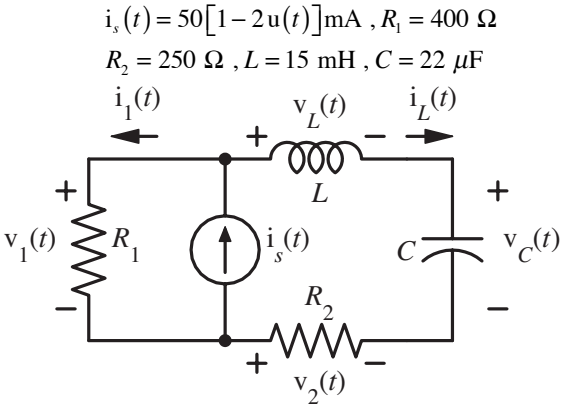
Solution of ECE 300 Test 9 F10

1. (a) Fill in the table below with numbers.



$v_1(0^-) = 20$ V $\quad v_2(0^-) = 0$ V $\quad v_L(0^-) = 0$ V $\quad v_C(0^-) = 20$ V

$v_1(0^+) = -20$ V $\quad v_2(0^+) = 0$ V $\quad v_L(0^+) = -40$ V $\quad v_C(0^+) = 20$ V

$v_1(\infty) = -20$ V $\quad v_2(\infty) = 0$ V $\quad v_L(\infty) = 0$ V $\quad v_C(\infty) = -20$ V

$i_1(0^-) = 50$ mA $\quad i_L(0^-) = 0$ mA

$i_1(0^+) = -50$ mA $\quad i_L(0^+) = 0$ mA

$i_1(\infty) = -50$ mA $\quad i_L(\infty) = 0$ mA

(b) Find these numerical values.

$$\alpha = R/2L = 650\Omega / 30\text{mH} = 21{,}667$$
$$\omega_0 = 1/\sqrt{LC} = 1/\sqrt{15\text{mH} \times 22\mu\text{F}} = 1740.8$$
$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} = -70.04$$
$$s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2} = -43{,}263$$

(c) If $\mathrm{v}_C(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} + \mathrm{v}_C(\infty)$ find the numerical values of A_1 and A_2.

$$\mathrm{v}_C(0^+) = A_1 + A_2 - 20 = 20 \text{ V}$$
$$\left.\frac{d\,\mathrm{v}_C(t)}{dt}\right|_{t=0^+} = s_1 A_1 + s_2 A_2 = \frac{\mathrm{i}_C(0^+)}{C} = \frac{\mathrm{i}_L(0^+)}{C} = 0$$

$$\begin{bmatrix} 1 & 1 \\ -70.04 & -43263 \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} 40 \\ 0 \end{bmatrix} \Rightarrow A_1 = 40.0649 \text{ , } A_2 = -0.0649$$

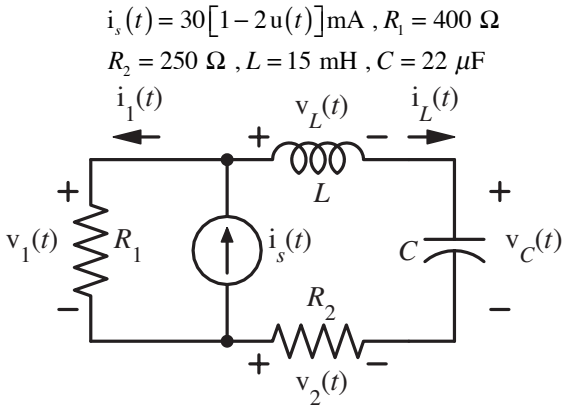
(d) Find the numerical value of $\mathrm{v}_C(0.5 \text{ ms})$.

$$\mathrm{v}_C(t) = 40.0649 e^{-70.04t} - 0.0649 e^{-43263t} - 20$$

$$\mathrm{v}_C(0.5 \text{ ms}) = 40.0649 e^{-70.04 \times 0.0005} - 0.0649 e^{-43263 \times 0.0005} - 20 = 18.6861 \text{ V}$$

Solution of ECE 300 Test 9 F10

1. (a) Fill in the table below with numbers.



$$v_1(0^-) = 12\text{ V} \quad v_2(0^-) = 0\text{ V} \quad v_L(0^-) = 0\text{ V} \quad v_C(0^-) = 12\text{ V}$$
$$v_1(0^+) = -12\text{ V} \quad v_2(0^+) = 0\text{ V} \quad v_L(0^+) = -24\text{ V} \quad v_C(0^+) = 12\text{ V}$$
$$v_1(\infty) = -12\text{ V} \quad v_2(\infty) = 0\text{ V} \quad v_L(\infty) = 0\text{ V} \quad v_C(\infty) = -12\text{ V}$$

$$i_1(0^-) = 30\text{ mA} \quad i_L(0^-) = 0\text{ mA}$$
$$i_1(0^+) = -30\text{ mA} \quad i_L(0^+) = 0\text{ mA}$$
$$i_1(\infty) = -30\text{ mA} \quad i_L(\infty) = 0\text{ mA}$$

(b) Find these numerical values.

$$\alpha = R/2L = 650\Omega/30\text{mH} = 21{,}667$$
$$\omega_0 = 1/\sqrt{LC} = 1/\sqrt{15\text{mH}\times 22\mu\text{F}} = 1740.8$$
$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} = -70.04$$
$$s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2} = -43{,}263$$

(c) If $\mathrm{v}_C(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} + \mathrm{v}_C(\infty)$ find the numerical values of A_1 and A_2.

$$\mathrm{v}_C(0^+) = A_1 + A_2 - 12 = 12 \text{ V}$$
$$\left.\frac{d\,\mathrm{v}_C(t)}{dt}\right|_{t=0^+} = s_1 A_1 + s_2 A_2 = \frac{\mathrm{i}_C(0^+)}{C} = \frac{\mathrm{i}_L(0^+)}{C} = 0$$

$$\begin{bmatrix} 1 & 1 \\ -70.04 & -43263 \end{bmatrix}\begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} 24 \\ 0 \end{bmatrix} \Rightarrow A_1 = 24.0389 \text{ , } A_2 = -0.0389$$

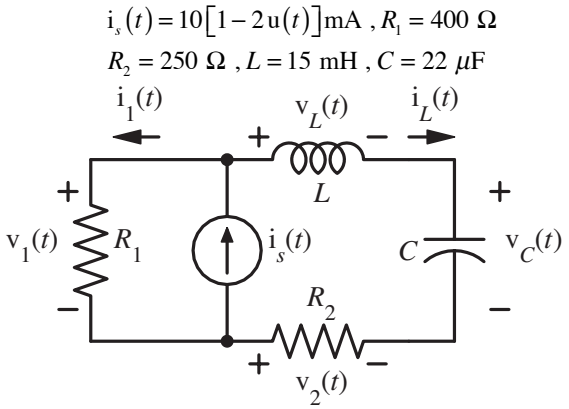
(d) Find the numerical value of $\mathrm{v}_C(0.5\text{ ms})$.

$$\mathrm{v}_C(t) = 24.0389e^{-70.04t} - 0.0389e^{-43263t} - 12$$

$$\mathrm{v}_C(0.5\text{ ms}) = 24.0389e^{-70.04\times 0.0005} - 0.0389e^{-43263\times 0.0005} - 12 = 11.2116 \text{ V}$$

Solution of ECE 300 Test 9 F10

1. (a) Fill in the table below with numbers.



$v_1(0^-) = 4$ V $\quad v_2(0^-) = 0$ V $\quad v_L(0^-) = 0$ V $\quad v_C(0^-) = 4$ V

$v_1(0^+) = -4$ V $\quad v_2(0^+) = 0$ V $\quad v_L(0^+) = -8$ V $\quad v_C(0^+) = 4$ V

$v_1(\infty) = -4$ V $\quad v_2(\infty) = 0$ V $\quad v_L(\infty) = 0$ V $\quad v_C(\infty) = -4$ V

$i_1(0^-) = 10$ mA $\quad i_L(0^-) = 0$ mA

$i_1(0^+) = -10$ mA $\quad i_L(0^+) = 0$ mA

$i_1(\infty) = -10$ mA $\quad i_L(\infty) = 0$ mA

(b) Find these numerical values.

$$\alpha = R/2L = 650\Omega/30\text{mH} = 21{,}667$$
$$\omega_0 = 1/\sqrt{LC} = 1/\sqrt{15\text{mH}\times 22\mu\text{F}} = 1740.8$$
$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} = -70.04$$
$$s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2} = -43{,}263$$

(c) If $\mathrm{v}_C(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} + \mathrm{v}_C(\infty)$ find the numerical values of A_1 and A_2.

$$\mathrm{v}_C(0^+) = A_1 + A_2 - 4 = 4 \text{ V}$$
$$\left.\frac{d\,\mathrm{v}_C(t)}{dt}\right|_{t=0^+} = s_1 A_1 + s_2 A_2 = \frac{\mathrm{i}_C(0^+)}{C} = \frac{\mathrm{i}_L(0^+)}{C} = 0$$

$$\begin{bmatrix} 1 & 1 \\ -70.04 & -43263 \end{bmatrix}\begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} 8 \\ 0 \end{bmatrix} \Rightarrow A_1 = 8.013\ , A_2 = -0.013$$

(d) Find the numerical value of $\mathrm{v}_C(0.5\text{ ms})$.

$$\mathrm{v}_C(t) = 8.013e^{-70.04t} - 0.013e^{-43263t} - 4$$

$$\mathrm{v}_C(0.5\text{ ms}) = 8.013e^{-70.04\times 0.0005} - 0.013e^{-43263\times 0.0005} - 4 = 3.737 \text{ V}$$