Solution of ECE 300 Test 7 S12

1. Fill in the blanks with correct numbers.

$i_1(0^-) =$ ____________ mA $i_2(0^-) =$ ____________ mA $i_C(0^-) =$ ____________ mA

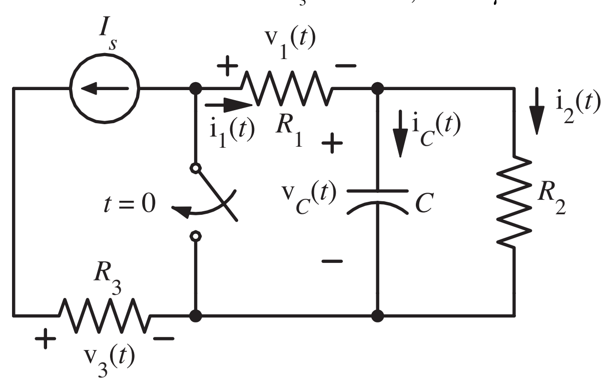
$v_1(0^-) =$ ____________ V $v_C(0^-) =$ ____________ V $v_3(0^-) =$ ____________ V

$i_1(0^+) =$ ____________ mA $i_2(0^+) =$ ____________ mA $i_C(0^+) =$ ____________ mA

$v_1(0^+) =$ ____________ V $v_C(0^+) =$ ____________ V $v_3(0^+) =$ ____________ V

For $t > 0$, the time constant τ is ____________ ms

$I_s = 2$ mA , $R_1 = 2.3$ kΩ , $R_2 = 1.8$ kΩ
$R_3 = 900$ Ω , $C = 22\mu$F



At $t = 0^-$, the switch is open, the capacitor is equivalent to an open circuit and all the I_s current flows through the three resistors counterclockwise. The voltage across the capacitor is $i_2 R_2 = -I_s R_2$ and does not change instantaneously when the switch is closed. So at $t = 0^+$ the switch is closed and the capacitor voltage and the current i_2 stay the same. The resistor R_1 is now in parallel with the capacitor so $v_1 = -v_C$ and $i_1 = v_1 / R_1$. The voltage across R_3 stays the same because it is in series with a current source that is constant. The time constant is $\tau = R_{eq}C$ where $R_{eq} = R_1 \parallel R_2$.

$i_1(0^-) = -2$ mA $i_2(0^-) = -2$ mA $i_C(0^-) = 0$ mA

$v_1(0^-) = -4.6$ V $v_C(0^-) = -3.6$ V $v_3(0^-) = 1.8$ V

$i_1(0^+) = 1.5652$ mA $i_2(0^+) = -2$ mA $i_C(0^+) = 3.5652$ mA

$v_1(0^+) = 3.6$ V $v_C(0^+) = -3.6$ V $v_3(0^+) = 1.8$ V

For $t > 0$, the time constant τ is 22.2 ms.

2. Fill in the blanks with correct numbers.

$i_1(0^-) =$ ___________ mA $i_2(0^-) =$ ___________ mA $i_L(0^-) =$ ___________ mA

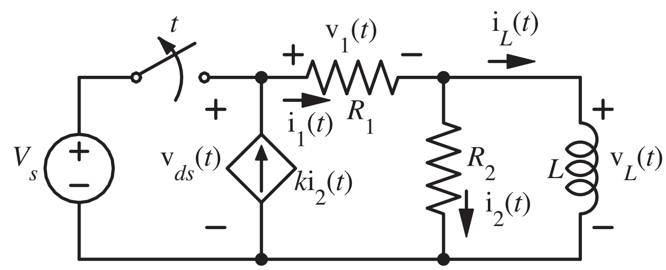
$v_1(0^-) =$ ___________ V $v_L(0^-) =$ ___________ V $v_{ds}(0^-) =$ ___________ V

$i_1(0^+) =$ ___________ mA $i_2(0^+) =$ ___________ mA $i_L(0^+) =$ ___________ mA

$v_1(0^+) =$ ___________ V $v_L(0^+) =$ ___________ V $v_{ds}(0^+) =$ ___________ V

For $t > 0$, the time constant τ is ___________ μs.

$V_s = 12$ V, $R_1 = 5.3$ kΩ, $R_2 = 8.8$ kΩ
$L = 24$ mH, $k = 0.6$



At $t = 0^-$, the switch is closed, the inductor is equivalent to a short circuit so the voltage across it is zero, making the voltage across R_2 zero, making the current i_2 zero, making the current $k\,i_2$ also zero. So $v_1 = V_s$ and the current through both R_1 and the inductor is V_s / R_1. At $t = 0^+$, $i_L + i_2 = k\,i_2$ (because the switch is now open) therefore $i_2 = \frac{i_L}{k-1}$. The currents $k\,i_2$ and i_1 are the same and $v_1 = i_1 R_1$. Also $v_L = i_2 R_2$ and $v_{ds} = v_L + v_1$. For $t > 0$, the equivalent resistance in parallel with the inductor is the Thevenin equivalent resistance of the network formed by the two resistors and the dependent source. Applying a 1 V test source at the load terminals of that network the current i_s flowing into the network is set by $i_2 = k\,i_2 + i_s$ and $i_2 = 1 / R_2$. Solving, $i_s = (1-k)/R_2$ and $R_{eq} = R_2 / (1-k)$ and $\tau = L / R_{eq} = (1-k)L / R_2$.

$i_1(0^-) = 2.2642$ mA $i_2(0^-) = 0$ mA $i_L(0^-) = 2.2642$ mA

$v_1(0^-) = 12$ V $v_L(0^-) = 0$ V $v_{ds}(0^-) = 12$ V

$i_1(0^+) = -3.3962$ mA $i_2(0^+) = -5.6604$ mA $i_L(0^+) = 2.2642$ mA

$v_1(0^+) = -18$ V $v_L(0^+) = -49.8115$ V $v_{ds}(0^+) = -67.8115$ V

For $t > 0$, the time constant τ is 1.091 μs.

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1. Fill in the blanks with correct numbers.

$i_1(0^-) =$ ____________ mA $i_2(0^-) =$ ____________ mA $i_C(0^-) =$ ____________ mA

$v_1(0^-) =$ ____________ V $v_C(0^-) =$ ____________ V $v_3(0^-) =$ ____________ V

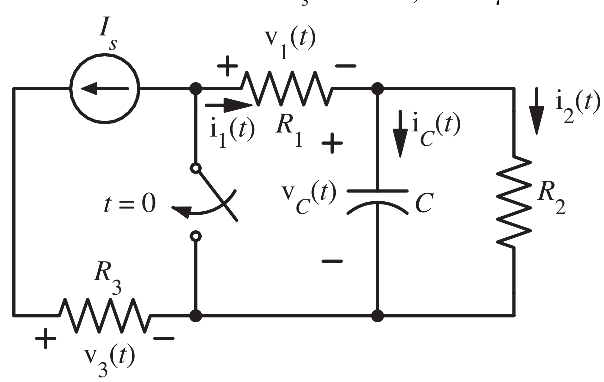
$i_1(0^+) =$ ____________ mA $i_2(0^+) =$ ____________ mA $i_C(0^+) =$ ____________ mA

$v_1(0^+) =$ ____________ V $v_C(0^+) =$ ____________ V $v_3(0^+) =$ ____________ V

For $t > 0$, the time constant τ is ____________ ms

$I_s = 1$ mA , $R_1 = 2.3$ kΩ , $R_2 = 1.8$ kΩ

$R_3 = 900$ Ω , $C = 47\mu$F



At $t = 0^-$, the switch is open, the capacitor is equivalent to an open circuit and all the I_s current flows through the three resistors counterclockwise. The voltage across the capacitor is $i_2 R_2 = -I_s R_2$ and does not change instantaneously when the switch is closed. So at $t = 0^+$ the switch is closed and the capacitor voltage and the current i_2 stay the same. The resistor R_1 is now in parallel with the capacitor so $v_1 = -v_C$ and $i_1 = v_1 / R_1$. The voltage across R_3 stays the same because it is in series with a current source that is constant. The time constant is $\tau = R_{eq} C$ where $R_{eq} = R_1 \parallel R_2$.

$i_1(0^-) = -1$ mA $i_2(0^-) = -1$ mA $i_C(0^-) = 0$ mA

$v_1(0^-) = -2.3$ V $v_C(0^-) = -1.8$ V $v_3(0^-) = 0.9$ V

$i_1(0^+) = 0.7826$ mA $i_2(0^+) = -1$ mA $i_C(0^+) = 1.7826$ mA

$v_1(0^+) = 1.8$ V $v_C(0^+) = -1.8$ V $v_3(0^+) = 0.9$ V

For $t > 0$, the time constant τ is 47.43 ms.

2. Fill in the blanks with correct numbers.

$i_1(0^-) =$ ____________ mA $i_2(0^-) =$ ____________ mA $i_L(0^-) =$ ____________ mA

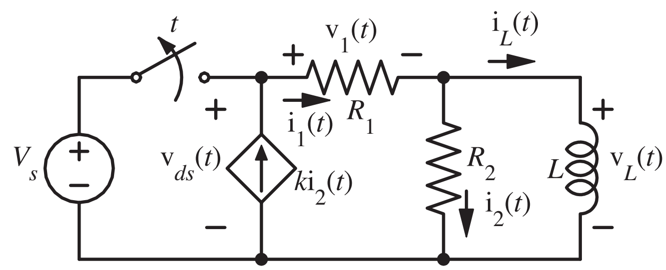
$v_1(0^-) =$ ____________ V $v_L(0^-) =$ ____________ V $v_{ds}(0^-) =$ ____________ V

$i_1(0^+) =$ ____________ mA $i_2(0^+) =$ ____________ mA $i_L(0^+) =$ ____________ mA

$v_1(0^+) =$ ____________ V $v_L(0^+) =$ ____________ V $v_{ds}(0^+) =$ ____________ V

For $t > 0$, the time constant τ is ____________ μs .

$V_s = 24$ V , $R_1 = 5.3$ kΩ , $R_2 = 8.8$ kΩ
$L = 12$ mH , $k = 0.6$



At $t = 0^-$, the switch is closed, the inductor is equivalent to a short circuit so the voltage across it is zero, making the voltage across R_2 zero, making the current i_2 zero, making the current $k i_2$ also zero. So $v_1 = V_s$ and the current through both R_1 and the inductor is V_s / R_1. At $t = 0^+$, $i_L + i_2 = k i_2$ (because the switch is now open) therefore $i_2 = \frac{i_L}{k-1}$. The currents $k i_2$ and i_1 are the same and $v_1 = i_1 R_1$. Also $v_L = i_2 R_2$ and $v_{ds} = v_L + v_1$. For $t > 0$, the equivalent resistance in parallel with the inductor is the Thevenin equivalent resistance of the network formed by the two resistors and the dependent source. Applying a 1 V test source at the load terminals of that network the current i_s flowing into the network is set by $i_2 = k i_2 + i_s$ and $i_2 = 1 / R_2$. Solving, $i_s = (1-k) / R_2$ and $R_{eq} = R_2 / (1-k)$ and $\tau = L / R_{eq} = (1-k) L / R_2$.

$i_1(0^-) = 4.5284$ mA $i_2(0^-) = 0$ mA $i_L(0^-) = 4.5284$ mA

$v_1(0^-) = 24$ V $v_L(0^-) = 0$ V $v_{ds}(0^-) = 24$ V

$i_1(0^+) = -6.7924$ mA $i_2(0^+) = -11.3208$ mA $i_L(0^+) = 4.5284$ mA

$v_1(0^+) = -36$ V $v_L(0^+) = -99.623$ V $v_{ds}(0^+) = -135.623$ V

For $t > 0$, the time constant τ is 0.5455 μs .

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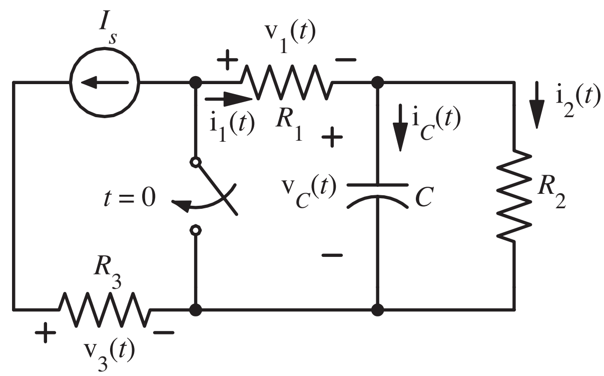
1. Fill in the blanks with correct numbers.

$i_1(0^-) =$ ____________ mA $i_2(0^-) =$ ____________ mA $i_C(0^-) =$ ____________ mA
$v_1(0^-) =$ ____________ V $v_C(0^-) =$ ____________ V $v_3(0^-) =$ ____________ V
$i_1(0^+) =$ ____________ mA $i_2(0^+) =$ ____________ mA $i_C(0^+) =$ ____________ mA
$v_1(0^+) =$ ____________ V $v_C(0^+) =$ ____________ V $v_3(0^+) =$ ____________ V

For $t > 0$, the time constant τ is ____________ ms

$I_s = 4$ mA , $R_1 = 2.3$ kΩ , $R_2 = 1.8$ kΩ
$R_3 = 900$ Ω , $C = 44\mu$F



At $t = 0^-$, the switch is open, the capacitor is equivalent to an open circuit and all the I_s current flows through the three resistors counterclockwise. The voltage across the capacitor is $i_2 R_2 = -I_s R_2$ and does not change instantaneously when the switch is closed. So at $t = 0^+$ the switch is closed and the capacitor voltage and the current i_2 stay the same. The resistor R_1 is now in parallel with the capacitor so $v_1 = -v_C$ and $i_1 = v_1 / R_1$. The voltage across R_3 stays the same because it is in series with a current source that is constant. The time constant is $\tau = R_{eq}C$ where $R_{eq} = R_1 \parallel R_2$.

$i_1(0^-) = -4$ mA $i_2(0^-) = -4$ mA $i_C(0^-) = 0$ mA
$v_1(0^-) = -9.2$ V $v_C(0^-) = -7.2$ V $v_3(0^-) = 3.6$ V
$i_1(0^+) = 3.1304$ mA $i_2(0^+) = -4$ mA $i_C(0^+) = 7.1304$ mA
$v_1(0^+) = 7.2$ V $v_C(0^+) = -7.2$ V $v_3(0^+) = 3.6$ V

For $t > 0$, the time constant τ is 44.4 ms.

2. Fill in the blanks with correct numbers.

$\mathrm{i}_1(0^-) =$ ____________ mA $\mathrm{i}_2(0^-) =$ ____________ mA $\mathrm{i}_L(0^-) =$ ____________ mA

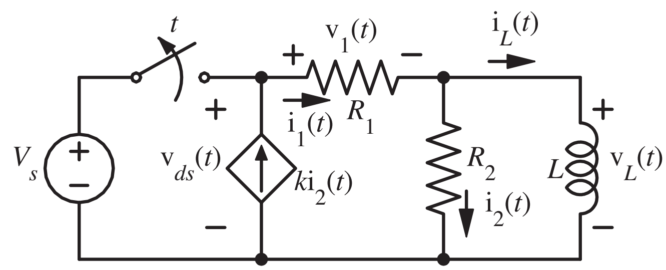
$\mathrm{v}_1(0^-) =$ ____________ V $\mathrm{v}_L(0^-) =$ ____________ V $\mathrm{v}_{ds}(0^-) =$ ____________ V

$\mathrm{i}_1(0^+) =$ ____________ mA $\mathrm{i}_2(0^+) =$ ____________ mA $\mathrm{i}_L(0^+) =$ ____________ mA

$\mathrm{v}_1(0^+) =$ ____________ V $\mathrm{v}_L(0^+) =$ ____________ V $\mathrm{v}_{ds}(0^+) =$ ____________ V

For $t > 0$, the time constant τ is ____________ μs.

$V_s = 6$ V, $R_1 = 5.3$ kΩ, $R_2 = 8.8$ kΩ
$L = 48$ mH, $k = 0.6$



At $t = 0^-$, the switch is closed, the inductor is equivalent to a short circuit so the voltage across it is zero, making the voltage across R_2 zero, making the current i_2 zero, making the current $k\,\mathrm{i}_2$ also zero. So $\mathrm{v}_1 = V_s$ and the current through both R_1 and the inductor is V_s / R_1. At $t = 0^+$, $\mathrm{i}_L + \mathrm{i}_2 = k\,\mathrm{i}_2$ (because the switch is now open) therefore $\mathrm{i}_2 = \dfrac{\mathrm{i}_L}{k-1}$. The currents $k\,\mathrm{i}_2$ and i_1 are the same and $\mathrm{v}_1 = \mathrm{i}_1 R_1$. Also $\mathrm{v}_L = \mathrm{i}_2 R_2$ and $\mathrm{v}_{ds} = \mathrm{v}_L + \mathrm{v}_1$. For $t > 0$, the equivalent resistance in parallel with the inductor is the Thevenin equivalent resistance of the network formed by the two resistors and the dependent source. Applying a 1 V test source at the load terminals of that network the current i_s flowing into the network is set by $\mathrm{i}_2 = k\,\mathrm{i}_2 + \mathrm{i}_s$ and $\mathrm{i}_2 = 1 / R_2$. Solving, $\mathrm{i}_s = (1-k) / R_2$ and $R_{eq} = R_2 / (1-k)$ and $\tau = L / R_{eq} = (1-k) L / R_2$.

$\mathrm{i}_1(0^-) = 1.1321$ mA $\mathrm{i}_2(0^-) = 0$ mA $\mathrm{i}_L(0^-) = 1.1321$ mA

$\mathrm{v}_1(0^-) = 6$ V $\mathrm{v}_L(0^-) = 0$ V $\mathrm{v}_{ds}(0^-) = 6$ V

$\mathrm{i}_1(0^+) = -1.6981$ mA $\mathrm{i}_2(0^+) = -2.8302$ mA $\mathrm{i}_L(0^+) = 1.1321$ mA

$\mathrm{v}_1(0^+) = -9$ V $\mathrm{v}_L(0^+) = -24.4058$ V $\mathrm{v}_{ds}(0^+) = -33.9057$ V

For $t > 0$, the time constant τ is 2.182 μs.