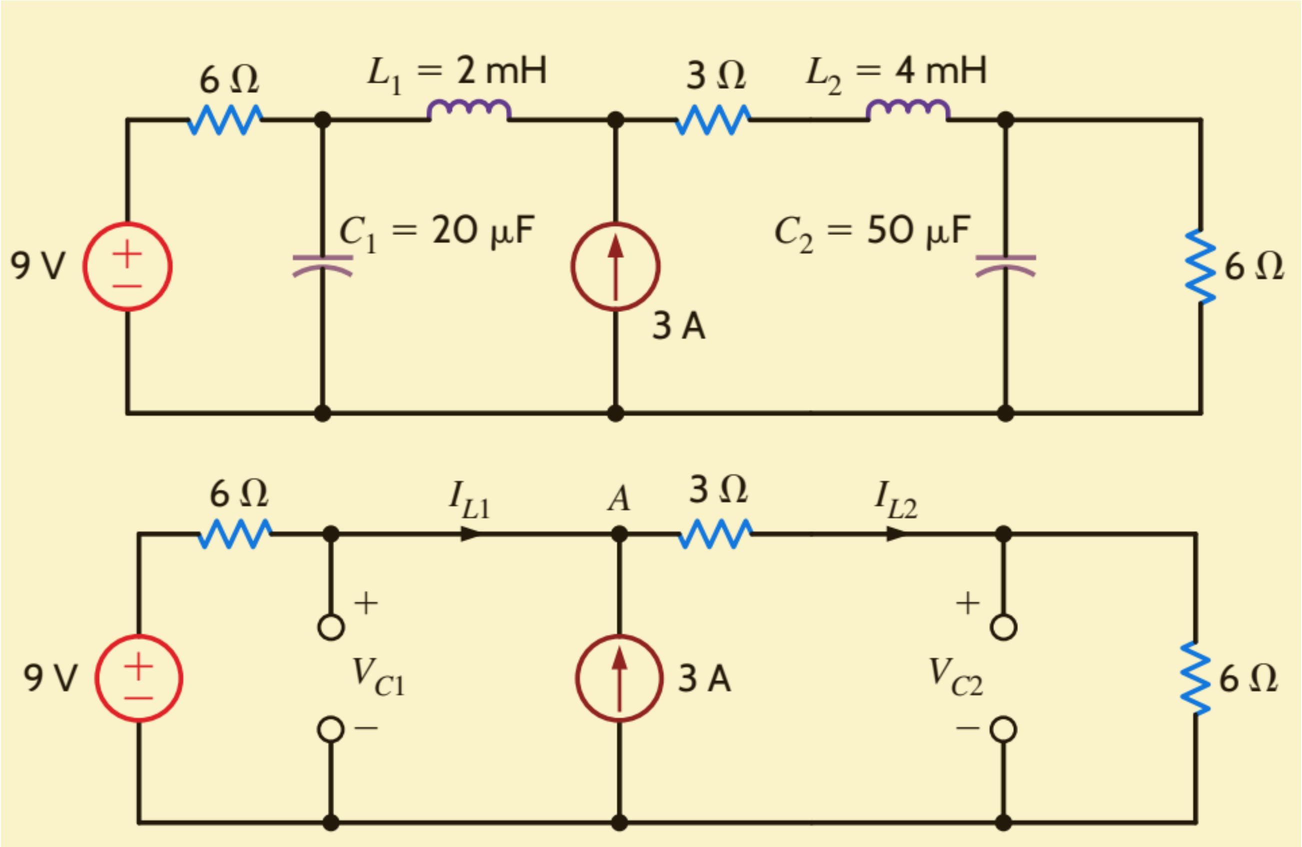
$$V_{C1} = -6I_{L1} + 9 = 16.2\ V$$

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

Energies:

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

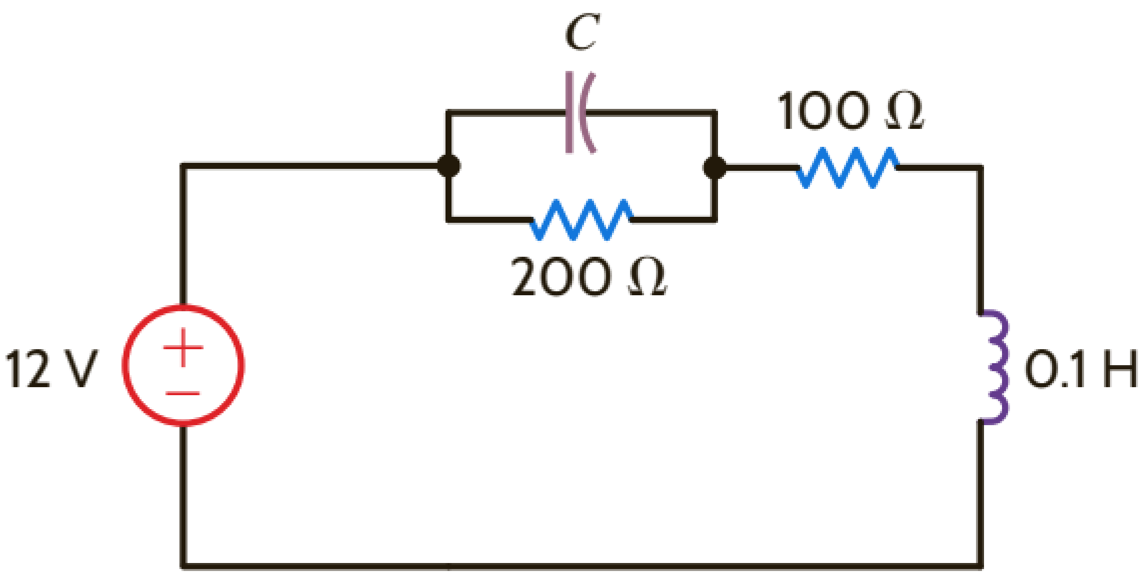
Find the total energy stored in the circuit



The total stored energy is 13.46 mJ

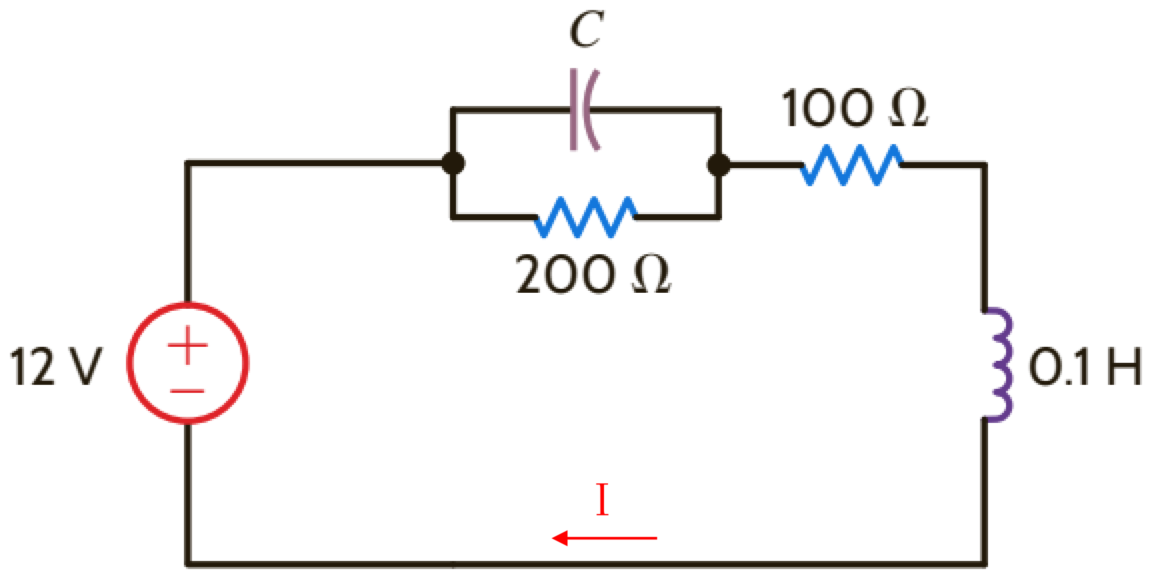
5.

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.



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

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

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

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

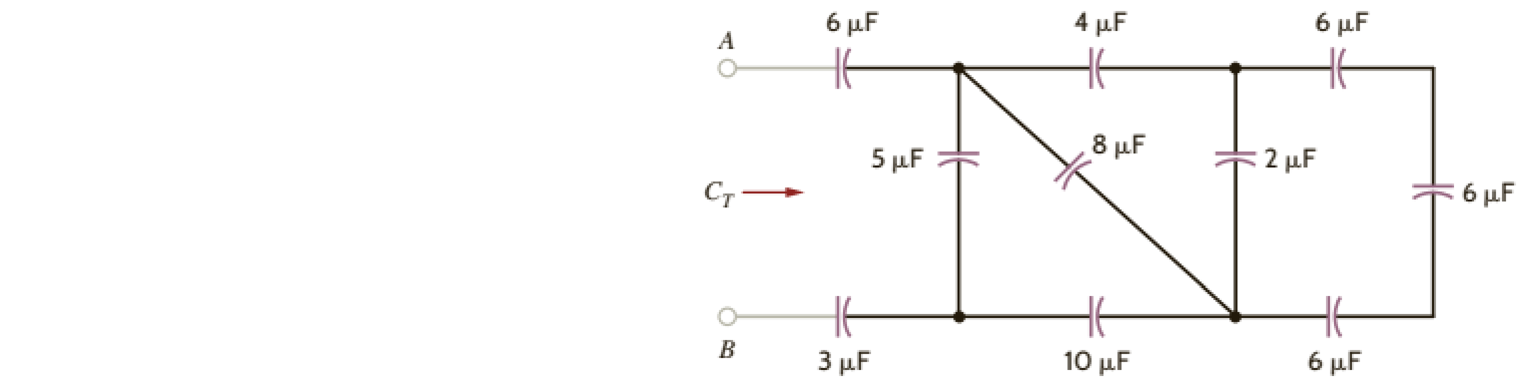
$$W_L = W_C$$

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

Answer: 2.5 μF

6.

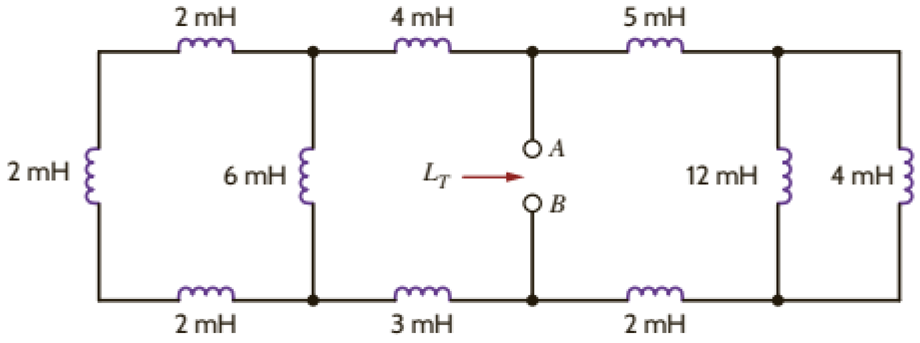
Compute the equivalent capacitance of the network



Answer: 5/3 μF

7.

Compute the equivalent inductance of the network



Answer: 5 mH

1.

Add the sinusoidal voltages $v_1(t) = A\cos(\omega t + \phi)$ and $v_2(t) = B\cos(\omega t + \theta)$ using phasor notation, and then convert back to time-domain form.

$$A = 1.5\text{ V},\ \phi = 10^\circ;\ B = 3.2\text{ V},\ \theta = 25^\circ.$$

1.

Add the sinusoidal voltages $v_1(t) = A\cos(\omega t + \phi)$ and $v_2(t) = B\cos(\omega t + \theta)$ using phasor notation, and then convert back to time-domain form.

$$A = 1.5\text{ V}, \phi = 10°; B = 3.2\text{ V}, \theta = 25°.$$

$$v_1(t) \to 1.5\left(cos(10^0) + j \cdot sin(10^0)\right) = 1.48 + j \cdot 0.26$$

$$v_2(t) \to 3.2\left(cos(25^0) + j \cdot sin(25^0)\right) = 2.9 + j \cdot 1.35$$

$$v_1(t) + v_2(t) \to 4.38 + j \cdot 1.61 = 4.66\angle 20.21^0$$

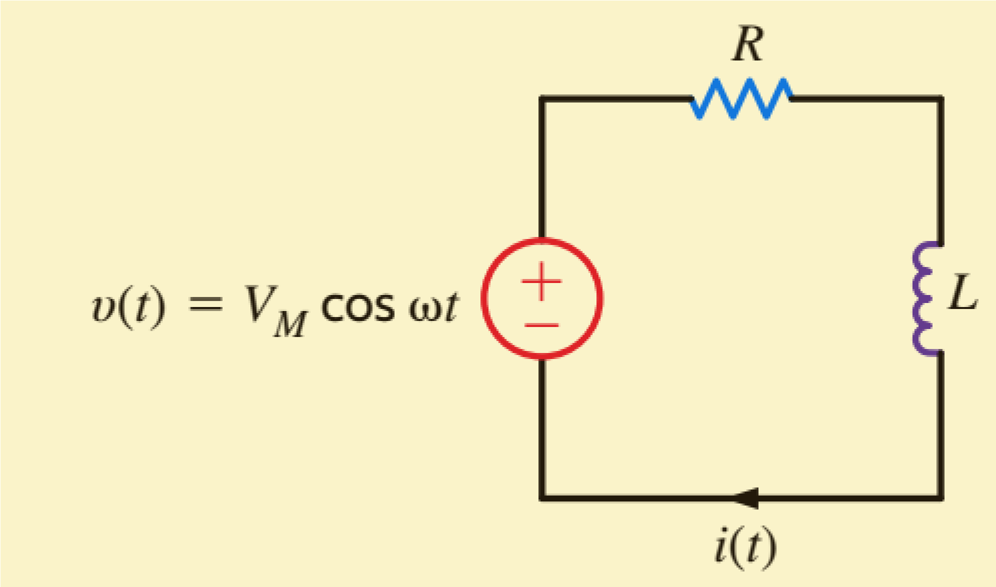
$$\sqrt{4.38^2 + 1.61^2} = 4.66$$

$$\text{atan}\left(\frac{1.612}{4.377}\right) \cdot \frac{180}{\pi} = 20.21^0$$

Answer: $v_1(t) + v_2(t) = 4.66 \cdot \cos(\omega t + 20.21^0)$

2.

Derive the expression for the current.

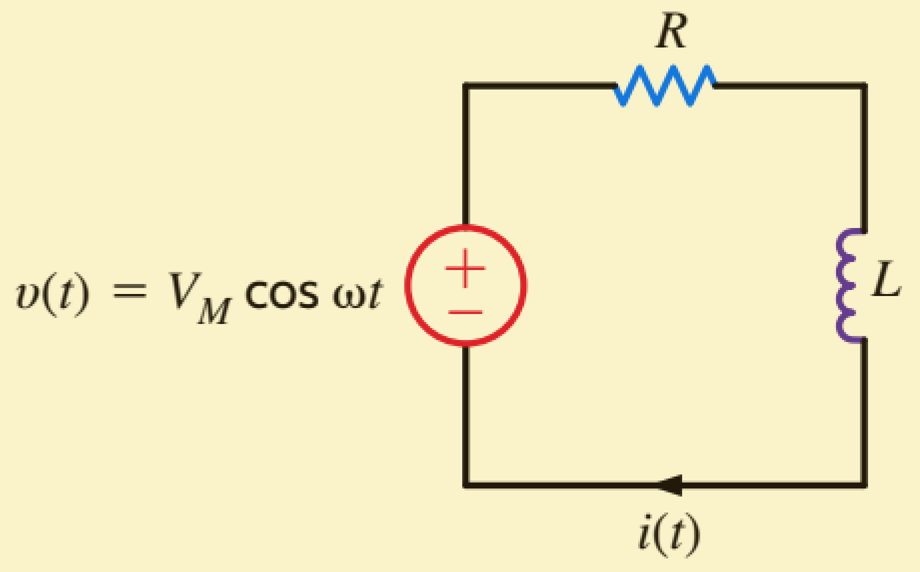


2.

Derive the expression for the current.

$$L\frac{di(t)}{dt} + Ri(t) = V_M \cos \omega t$$ /KVL

$$i(t) = A \cos(\omega t + \phi)$$ /we assume this form of current function



$$\begin{aligned} i(t) &= A\cos\phi\cos\omega t - A\sin\phi\sin\omega t \\ &= A_1\cos\omega t + A_2\sin\omega t \end{aligned}$$

$$L\frac{d}{dt}(A_1\cos\omega t + A_2\sin\omega t) + R(A_1\cos\omega t + A_2\sin\omega t) = V_M\cos\omega t$$

$$-A_1\omega L\sin\omega t + A_2\omega L\cos\omega t + RA_1\cos\omega t + RA_2\sin\omega t = V_M\cos\omega t$$

$$-A_1\omega L + A_2 R = 0$$ /coefficients of sine function

$$A_1 R + A_2\omega L = V_M$$ /coefficients of cosine function

$$A_1 = \frac{RV_M}{R^2 + \omega^2L^2}$$

$$A_2 = \frac{\omega L V_M}{R^2 + \omega^2L^2}$$

/solution for A_1 and A_2

Derived expression for current

$$i(t) = \frac{RV_M}{R^2 + \omega^2L^2}\cos\omega t + \frac{\omega L V_M}{R^2 + \omega^2L^2}\sin\omega t$$

Derive the expression for the current.

Derived expression for current

$$i(t) = \frac{RV_M}{R^2 + \omega^2 L^2}\cos \omega t + \frac{\omega L V_M}{R^2 + \omega^2 L^2}\sin \omega t \Leftrightarrow i(t) = A\cos(\omega t + \phi)$$

$$A\cos\phi = \frac{RV_M}{R^2 + \omega^2 L^2}$$

$$A\sin\phi = \frac{-\omega L V_M}{R^2 + \omega^2 L^2}$$

$$\tan\phi = \frac{A\sin\phi}{A\cos\phi} = -\frac{\omega L}{R}$$

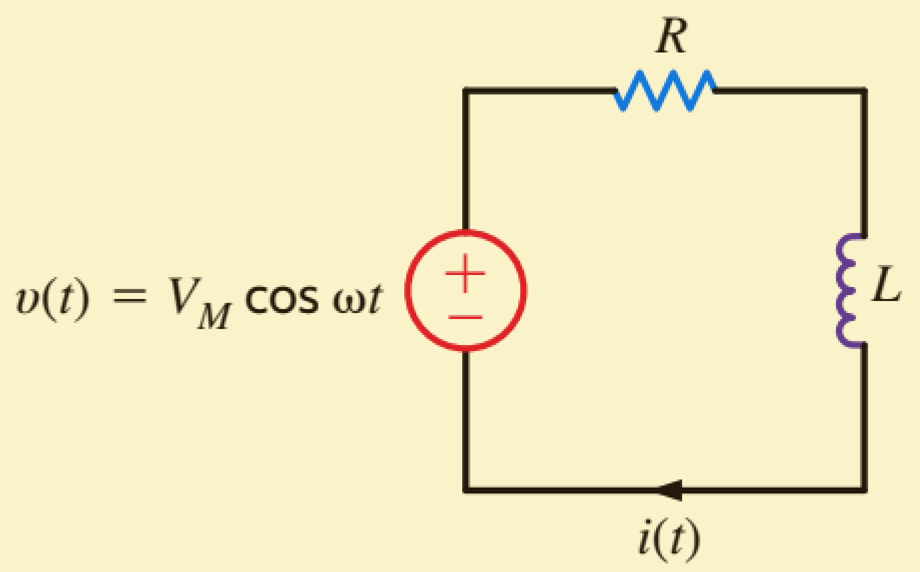
$$\phi = -\tan^{-1}\frac{\omega L}{R}$$

$$(A\cos\phi)^2 + (A\sin\phi)^2 = A^2(\cos^2\phi + \sin^2\phi) = A^2$$

$$A^2 = \frac{R^2 V_M^2}{(R^2 + \omega^2 L^2)^2} + \frac{(\omega L)^2 V_M^2}{(R^2 + \omega^2 L^2)^2}$$

$$= \frac{V_M^2}{R^2 + \omega^2 L^2}$$

$$A = \frac{V_M}{\sqrt{R^2 + \omega^2 L^2}}$$

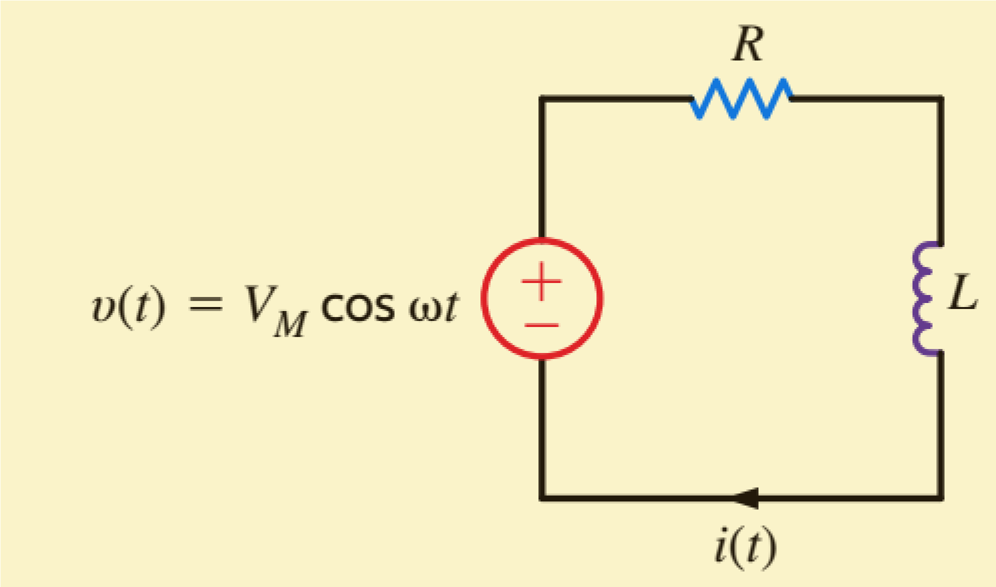


Final expression for current

$$i(t) = \frac{V_M}{\sqrt{R^2 + \omega^2 L^2}}\cos\left(\omega t - \tan^{-1}\frac{\omega L}{R}\right)$$

2.

Derive the expression for the current with phasor notation.



HINT

Technique for taking the reciprocal:

$$\frac{1}{R + jX} = \frac{R - jX}{(R + jX)(R - jX)}$$

$$= \frac{R - jX}{R^2 + X^2}$$

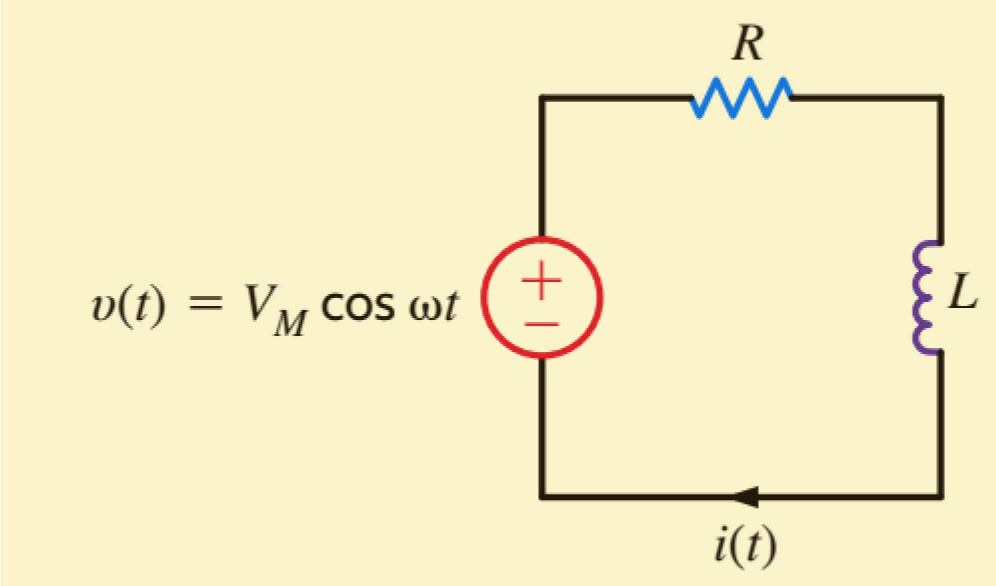
2.

Derive the expression for the current with phasor notation.

$$L\frac{di(t)}{dt} + Ri(t) = V_M \cos \omega t$$ /KVL

$$L\frac{d}{dt}(\mathbf{I}e^{j\omega t}) + R\mathbf{I}e^{j\omega t} = \mathbf{V}e^{j\omega t}$$
$$j\omega L\mathbf{I}e^{j\omega t} + R\mathbf{I}e^{j\omega t} = \mathbf{V}e^{j\omega t}$$

$$j\omega L\mathbf{I} + R\mathbf{I} = \mathbf{V}$$ /linear equation with one unknown $\mathbf{I}$



$$\mathbf{I} = \frac{\mathbf{V}}{R + j\omega L} = I_M \angle \phi = \frac{V_M}{\sqrt{R^2 + \omega^2 L^2}} \angle -\tan^{-1}\frac{\omega L}{R}$$ /Answer for phasor current

$$i(t) = \frac{V_M}{\sqrt{R^2 + \omega^2 L^2}} \cos\left(\omega t - \tan^{-1}\frac{\omega L}{R}\right)$$ /Final answer

HINT

Technique for taking the reciprocal:

$$\frac{1}{R + jX} = \frac{R - jX}{(R + jX)(R - jX)} = \frac{R - jX}{R^2 + X^2}$$

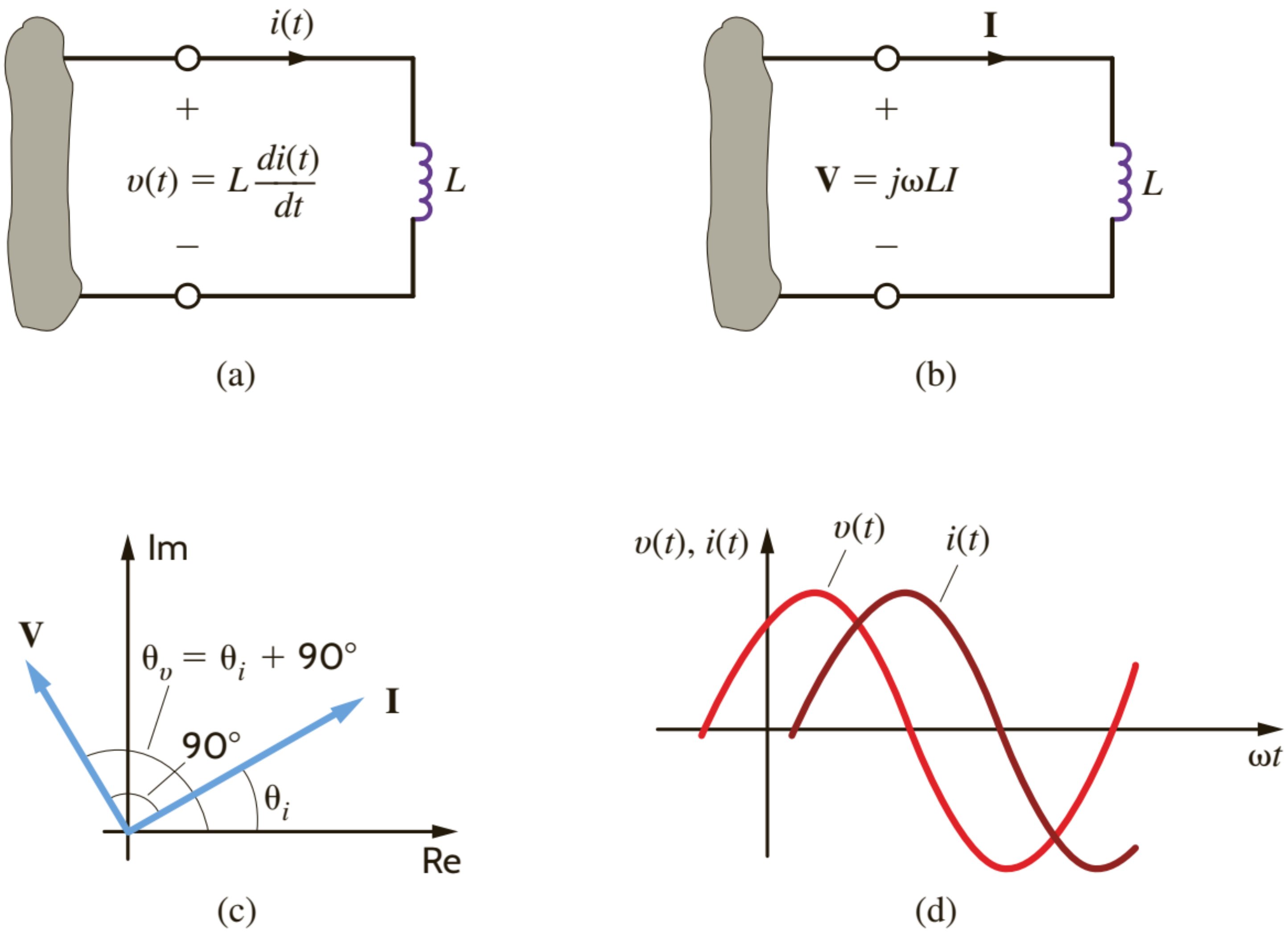
3.

The voltage u(t) = 12 cos (377t + 20°) V is applied to a 20-mH inductor. Find the resultant current.

HINT

Applying $\mathbf{V} = j\omega L\mathbf{I}$

$$\frac{x_1\angle\theta_1}{x_2\angle\theta_2} = \frac{x_1}{x_2}\angle\theta_1 - \theta_2$$



3.

The voltage u(t) = 12 cos (377t + 20°) V is applied to a 20-mH inductor. Find the resultant current.

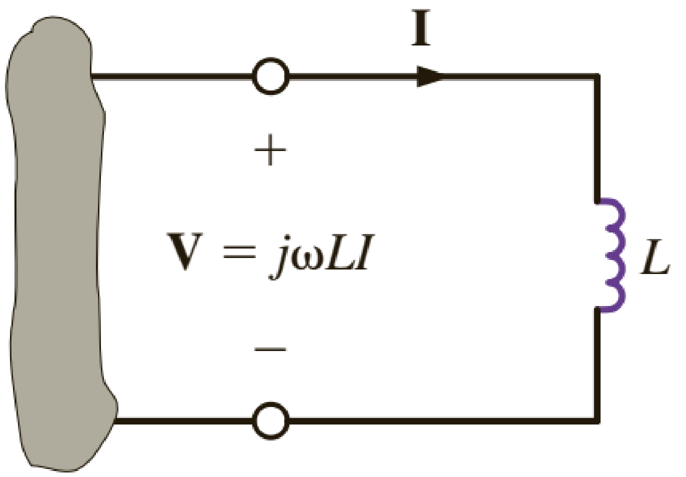
Solution:

$$\mathbf{I} = \frac{\mathbf{V}}{j\omega L} = \frac{12\,\angle 20^\circ}{\omega L\,\angle 90^\circ}$$

$$= \frac{12\,\angle 20^\circ}{(377)(20 \times 10^{-3})\,\angle 90^\circ}$$

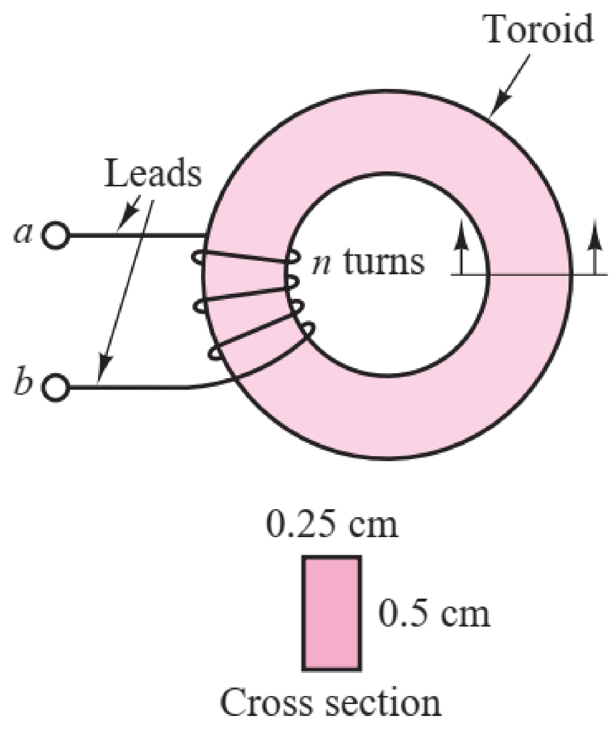
$$= 1.59\,\angle -70^\circ \text{ A}$$

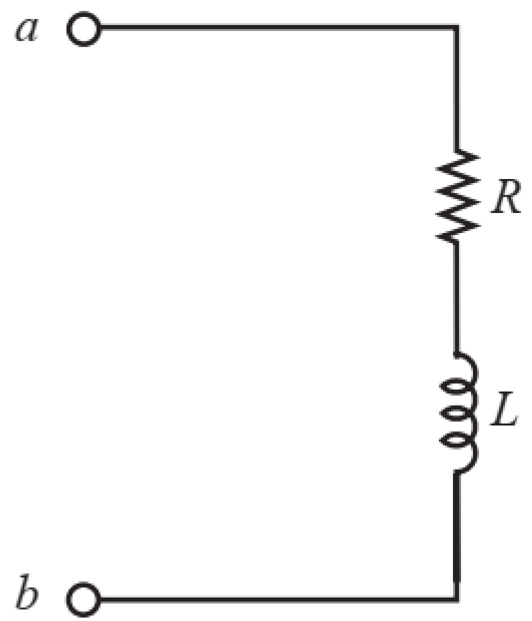
Answer: $i(t) = 1.59 \cos(377t - 70^\circ)$ A



4.

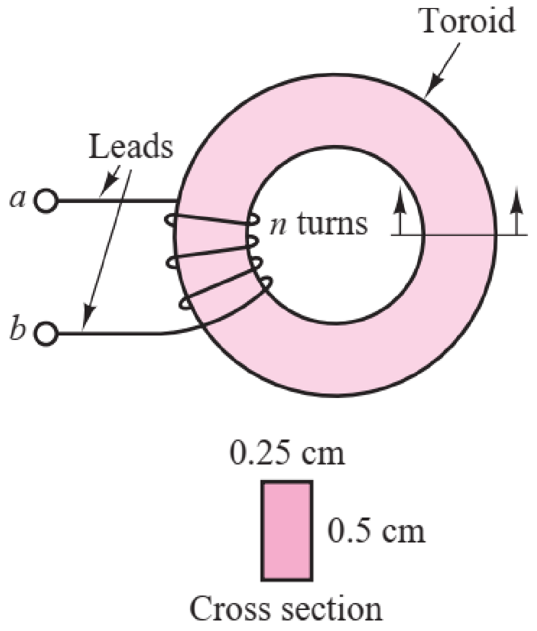
Figure shows a *toroidal* (doughnut-shaped) inductor. The series resistance represents the resistance of the coil wire and is usually small. Find the range of frequencies over which the impedance of this practical inductor is largely *inductive* (i.e., due to the inductance in the circuit). We shall consider the impedance to be inductive if the impedance of the inductor in the circuit is at least 10 times as large as that of the resistor.





L = 0.098 H; lead length = l_c = 2 × 10 cm; n = 250 turns. Resistance of 30-gauge wire = 0.344 Ω/m.

4. $L = 0.098$ H; lead length = $l_c = 2 \times 10$ cm; $n = 250$ turns. Resistance of 30-gauge wire = 0.344 Ω/m.



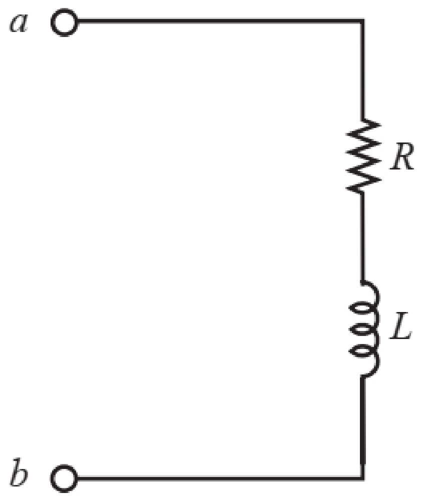
Resistance impedance:

$$l_w = 250(2 \times 0.25 + 2 \times 0.5) = 375 \text{ cm}$$ /Length of coil wire

$$l = \text{ total length} = l_w + l_c = 375 + 20 = 395 \text{ cm}$$

$$R = 0.344(\Omega/m) \cdot 3.95m = 1.36\Omega$$ /Wire resistance

Inductor impedance:



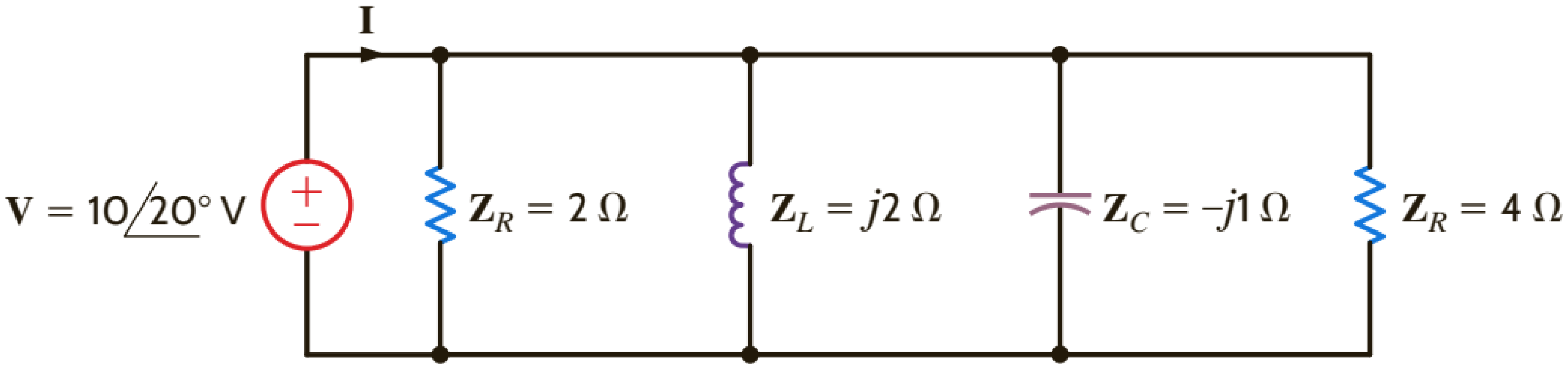
Thus, we wish to determine the range of radian frequencies, ω, over which the magnitude of $j\omega L$ is greater than $10 \cdot 1.36\Omega$:

$$\omega L > 13.6\Omega \quad \text{or} \quad \omega > 138.7 \text{ rad/s}$$

Alternatively, the range is $f = \omega/2\pi > 22$ Hz. /Answer

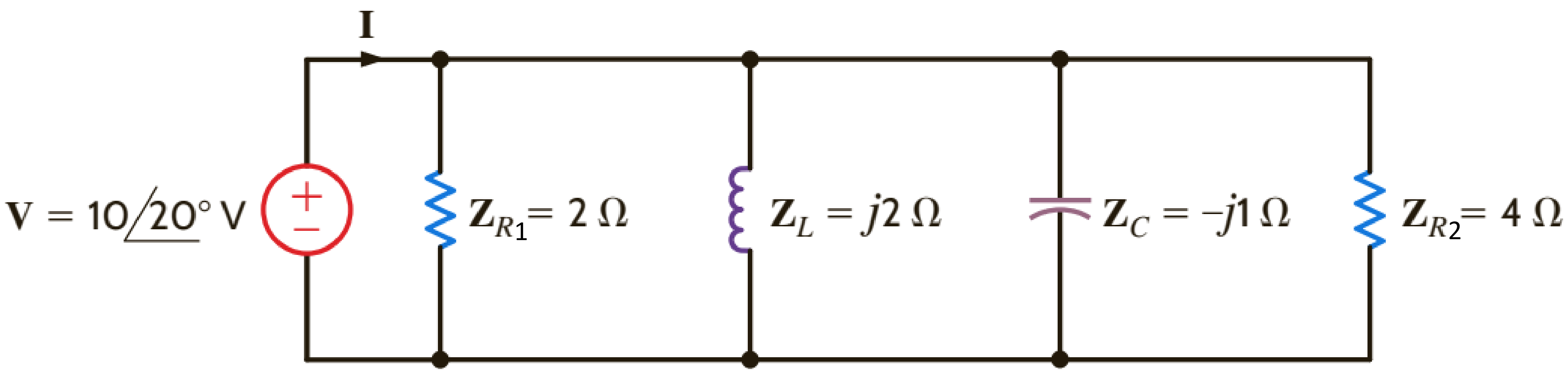
5.

Find the current in the network



5.

Find the current in the network



$$Y = Z^{-1} = \left(\frac{1}{Z_{R1}} + \frac{1}{Z_L} + \frac{1}{Z_C} + \frac{1}{Z_{R2}}\right) = \left(\frac{1}{2} + \frac{1}{j2} + \frac{1}{-j1} + \frac{1}{4}\right) = \left(\frac{3}{4} + j\frac{1}{2}\right) \text{ S}$$

$$\left[\left(\frac{3}{4}\right)^2 + \left(\frac{1}{2}\right)^2\right]^{\frac{1}{2}} \rightarrow \frac{\sqrt{13}}{4} = 0.901 \quad \text{S}$$

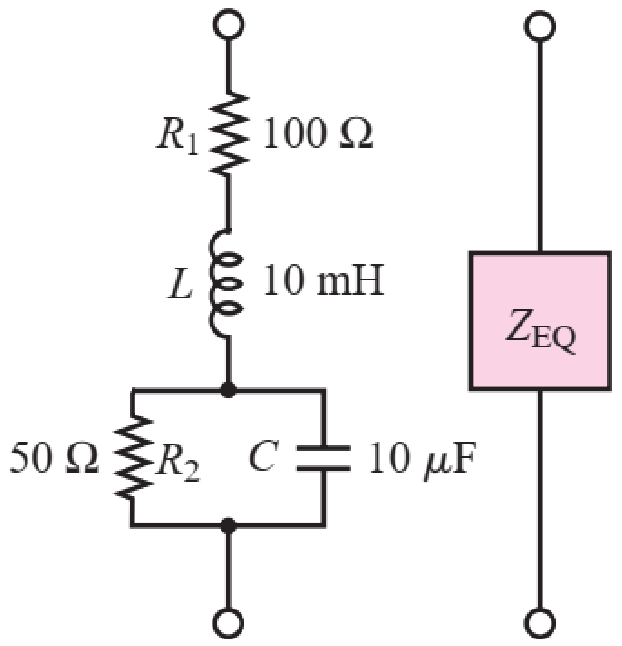
$$\text{atan}\left(\frac{\frac{1}{2}}{\frac{3}{4}}\right) \cdot \frac{180}{\pi} = 33.69 \ ^{o}$$

$$Y = 0.901\angle 33.69\ ^{o}$$

Answer: $I = VY = 10\angle 20\ ^{o} \cdot 0.901\angle 33.69\ ^{o} = 9.01\angle 53.69\ ^{o}$

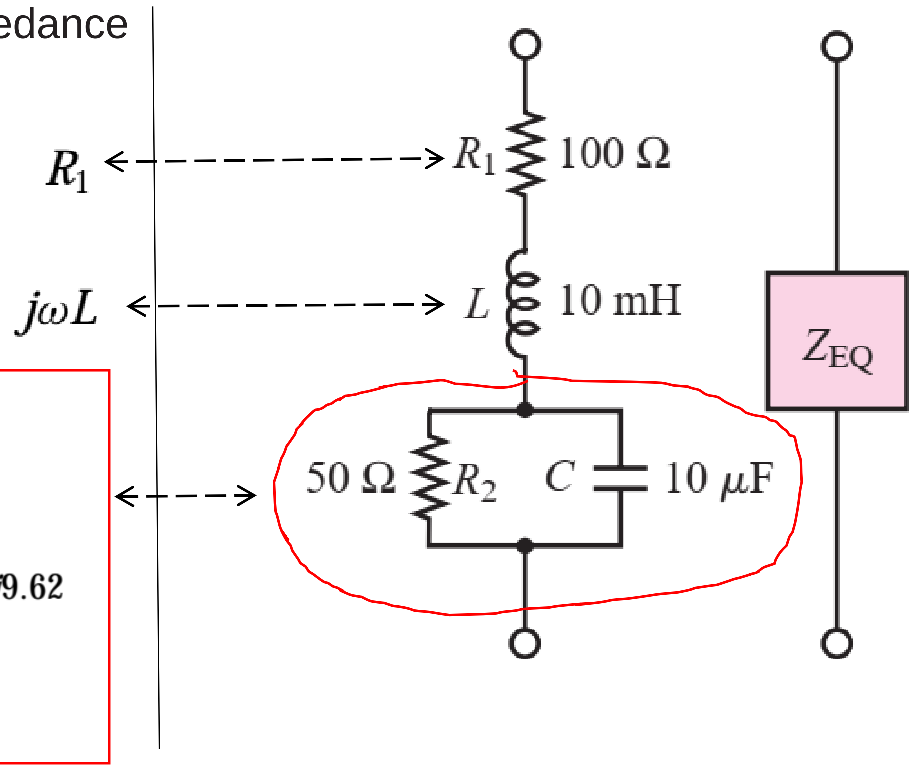
6.

Find the equivalent impedance of the circuit operating at $\omega = 10^4\,\mathrm{rad}/s$



6.

Find the equivalent impedance of the circuit operating at $\omega = 10^4\,\mathrm{rad}/s$



$$Z_{\|} = R_2 \left\| \frac{1}{j\omega C} \right. = \frac{R_2(1/j\omega C)}{R_2 + 1/j\omega C} = \frac{R_2}{1 + j\omega C R_2}$$

$$= \frac{50}{1 + j10^4 \times 10 \times 10^{-6} \times 50} = \frac{50}{1 + j5} = 1.92 - j9.62$$

$$= 9.81\angle(-1.3734)\ \Omega$$

Answer:

$$Z_{eq} = R_1 + j\omega L + Z_{\|} = 100 + j10^4 \times 10^{-2} + 1.92 - j9.62$$

$$= 101.92 + j90.38 = 136.2\angle 0.723\ \Omega$$