Solution of ECE 300 Test 9 F09

1. With reference to the circuit below, find numerical values for the following.

$v_C(0^+)$ = ____________ V , $i_L(0^+)$ = ____________ A

$v_L(0^+)$ = ____________ V , $i_C(0^+)$ = ____________ A

$\frac{d}{dt}(i_L(t))\Big|_{t=0^+}$ = ____________ A/s , $\frac{d}{dt}(v_C(t))\Big|_{t=0^+}$ = ____________ V/s

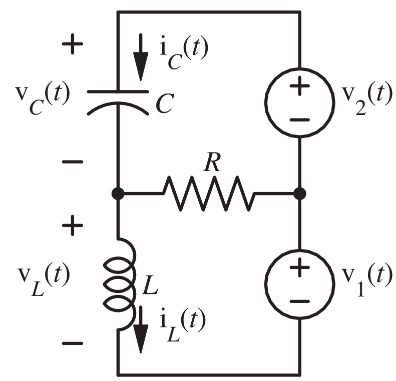
$\frac{d}{dt}(i_C(t))\Big|_{t=0^+}$ = ____________ A/s , $\frac{d}{dt}(v_L(t))\Big|_{t=0^+}$ = ____________ V/s

$v_C(+\infty)$ = ____________ V , $i_L(+\infty)$ = ____________ A

The damping factor α = ____________ /s. The natural radian frequency ω_0 = ____________ /s

$v_1(t) = 15\,u(t)$ V , $v_2(t) = 5$ V

$R = 20\Omega$, $L = 200$mH , $C = 10\mu$F



Before $t = 0$ all voltages and currents are constant, the capacitor is an open circuit and the inductor is a short circuit. There is no current through the capacitor and therefore no current anywhere in the circuit. By KVL around the top mesh the capacitor voltage must equal 5 V and that voltage will be the same at $t = 0^+$.

At $t = 0^+$ the 15 V source has just turned on, the voltage across the resistor is zero by KVL in the top mesh and its current is therefore zero. KCL on the left middle node results in zero current in the capacitor. KVL around the bottom mesh yields the inductor voltage of 15 V. The derivative of the inductor current is the inductor voltage divided by the inductance or $15\text{V}/200\text{mH} = 75$ A/s. The derivative of the capacitor voltage is the capacitor current divided by the capacitance or $0\text{A}/10\mu\text{F} = 0$ V/s. By KCL at the left middle node, the derivative of the capacitor current is the sum of the derivative of the inductor current and the derivative of the current to the right in the resistor. The derivative of the voltage across the resistor is zero by KVL on the top mesh. Therefore by Ohm's law the derivative of the current in the resistor is also zero and the derivative of the capacitor current is the same as the derivative of the inductor current, 75 A/s. By KVL the derivative of the inductor voltage is the sum of the derivative of $v_1(t)$ and the derivative of the voltage across the resistor, both of which are zero. Therefore the derivative of the inductor voltage is zero.

At $t \to +\infty$, the current through the capacitor is zero and the voltage across the inductor is zero. The voltage across the resistor is 15 V (positive on the right) and the current through the resistor and the inductor is $15\text{V}/20\Omega = 0.75$ A. By KVL around the top mesh the capacitor voltage is 20V.

The circuit is a parallel *RLC* circuit. Therefore $\alpha = 1/2RC = 1/(2)(20\Omega)(10\mu\text{F}) = 2500$ /s . The natural radian frequency is $\omega_0 = 1/\sqrt{LC} = 1/\sqrt{(200\text{mH})(10\mu\text{F})} = 707$ /s .

Solution of ECE 300 Test 9 F09

1. With reference to the circuit below, find numerical values for the following.

$v_C(0^+) =$ ____________ V , $i_L(0^+) =$ ____________ A

$v_L(0^+) =$ ____________ V , $i_C(0^+) =$ ____________ A

$\frac{d}{dt}(i_L(t))\Big|_{t=0^+} =$ ____________ A/s , $\frac{d}{dt}(v_C(t))\Big|_{t=0^+} =$ ____________ V/s

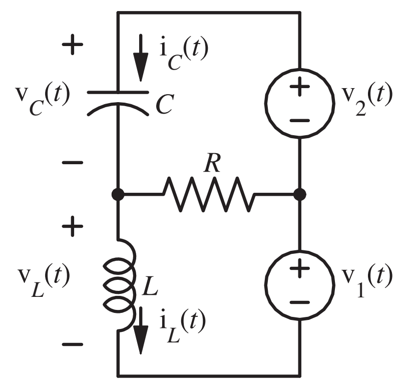
$\frac{d}{dt}(i_C(t))\Big|_{t=0^+} =$ ____________ A/s , $\frac{d}{dt}(v_L(t))\Big|_{t=0^+} =$ ____________ V/s

$v_C(+\infty) =$ ____________ V , $i_L(+\infty) =$ ____________ A

The damping factor $\alpha =$ ____________ /s. The natural radian frequency $\omega_0 =$ ____________ /s

$v_1(t) = 10\,u(t)$ V , $v_2(t) = 10$ V

$R = 20\Omega$, $L = 200\text{mH}$, $C = 10\mu\text{F}$



Before $t = 0$ all voltages and currents are constant, the capacitor is an open circuit and the inductor is a short circuit. There is no current through the capacitor and therefore no current anywhere in the circuit. By KVL around the top mesh the capacitor voltage must equal 10 V and that voltage will be the same at $t = 0^+$.

At $t = 0^+$ the other 10 V source has just turned on, the voltage across the resistor is zero by KVL in the top mesh and its current is therefore zero. KCL on the left middle node results in zero current in the capacitor. KVL around the bottom mesh yields the inductor voltage of 10 V. The derivative of the inductor current is the inductor voltage divided by the inductance or $10\text{V}/200\text{mH} = 50$ A/s. The derivative of the capacitor voltage is the capacitor current divided by the capacitance or $0\text{A}/10\mu\text{F} = 0$ V/s. By KCL at the left middle node, the derivative of the capacitor current is the sum of the derivative of the inductor current and the derivative of the current to the right in the resistor. The derivative of the voltage across the resistor is zero by KVL on the top mesh. Therefore by Ohm's law the derivative of the current in the resistor is also zero and the derivative of the capacitor current is the same as the derivative of the inductor current, 50 A/s. By KVL the derivative of the inductor voltage is the sum of the derivative of $v_1(t)$ and the derivative of the voltage across the resistor, both of which are zero. Therefore the derivative of the inductor voltage is zero.

At $t \to +\infty$, the current through the capacitor is zero and the voltage across the inductor is zero. The voltage across the resistor is 10 V (positive on the right) and the current through the resistor and the inductor is $10\text{V}/20\Omega = 0.5$ A. By KVL around the top mesh the capacitor voltage is 20V.

The circuit is a parallel *RLC* circuit. Therefore $\alpha = 1/2RC = 1/(2)(20\Omega)(10\mu\text{F}) = 2500$ /s. The natural radian frequency is $\omega_0 = 1/\sqrt{LC} = 1/\sqrt{(200\text{mH})(10\mu\text{F})} = 707$ /s.

Solution of ECE 300 Test 9 F09

1. With reference to the circuit below, find numerical values for the following.

$v_C(0^+)$ = ____________ V , $i_L(0^+)$ = ____________ A

$v_L(0^+)$ = ____________ V , $i_C(0^+)$ = ____________ A

$\frac{d}{dt}(i_L(t))\Big|_{t=0^+}$ = ____________ A/s , $\frac{d}{dt}(v_C(t))\Big|_{t=0^+}$ = ____________ V/s

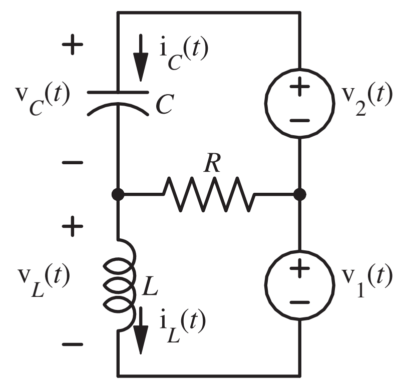
$\frac{d}{dt}(i_C(t))\Big|_{t=0^+}$ = ____________ A/s , $\frac{d}{dt}(v_L(t))\Big|_{t=0^+}$ = ____________ V/s

$v_C(+\infty)$ = ____________ V , $i_L(+\infty)$ = ____________ A

The damping factor α = ____________ /s. The natural radian frequency ω_0 = ____________ /s

$v_1(t) = 5\,u(t)$ V , $v_2(t) = 15$ V

$R = 20\Omega$, $L = 200\text{mH}$, $C = 10\mu\text{F}$



Before $t = 0$ all voltages and currents are constant, the capacitor is an open circuit and the inductor is a short circuit. There is no current through the capacitor and therefore no current anywhere in the circuit. By KVL around the top mesh the capacitor voltage must equal 15 V and that voltage will be the same at $t = 0^+$.

At $t = 0^+$ the 5 V source has just turned on, the voltage across the resistor is zero by KVL in the top mesh and its current is therefore zero. KCL on the left middle node results in zero current in the capacitor. KVL around the bottom mesh yields the inductor voltage of 5 V. The derivative of the inductor current is the inductor voltage divided by the inductance or $5\text{V}/200\text{mH} = 25$ A/s. The derivative of the capacitor voltage is the capacitor current divided by the capacitance or $0\text{A}/10\mu\text{F} = 0$ V/s. By KCL at the left middle node, the derivative of the capacitor current is the sum of the derivative of the inductor current and the derivative of the current to the right in the resistor. The derivative of the voltage across the resistor is zero by KVL on the top mesh. Therefore by Ohm's law the derivative of the current in the resistor is also zero and the derivative of the capacitor current is the same as the derivative of the inductor current, 25 A/s. By KVL the derivative of the inductor voltage is the sum of the derivative of $v_1(t)$ and the derivative of the voltage across the resistor, both of which are zero. Therefore the derivative of the inductor voltage is zero.

At $t \to +\infty$, the current through the capacitor is zero and the voltage across the inductor is zero. The voltage across the resistor is 5 V (positive on the right) and the current through the resistor and the inductor is $5\text{V}/20\Omega = 0.25$ A. By KVL around the top mesh the capacitor voltage is 20V.

The circuit is a parallel *RLC* circuit. Therefore $\alpha = 1/2RC = 1/(2)(20\Omega)(10\mu\text{F}) = 2500\ /\text{s}$. The natural radian frequency is $\omega_0 = 1/\sqrt{LC} = 1/\sqrt{(200\text{mH})(10\mu\text{F})} = 707\ /\text{s}$.