EE2210 Electric Circuits, Spring 2017

Practice Problems Solutions (Lecture4-Lecture7)

1.

Solution:

$$(1)\ \frac{1}{C_{total}} = \frac{1}{1uF} + \frac{1}{10uF} \quad \rightarrow\rightarrow\rightarrow \quad C_{total} = \frac{1uF*10uF}{1uF+10uF} = \frac{10}{11}uF$$

$$(2)\ \frac{1}{L_P} = \frac{1}{2mH} + \frac{1}{1mH} \quad \rightarrow\rightarrow\rightarrow \quad L_p = \frac{2mH*1mH}{1mH+2mH} = \frac{2}{3}mH$$

$$L_{total} = L_P + 1uH = 666.67uH + 1uH = 667.67uH$$

2.

Solution:

$$\mathrm{v}(t) = L * \frac{di(t)}{dt} \rightarrow\rightarrow\rightarrow v(t)dt = \mathrm{L} * \mathrm{di(t)}$$

$$\int v(t)dt = L * i(t) \rightarrow\rightarrow\rightarrow i(t) = \frac{\int v(t)dt}{L} \quad \rightarrow\rightarrow\rightarrow \quad i(t) = \frac{1}{L}$$

3.

Solution:

$$\mathrm{v} = L_2 * \frac{di(t)}{dt} \rightarrow\rightarrow\rightarrow 1 = L_2 * 100 \rightarrow\rightarrow\rightarrow L_2 = \frac{1}{100}H$$

$$\frac{L_1/100}{L_1 + 100} * 400 = 1 \rightarrow\rightarrow\rightarrow 4L_1 = L_1 + \frac{1}{100} \rightarrow\rightarrow\rightarrow L_1 = \frac{1}{300}H$$

4.

Solution:

$$\mathrm{v(t)} = \frac{d(L(t) * I)}{dt} = I\frac{dL(t)}{dt} = \mathrm{I}L_1\omega \cos \omega t$$

ANS:$\mathrm{v(t)} = \mathrm{I}L_1\omega \cos \omega t$

5.

Solution:

(a)

$$i_D = K_1 v_B = K_1 v_I$$
$$v_o = i_D R_V = K_1 v_I R_V$$

(b)

$$i_D = K_1 v_B = K_2 i_B = K_2 \frac{v_I}{R_I}$$
$$v_o = i_D R_V = K_2 \frac{v_I R_V}{R_I}$$

ANS:(a)$v_o = K_1 v_I R_V$(b)$v_o = K_2 \frac{v_I R_V}{R_I}$

6.

Solution:

The inductor first acts as an open circuit and eventually becomes a wire:

$$t \geq 0 \begin{cases} \text{initially: } i_1(t) = 0 \text{ (open circuit)} \\ \text{finally: } i_1(t) = \frac{V_S(t)}{3k} + i_S(t) = \frac{4}{3} \text{ mA} \end{cases}$$

Assume $i_S(t)$ source points down.

$$i_1(t) = (Final\ Value) + (Initial\ Value - Final\ Value)\ e^{-t/\tau}$$
$$i_1(t) = 4/3\left(1 - e^{-t/\tau}\right)[mA]$$
$$\tau = L/R = 1/3ms$$

7.

Solution:

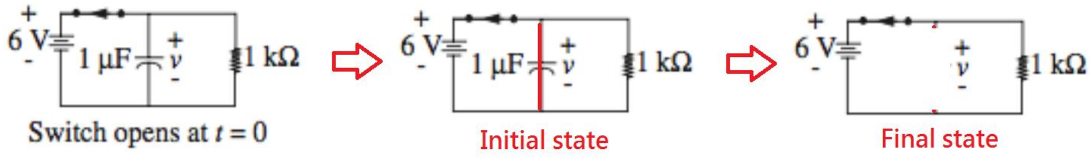
$$i_c = C \cdot \frac{dv_c}{dt}$$
$$v_c = \frac{\int i_c}{C} = 10t \text{ for } 0 < t < 1\ second$$
$$v_c = \frac{\int i_c}{C} = \text{ a constant, otherwise, when } i_c = 0$$

Therefore,

$$v_c(t = -1 \text{ second}) = -5V$$

8.

## Solution:




For t>0, the capacitor just like short circuit at initial state

$$\rightarrow \mathrm{V} = 0\ \mathrm{V}$$

At final state, the capacitor just like open circuit.

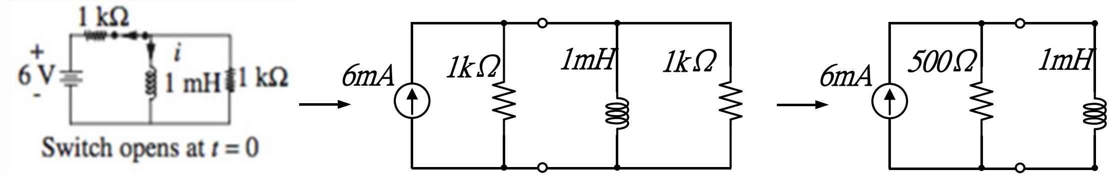
$$\rightarrow \mathrm{V} = 6\ \mathrm{V}$$

Thus,

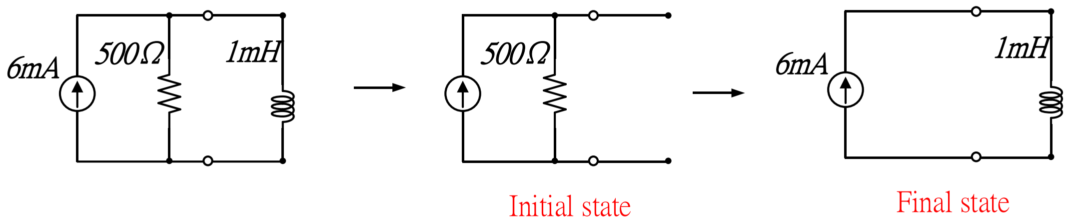
$$\mathrm{V(t)} = \text{final state} + (\text{ initial state} - \text{final state})e^{-\frac{t}{\tau}}$$

$$\rightarrow \mathrm{V(t)} = 6\ \mathrm{V} + (0\mathrm{V} - 6\mathrm{V})e^{-1000t} = 6(1 - e^{-1000t})\ V$$

## Solution:




For an easy way to calculate, we may transfer the circuit into Norton equivalent.




For t>0, the inductor just like open circuit at initial state

$$\rightarrow \mathrm{i} = 0\ \mathrm{A}$$

At final state, the inductor just like short circuit.

$$\rightarrow \mathrm{i} = 6\ \mathrm{mA}$$

Thus,

$$\mathrm{i(t)} = \text{final state} + (\text{ initial state} - \text{final state})e^{-\frac{t}{\tau}}$$

$$\rightarrow \mathrm{i(t)} = 6\ \mathrm{mA} + (0\mathrm{V} - 6\mathrm{mA})e^{-500000t} = 6(1 - e^{-500000t})\ mA$$

9.

Solution:

[a] $v_o(t) = v_o(0^+)e^{-t/\tau}$

$$\therefore \quad v_o(0^+)e^{-10^{-3}/\tau} = 0.5v_o(0^+)$$

$$\therefore \quad e^{10^{-3}/\tau} = 2$$

$$\therefore \quad \tau = \frac{L}{R} = \frac{10^{-3}}{\ln 2}$$

$$\therefore \quad L = \frac{10 \times 10^{-3}}{\ln 2} = 14.43\,\text{mH}$$

[b] $v_o(0^+) = -10i_L(0^+) = -10(1/10)(30 \times 10^{-3}) = -30\,\text{mV}$

$$v_o(t) = -0.03e^{-t/\tau}\,\text{V}$$

$$p_{10\Omega} = \frac{v_o^2}{10} = 9 \times 10^{-5}e^{-2t/\tau}$$

$$w_{10\Omega} = \int_0^{10^{-3}} 9 \times 10^{-5}e^{-2t/\tau}\,dt = 4.5\tau \times 10^{-5}(1 - e^{-2\times10^{-3}/\tau})$$

$$\tau = \frac{1}{1000\ln 2} \qquad \therefore \qquad w_{10\Omega} = 48.69\,\text{nJ}$$