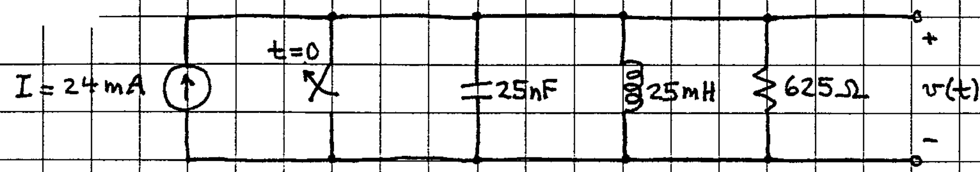
Ref: Nilsson & Riedel, Rev 6, Prob 8.18



Initial stored energy = 0

a) Find $v(t \geq 0)$　　b) Find $i_C(t>0)$

ans: a) $v(t \geq 0) = 40 e^{-32kt} \sin 24kt$ V

b) $i_C(t>0) = 24 e^{-32kt} \cos 24kt - 32 e^{-32kt} \sin 24kt$ mA

sol'n a) This problem is based on Example 8.7, whose sol'n is:

$$i_L(t \geq 0) = 24 - 24 e^{-32kt} \cos 24kt - 32 e^{-32kt} \sin 24kt \text{ mA}$$

$$v(t) = L \frac{d\, i_L(t)}{dt} = L \Big\{ -24 \left[(-32k) \cos 24kt + (-24kt) \sin 24kt \right] \cdot e^{-32kt} - 32 \left[(-32k) \sin 24kt + (24kt) \cos 24kt \right] \cdot e^{-32kt} \Big\}$$

The cos terms are equal and opposite, so they cancel out. We are left with:

$$v(t \geq 0) = \left[(24k)^2 + (32k)^2 \right] e^{-32kt} \sin 24kt \cdot L \text{ V}$$

$$v(t \geq 0) = 40^2 \cdot 25m \; e^{-32kt} \sin 24kt \text{ V}$$

$$v(t \geq 0) = 40 e^{-32kt} \sin 24kt \text{ V}$$

b) $$i_C(t>0) = I - i_L(t>0) - i_R(t>0)$$

where $i_L(t>0)$ is given in sol'n to A

and $$i_R(t>0) = \frac{v(t>0)}{R} = \frac{v(t>0)}{625\,\Omega} = \frac{v(t>0)}{\frac{5}{8} \cdot 1k}$$

Thus, $$i_R(t>0) = \frac{8}{5k} 40 e^{-32kt} \sin 24kt \text{ V}$$

$$i_R(t>0) = 64 e^{-32t} \sin 24kt \text{ mA}$$

$$i_c(t>0) = \cancel{24} \text{ mA}$$
$$-\left(\cancel{24} - 24e^{-32kt}\cos 24kt - 32e^{-32kt}\sin 24kt\right) \text{ mA}$$
$$-\left(64e^{-32kt}\sin 24kt\right) \text{ mA}$$

$$i_c(t>0) = 24e^{-32kt}\cos 24kt - 32e^{-32kt}\sin 24kt \quad \text{mA}$$

Comment: We cannot say $i_c(t \geq 0)$ [because $i_c(t)$ changes from 0 mA at $t=0^-$ to 24 mA at $t=0^+$]. $i_c(t=0)$ is undefined.

We can say, however, that $v(t)$ is defined at $t=0$. Why? because $v_c(t)$ cannot change instantly. $v_c(t=0^-) = v_c(t=0) = v_c(t=0^+) = 0V$.

When in doubt, use initial conditions for $t=0^+$. Then check to see if the solution holds for $t=0$ owing to some quantity that does not change instantly.