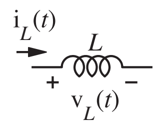
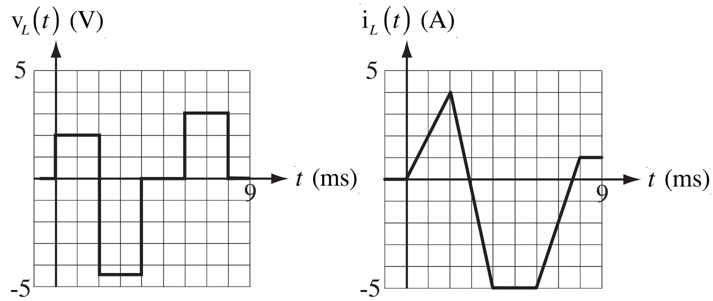
Solution of ECE 300 Test 6 S09

1. Let the inductance of the inductor L below be 1 mH. Draw a graph of the voltage across the inductor in the time range $0 < t < 9$ ms. Put a vertical scale for voltage on the graph so that numerical values could be read from it.





Between 0 and 2 ms the slope of the current is 2000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 2 volts.

Between 2 and 4 ms the slope of the current is -4500 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is -4.5 volts.

Between 4 and 6 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is -
0 volts.

Between 6 and 8 ms the slope of the current is 3000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 3 volts.

Between 8 and 9 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is -
0 volts.

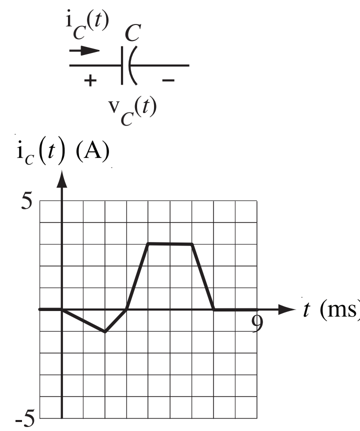
2. Let the capacitance of the capacitor below be $100\ \mu\text{F}$. If the initial capacitor voltage at $t = 0$ is 0 volts, what is the numerical value of the voltage across the capacitor at 9 ms?

$$v_C(t) = (1/C)\int_0^t i_C(\tau)\,d\tau + \underbrace{v_C(0)}_{=0}$$

Therefore $v_C(9\text{ ms})$ is the net area under the current curve in the time interval $0 < t < 9$ ms, divided by the capacitance

$$\begin{aligned}\text{Area} &= -1\text{A}\times 3\text{ms}/2 + 3\text{A}\times 1\text{ms}/2 + 3\text{A}\times 2\text{ms} + 3\text{A}\times 1\text{ms}/2 \\ &= (-1.5\text{mC} + 1.5\text{mC} + 6\text{mC} + 1.5\text{mC}) = 7.5\text{mC}\end{aligned}$$

and $v_C(9\text{ ms})$ is $7.5\text{mC}/100\mu\text{F} = 75\text{ V}$.



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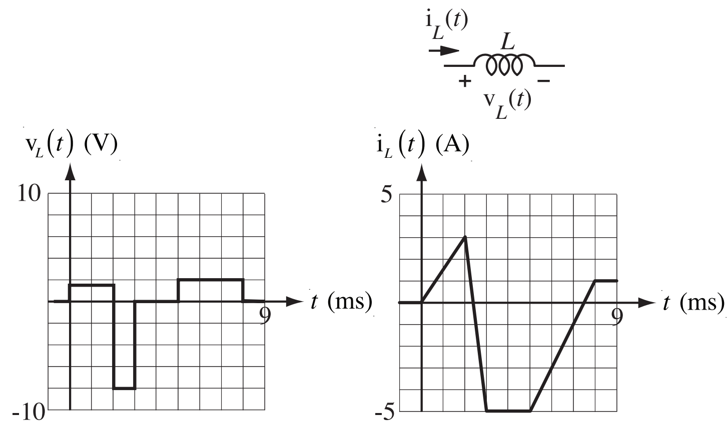


Between 0 and 2 ms the slope of the current is 1500 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 1.5 volts.

Between 2 and 3 ms the slope of the current is -8000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is -8 volts.

Between 3 and 5 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is - 0 volts.

Between 5 and 8 ms the slope of the current is 2000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 2 volts.

Between 8 and 9 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is - 0 volts.

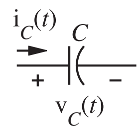
2. Let the capacitance of the capacitor below be $100\ \mu\text{F}$. If the initial capacitor voltage at $t = 0$ is 0 volts, what is the numerical value of the voltage across the capacitor at 9 ms?

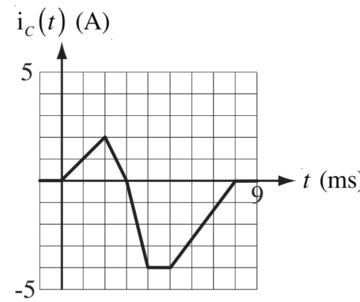
$$\text{v}_C(t) = (1/C)\int_0^t \text{i}_C(\tau)\,d\tau + \underbrace{\text{v}_C(0)}_{=0}$$

Therefore $\text{v}_C(9\text{ ms})$ is the net area under the current curve in the time interval $0 < t < 9$ ms, divided by the capacitance

$$\begin{aligned}\text{Area} &= 2\text{A}\times 3\text{ms}/2 - 4\text{A}\times 1\text{ms}/2 - 4\text{A}\times 1\text{ms} - 4\text{A}\times 3\text{ms}/2 \\ &= (3\text{mC} - 2\text{mC} - 4\text{mC} - 6\text{mC}) = -9\text{mC}\end{aligned}$$

and $\text{v}_C(9\text{ ms})$ is $-9\text{mC}/100\mu\text{F} = -90\text{ V}$.





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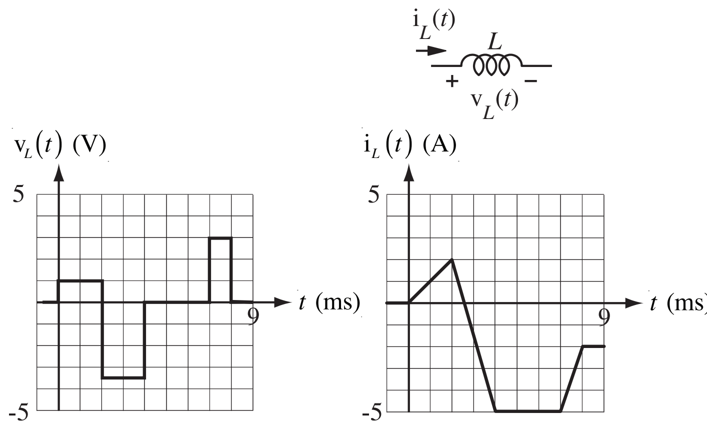

Between 0 and 2 ms the slope of the current is 1000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 1 volts.

Between 2 and 4 ms the slope of the current is -3500 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is -3.5 volts.

Between 4 and 7 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is - 0 volts.

Between 7 and 8 ms the slope of the current is 3000 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is 3 volts.

Between 8 and 9 ms the slope of the current is 0 A/s. Therefore by $v_L(t) = L\frac{d}{dt}(i_L(t))$, the voltage is - 0 volts.

2. Let the capacitance of the capacitor below be $100\ \mu\text{F}$. If the initial capacitor voltage at $t = 0$ is 0 volts, what is the numerical value of the voltage across the capacitor at 9 ms?

$$\text{v}_C(t) = (1/C)\int_0^t \text{i}_C(\tau)\,d\tau + \underbrace{\text{v}_C(0)}_{=0}$$

Therefore $\text{v}_C(9\text{ ms})$ is the net area under the current curve in the time interval $0 < t < 9$ ms, divided by the capacitance

$$\text{Area} = 2\text{A} \times 3\text{ms}/2 - 3\text{A} \times 1\text{ms}/2 - 3\text{A} \times 2\text{ms} - 2\text{A} \times 2\text{ms}/2 - 1\text{A} \times 3\text{ms} - 1\text{A} \times 1\text{ms}/2$$
$$= (3\text{mC} - 1.5\text{mC} - 6\text{mC} - 2\text{mC} - 3\text{mC} - 0.5\text{mC}) = -10\text{mC}$$

and $\text{v}_C(9\text{ ms})$ is $-10\text{mC}/100\mu\text{F} = -100\text{ V}$.