Solution of ECE 300 Test 7 S11

1. With reference to the circuit below fill in the blanks with numbers.

Before $t = 0$ the capacitor current is zero. Due to the voltage source alone $i_1 = i_2 = i_3 = -\dfrac{10\text{V}}{22\Omega + 50\Omega + 35\Omega} = -93.5\text{mA}$. The three resistor voltages are then $v_1 = -93.5\text{mA} \times 22\Omega = -2.057$ V, $v_2 = -93.5\text{mA} \times 50\Omega = -4.675$ V and $v_3 = -93.5$ mA $\times 35\Omega = -3.2725$ V. The capacitor voltage is $v_2 + v_3$ and that is -7.9475 V. Due to the current source alone $v_3(t) = 100\text{mA} \times 35\Omega \| (50\Omega + 22\Omega) = 2.3551$ V, $i_3 = 2.3551$ V$/35\Omega = 67.3$ mA $i_1 = i_2 = -2.3551$ V$/(50\Omega + 22\Omega) = -32.7$mA, $v_1 = -32.7\text{mA} \times 22\Omega = -0.7196$ V and $v_2 = -32.7\text{mA} \times 50\Omega = -1.635$ V and $v_C = -v_1 = 0.7196$ V.

At $t = 0^+$, due to the voltage source alone the capacitor voltage is still -7.9475 V and $v_s = -2$ V. Therefore $v_1 = 5.9475$ V, $i_1 = 5.9475 / 22\Omega = 270.3$mA, $i_2 = i_3 = -7.9475\text{V}/(50\Omega + 35\Omega) = -93.5$ mA, $v_2 = -4.675$ V and $v_3 = -3.2725$ V, $i_C = i_1 - i_2 = 270.3\text{mA} - (-93.5\text{mA}) = 363.8$mA. Due to the current source alone, $i_s = 0$, the capacitor voltage is still 0.7196 V, $i_1 = -v_C / 22\Omega = -32.7$ mA, $i_2 = i_3 = 0.7196\text{V}/(50\Omega + 35\Omega) = 8.5$ mA, $v_2 = 8.5\text{mA} \times 50\Omega = 0.4233$ V and $v_3 = 8.5\text{mA} \times 35\Omega = 0.2975$ V. The capacitor current is $i_C = i_1 - i_2 = -32.7\text{mA} - 8.5\text{mA} = -41.2$mA.

At $t \to \infty$, capacitor current is again zero, current source is at zero and voltage source is -2 V.
$i_1 = i_2 = i_2 = -2\text{V}/(22\Omega + 50\Omega + 35\Omega) = -18.7$mA, $v_1 = -18.7\text{mA} \times 22\Omega = -0.4122$V, $v_2 = -18.7\text{mA} \times 50\Omega = -0.935$V, $v_3 = -18.7\text{mA} \times 35\Omega = -0.6545$V and $v_C = v_2 + v_3 = -1.5895$ V.

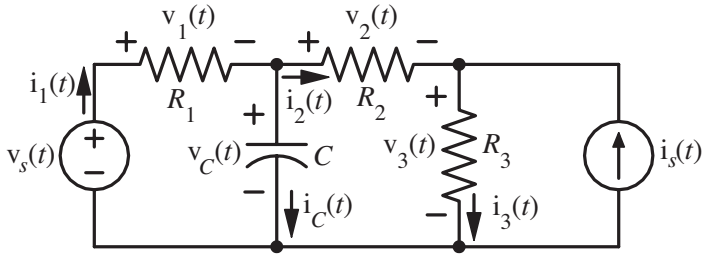
$$v_1(0^-) = -2.7766 \text{ V} \quad v_2(0^-) = -6.31 \text{ V} \quad v_3(0^-) = -0.9174 \text{ V} \quad v_C(0^-) = -7.2279 \text{ V}$$
$$v_1(0^+) = 5.2279 \text{ V} \quad v_2(0^+) = -4.2517 \text{ V} \quad v_3(0^+) = -2.975 \text{ V} \quad v_C(0^+) = -7.2279 \text{ V}$$
$$v_1(\infty) = -0.4122 \text{ V} \quad v_2(\infty) = -0.935 \text{ V} \quad v_3(\infty) = -0.6545 \text{ V} \quad v_C(\infty) = -1.5895 \text{ V}$$

$$i_1(0^-) = -126.2 \text{ mA} \quad i_2(0^-) = -126.2 \text{ mA} \quad i_3(0^-) = -26.2 \text{ A} \quad i_C(0^-) = 0 \text{ mA}$$
$$i_1(0^+) = 237.6 \text{ mA} \quad i_2(0^+) = -85 \text{ mA} \quad i_3(0^+) = -85 \text{ mA} \quad i_C(0^+) = 322.6 \text{ mA}$$
$$i_1(\infty) = -18.7 \text{ mA} \quad i_2(\infty) = -18.7 \text{ mA} \quad i_3(\infty) = -18.7 \text{ mA} \quad i_C(\infty) = 0 \text{ mA}$$

The time constant is $\tau = 15\mu\text{F} \times 22\Omega \| (50\Omega + 35\Omega) = 0.2622$ms.

$$i_3(t) = \left[-66.3\text{mA}e^{-t/\tau} + i_3(\infty)\right], t > 0 \qquad i_C(t) = \left[322.6\text{mA}e^{-t/\tau} + i_C(\infty)\right], t > 0$$
$$v_3(t) = \left[-2.3205\text{V}e^{-t/\tau} + v_3(\infty)\right], t > 0 \qquad v_C(t) = \left[-5.6384\text{V}e^{-t/\tau} + v_C(\infty)\right], t > 0$$

$v_s(t) = -10 + 8\,u(t)$ V, $i_s(t) = 100\,u(-t)$ mA, $R_1 = 22\Omega$
$R_2 = 50\Omega$, $R_3 = 35\Omega$, $C = 15\mu$F



Solution of ECE 300 Test 7 S11

1. With reference to the circuit below fill in the blanks with numbers.

Before $t = 0$ the capacitor current is zero. Due to the voltage source alone $i_1 = i_2 = i_3 = \dfrac{10\text{V}}{22\Omega + 50\Omega + 35\Omega} = 93.5\text{ mA}$. The three resistor voltages are then $v_1 = 93.5\text{mA} \times 22\Omega = 2.057\text{ V}$, $v_2 = 93.5\text{mA} \times 50\Omega = 4.675\text{ V}$ and $v_3 = 93.5\text{ mA} \times 35\Omega = 3.2725\text{ V}$. The capacitor voltage is $v_2 + v_3$ and that is 7.9475 V. Due to the current source alone $v_3(t) = 200\text{mA} \times 35\Omega \| (50\Omega + 22\Omega) = 4.71\text{ V}$, $i_3 = 4.71\text{V}/35\Omega = 134.6\text{ mA}$ $i_1 = i_2 = -4.71\text{ V}/(50\Omega + 22\Omega) = -65.4\text{mA}$, $v_1 = -65.4\text{mA} \times 22\Omega = -1.4392\text{ V}$ and $v_2 = -65.4\text{mA} \times 50\Omega = -3.27\text{ V}$ and $v_C = -v_1 = 1.4392\text{ V}$.

At $t = 0^+$, due to the voltage source alone the capacitor voltage is still 7.9475 V and $v_s = 2\text{ V}$. Therefore $v_1 = -5.9475\text{ V}$, $i_1 = -5.9475 / 22\Omega = -270.3\text{mA}$, $i_2 = i_3 = 7.9475\text{V}/(50\Omega + 35\Omega) = 93.5\text{ mA}$, $v_2 = 4.675\text{ V}$ and $v_3 = 3.2725\text{ V}$, $i_C = i_1 - i_2 = -270.3\text{mA} - (93.5\text{mA}) = -363.8\text{mA}$. Due to the current source alone, $i_s = 0$, the capacitor voltage is still 1.4392 V, $i_1 = -v_C / 22\Omega = -65.4\text{ mA}$, $i_2 = i_3 = 1.4392\text{V}/(50\Omega + 35\Omega) = 17\text{ mA}$, $v_2 = 17\text{mA} \times 50\Omega = 0.8466\text{ V}$ and $v_3 = 17\text{mA} \times 35\Omega = 0.595\text{ V}$. The capacitor current is $i_C = i_1 - i_2 = -65.4\text{mA} - 17\text{mA} = -82.4\text{mA}$.

At $t \to \infty$, capacitor current is again zero, current source is at zero and voltage source is 2 V.
$i_1 = i_2 = i_2 = 2\text{V}/(22\Omega + 50\Omega + 35\Omega) = 18.7\text{mA}$, $v_1 = 18.7\text{mA} \times 22\Omega = 0.4122\text{V}$, $v_2 = 18.7\text{mA} \times 50\Omega = 0.935\text{V}$, $v_3 = 18.7\text{mA} \times 35\Omega = 0.6545\text{V}$ and $v_C = v_2 + v_3 = 1.5895\text{ V}$.

$$v_1(0^-) = 0.618\text{ V} \quad v_2(0^-) = 1.405\text{ V} \quad v_3(0^-) = 7.9825\text{ V} \quad v_C(0^-) = 9.3867\text{ V}$$
$$v_1(0^+) = -7.3867\text{ V} \quad v_2(0^+) = 5.5216\text{ V} \quad v_3(0^+) = 3.8675\text{ V} \quad v_C(0^+) = 9.3867\text{ V}$$
$$v_1(\infty) = 0.4122\text{ V} \quad v_2(\infty) = 0.935\text{ V} \quad v_3(\infty) = 0.6545\text{ V} \quad v_C(\infty) = 1.5895\text{ V}$$

$$i_1(0^-) = 28.1\text{ mA} \quad i_2(0^-) = 28.1\text{ mA} \quad i_3(0^-) = 228.1\text{ A} \quad i_C(0^-) = 0\text{ mA}$$
$$i_1(0^+) = -335.7\text{ mA} \quad i_2(0^+) = 110.5\text{ mA} \quad i_3(0^+) = 110.5\text{ mA} \quad i_C(0^+) = -446.2\text{ mA}$$
$$i_1(\infty) = 18.7\text{ mA} \quad i_2(\infty) = 18.7\text{ mA} \quad i_3(\infty) = 18.7\text{ mA} \quad i_C(\infty) = 0\text{ mA}$$

The time constant is $\tau = 15\mu\text{F} \times 22\Omega \| (50\Omega + 35\Omega) = 0.2622\text{ms}$.

$$i_3(t) = \left[91.8\text{mA}e^{-t/\tau} + i_3(\infty)\right],\ t > 0 \qquad i_C(t) = \left[-446.2\text{mA}e^{-t/\tau} + i_C(\infty)\right],\ t > 0$$
$$v_3(t) = \left[3.213\text{V}e^{-t/\tau} + v_3(\infty)\right],\ t > 0 \qquad v_C(t) = \left[7.7972\text{V}e^{-t/\tau} + v_C(\infty)\right],\ t > 0$$

$v_s(t) = 10 - 8\,u(t)\text{ V}$, $i_s(t) = 200\,u(-t)\text{ mA}$, $R_1 = 22\Omega$
$R_2 = 50\Omega$, $R_3 = 35\Omega$, $C = 15\mu\text{F}$