Solution of ECE 300 Test 7 S09

1. The switch in the circuit below has been closed a very long time. Find the numerical values of $v_c(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $v_c(200\text{ms})$ and $i_C(200\text{ms})$.

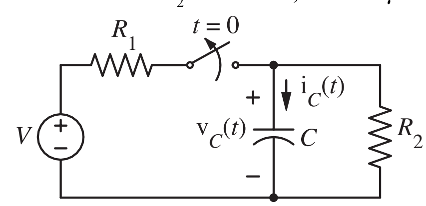
Just before the switch opens the capacitor has no current through it $\left[i_C(0^-)=0\right]$ and $v_C(0^-)$ is the same as the voltage across R_2 which is $100\text{ V}\dfrac{40\text{ k}\Omega}{40\text{ k}\Omega+20\text{ k}\Omega}=66.67\text{ V}$. The capacitor voltage cannot change instantaneously so the voltage is the same at $t=0^+$, 66.67 V. At $t=0^+$ the switch is open and the voltage across R_2 is 66.67 V. Therefore its current (downward) is 1.667 mA and that must be the negative of the capacitor current. So $i_C(0^+)=-1.667\text{ mA}$. The time constant is $\tau=400\text{ ms}$.

$$v_C(t)=v_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow v_C(200\text{ ms})=66.67e^{-0.5}=40.44\text{ V}$$

$$i_C(t)=i_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow i_C(200\text{ ms})=-1.67e^{-0.5}=-1.011\text{ mA}$$

$V=100\text{ V}$, $R_1=20\text{ k}\Omega$

$R_2=40\text{ k}\Omega$, $C=10\ \mu\text{F}$

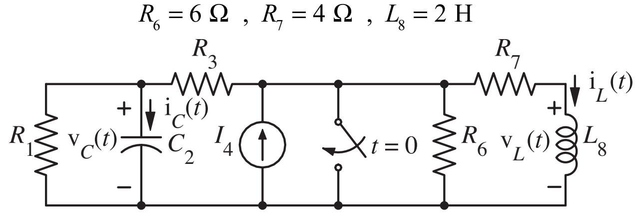


2. The switch in the circuit below has been open a very long time. Find the numerical values of $v_C(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $i_L(0^+)$, $v_L(0^-)$, $v_L(0^+)$, $\frac{d}{dt}(v_C(t))_{t=0^+}$ and $\frac{d}{dt}(i_L(t))_{t=0^+}$.

Before the switch closes all currents and voltages are constant so we know that $i_C(0^-)=0$ and $v_L(0^-)=0$. At $t=0^-$ the current downward through R_1 is $3\text{A}\frac{4\Omega\|6\Omega}{15\Omega+10\Omega+4\Omega\|6\Omega}=3\text{A}\frac{2.4\Omega}{27.4\Omega}=0.263\text{ A}$. So the voltage across it and $v_C(0^-)$ are both 3.94 V. That means that $v_C(0^+)$ is also 3.94 V because the capacitor voltage cannot change instantaneously. Before the switch closes $i_L(0^-)$ is $3\text{A}\times\frac{15\Omega+10\Omega}{15\Omega+10\Omega+4\Omega\|6\Omega}\times\frac{6\Omega}{6\Omega+4\Omega}=1.642\text{ A}$. Therefore $i_L(0^+)$ is also 1.642 A because the current in an inductor cannot change instantaneously. At $t=0^+$ the switch is closed and the current-source current all flows through the switch. The capacitor is in parallel with R_1 and R_3 and its current is the negative of its voltage divided by $R_1 \| R_3$ or -0.656 A. The inductor is now in parallel (and in series) with R_7 and its voltage must be the negative of its current times R_7 or -6.57 V. Using the defining equation for current and voltage for a capacitor, $\frac{d}{dt}(v_C(t))_{t=0^+}=\frac{i_C(0^+)}{C}=\frac{-0.656\text{ A}}{5\text{ mF}}=-131.2\text{ V/s}$. Using the defining equation for current and voltage for an inductor, $\frac{d}{dt}(i_L(t))_{t=0^+}=\frac{v_L(0^+)}{L}=\frac{-6.57\text{ V}}{2\text{ H}}=-3.285\text{ A/s}$.

$R_1=15\ \Omega$, $C_2=5\text{ mF}$, $R_3=10\ \Omega$, $I_4=3\text{ A}$

$R_6=6\ \Omega$, $R_7=4\ \Omega$, $L_8=2\text{ H}$



Solution of ECE 300 Test 7 S09

1. The switch in the circuit below has been closed a very long time. Find the numerical values of $v_c(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $v_c(200\text{ms})$ and $i_C(200\text{ms})$.

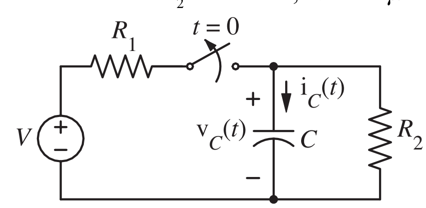
   Just before the switch opens the capacitor has no current through it $\left[i_C(0^-)=0\right]$ and $v_C(0^-)$ is the same as the voltage across R_2 which is $60\text{ V}\dfrac{40\text{ k}\Omega}{40\text{ k}\Omega+20\text{ k}\Omega}=40\text{ V}$. The capacitor voltage cannot change instantaneously so the voltage is the same at $t=0^+$, 40 V. At $t=0^+$ the switch is open and the voltage across R_2 is 40 V. Therefore its current (downward) is 1 mA and that must be the negative of the capacitor current. So $i_C(0^+)=-1\text{ mA}$. The time constant is $\tau=400\text{ ms}$.

   $v_C(t)=v_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow v_C(200\text{ ms})=40e^{-0.5}=24.264\text{ V}$

   $i_C(t)=i_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow i_C(200\text{ ms})=-1e^{-0.5}=-0.607\text{ mA}$

   $V=60\text{ V}\ ,\ R_1=20\text{ k}\Omega$

   $R_2=40\text{ k}\Omega\ ,\ C=10\ \mu\text{F}$

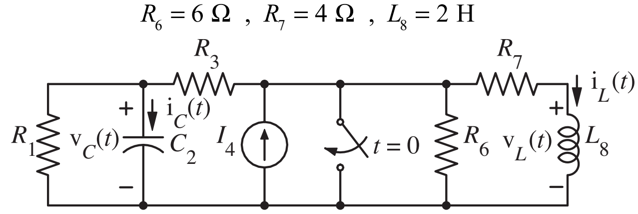


2. The switch in the circuit below has been open a very long time. Find the numerical values of $v_C(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $i_L(0^+)$, $v_L(0^-)$, $v_L(0^+)$, $\frac{d}{dt}(v_C(t))_{t=0^+}$ and $\frac{d}{dt}(i_L(t))_{t=0^+}$.

Before the switch closes all currents and voltages are constant so we know that $i_C(0^-)=0$ and $v_L(0^-)=0$. At $t=0^-$ the current downward through R_1 is $5\text{A}\frac{4\Omega \| 6\Omega}{15\Omega+10\Omega+4\Omega \| 6\Omega}=5\text{A}\frac{2.4\Omega}{27.4\Omega}=0.438\text{ A}$. So the voltage across it and $v_C(0^-)$ are both 6.57 V. That means that $v_C(0^+)$ is also 6.57 V because the capacitor voltage cannot change instantaneously. Before the switch closes $i_L(0^-)$ is $5\text{A}\times\frac{15\Omega+10\Omega}{15\Omega+10\Omega+4\Omega \| 6\Omega}\times\frac{6\Omega}{6\Omega+4\Omega}=2.74\text{ A}$. Therefore $i_L(0^+)$ is also 2.74 A because the current in an inductor cannot change instantaneously. At $t=0^+$ the switch is closed and the current-source current all flows through the switch. The capacitor is in parallel with R_1 and R_3 and its current is the negative of its voltage divided by $R_1 \| R_3$ or -1.095 A. The inductor is now in parallel (and in series) with R_7 and its voltage must be the negative of its current times R_7 or -10.95 V. Using the defining equation for current and voltage for a capacitor, $\frac{d}{dt}(v_C(t))_{t=0^+}=\frac{i_C(0^+)}{C}=\frac{-1.095\text{ A}}{5\text{ mF}}=-219\text{ V/s}$. Using the defining equation for current and voltage for an inductor, $\frac{d}{dt}(i_L(t))_{t=0^+}=\frac{v_L(0^+)}{L}=\frac{-10.95\text{ V}}{2\text{H}}=-5.475\text{ A/s}$.

$R_1=15\ \Omega$, $C_2=5\text{ mF}$, $R_3=10\ \Omega$, $I_4=5\text{ A}$

$R_6=6\ \Omega$, $R_7=4\ \Omega$, $L_8=2\text{ H}$



Solution of ECE 300 Test 7 S09

1. The switch in the circuit below has been closed a very long time. Find the numerical values of $v_c(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $v_c(200\text{ms})$ and $i_C(200\text{ms})$.

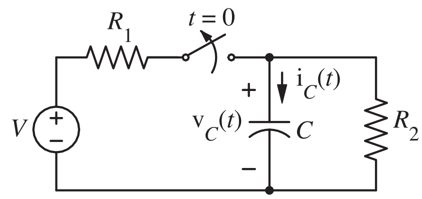
Just before the switch opens the capacitor has no current through it $\left[i_C(0^-)=0\right]$ and $v_C(0^-)$ is the same as the voltage across R_2 which is $40\text{ V}\dfrac{40\text{ k}\Omega}{40\text{ k}\Omega+20\text{ k}\Omega}=26.67\text{ V}$. The capacitor voltage cannot change instantaneously so the voltage is the same at $t=0^+$, 26.67 V. At $t=0^+$ the switch is open and the voltage across R_2 is 26.67 V. Therefore its current (downward) is 0.667 mA and that must be the negative of the capacitor current. So $i_C(0^+)=-0.667\text{ mA}$. The time constant is $\tau = 400\text{ ms}$.

$$v_C(t)=v_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow v_C(200\text{ ms})=26.67e^{-0.5}=16.18\text{ V}$$

$$i_C(t)=i_C(0^+)e^{-2.5t}\ ,\ t>0\ \Rightarrow i_C(200\text{ ms})=-0.667e^{-0.5}=-0.4044\text{ mA}$$

$V=40\text{ V}$, $R_1=20\text{ k}\Omega$

$R_2=40\text{ k}\Omega$, $C=10\ \mu\text{F}$



2. The switch in the circuit below has been open a very long time. Find the numerical values of $v_C(0^+)$, $i_C(0^-)$, $i_C(0^+)$, $i_L(0^+)$, $v_L(0^-)$, $v_L(0^+)$, $\frac{d}{dt}(v_C(t))_{t=0^+}$ and $\frac{d}{dt}(i_L(t))_{t=0^+}$.

Before the switch closes all currents and voltages are constant so we know that $i_C(0^-)=0$ and $v_L(0^-)=0$. At $t=0^-$ the current downward through R_1 is $2\text{A}\frac{4\Omega\|6\Omega}{15\Omega+10\Omega+4\Omega\|6\Omega}=2\text{A}\frac{2.4\Omega}{27.4\Omega}=0.175\text{ A}$. So the voltage across it and $v_C(0^-)$ are both 2.63 V. That means that $v_C(0^+)$ is also 2.63 V because the capacitor voltage cannot change instantaneously. Before the switch closes $i_L(0^-)$ is $2\text{A}\times\frac{15\Omega+10\Omega}{15\Omega+10\Omega+4\Omega\|6\Omega}\times\frac{6\Omega}{6\Omega+4\Omega}=1.095\text{ A}$. Therefore $i_L(0^+)$ is also 1.095 A because the current in an inductor cannot change instantaneously. At $t=0^+$ the switch is closed and the current-source current all flows through the switch. The capacitor is in parallel with R_1 and R_3 and its current is the negative of its voltage divided by $R_1 \| R_3$ or -0.437 A. The inductor is now in parallel (and in series) with R_7 and its voltage must be the negative of its current times R_7 or -4.38 V. Using the defining equation for current and voltage for a capacitor, $\frac{d}{dt}(v_C(t))_{t=0^+}=\frac{i_C(0^+)}{C}=\frac{-0.437\text{ A}}{5\text{ mF}}=-87.4\text{ V/s}$. Using the defining equation for current and voltage for an inductor, $\frac{d}{dt}(i_L(t))_{t=0^+}=\frac{v_L(0^+)}{L}=\frac{-4.38\text{ V}}{2\text{ H}}=-2.19\text{ A/s}$.

$R_1=15\ \Omega$, $C_2=5\text{ mF}$, $R_3=10\ \Omega$, $I_4=2\text{ A}$

$R_6=6\ \Omega$, $R_7=4\ \Omega$, $L_8=2\text{ H}$