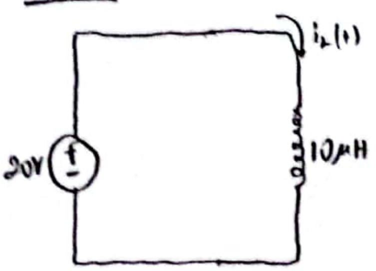
15212021104 - Doğukan Kıyıklık

Q1



Inductance at $t=0$ is $-200mA$. What time t_x does the current reach $+200\,mA$?

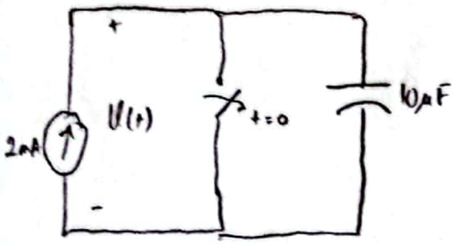
$$L \cdot \frac{di}{dt} = V(t) \longrightarrow \frac{di}{dt} = \frac{1}{L} V(t) \xrightarrow{\text{integrate}} i(t) = \frac{1}{L}\int_0^{t_x} v(t)\,dt + i(t)$$

$$\Rightarrow i(t) = 10^5\left(20t_x - 0\right) - \underbrace{200\times10^{-3}}_{\text{initial value}}$$

$$\Rightarrow 20t_x \times 10^5 = 200\times10^{-3} + 200\times10^{-3}$$

$$\boxed{t_x = 0.2\times10^{-6}\,s}$$

Q2



Determine voltage, power, and stored energy at $t = 10ms$

$$2\times10^{-3} = 10\frac{dv}{dt}\times10^{-6} \Rightarrow 200 = \frac{dv}{dt}$$

$$\xrightarrow{\text{integrate}} \underline{200t = V(t)}$$

$$P \Rightarrow i(t)\times v(t) \Rightarrow 10\times10^{-6}\times200\times200t = \underline{0{,}4t}$$

$$w \Rightarrow \int_{t_0}^{t} 0{,}4t\,dt \Rightarrow 0{,}2t^2\Big|_0^t \rightarrow \underline{0{,}2t^2}$$

At 10^{-2} s

$$\boxed{\begin{aligned} V &= 2 \\ P &= 4\times10^{-3} \\ w &= 2\times10^{-5} \end{aligned}}$$

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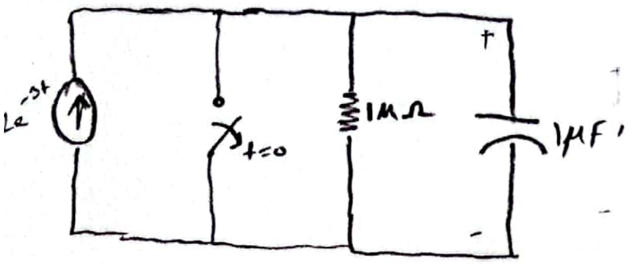
Q3



Solve for $V_c(t)$ for $t>0$ (Use $V_{cp}(t) = Ae^{-3t}$)

$$C \cdot \frac{dV_c(t)}{dt} + \frac{V_c(t)}{R} = 2e^{-3t}$$

$$\xrightarrow{\text{rearrange}} \frac{dV_c(t)}{dt} + V_c(t) = 2e^{-3t} \times 10^6$$

$$V_c(t) = V_{cp}(t) + V_{cH}(t)$$

$$V_{cH}(t) = \frac{dV_c(t)}{dt} + V_c(t) = 0 \Rightarrow K_1 \cdot e^{-t}$$

$$V_{cp}(t) = Ae^{-3t}$$

$$\frac{dV_{cp}(t)}{dt} = -3Ae^{-3t}$$

$$-3Ae^{-3t} + Ae^{-3t} = 2e^{-3t} \times 10^6$$

$$-2Ae^{-3t} = 2e^{-3t} \times 10^6 \rightarrow A = -10^6$$

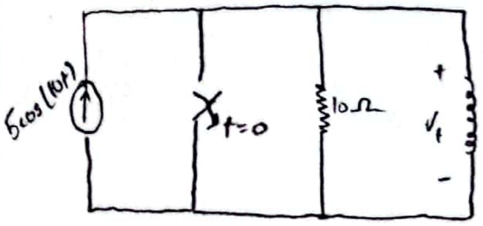
$$V_c(t) = K_1 e^{-t} - 10^6 \times e^{-3t}$$

$$V(0-) = V(0+) = 0$$

$$K_1 e^0 - 10^6 \times e^0 = 0 \rightarrow K_1 = 10^6$$

$$\boxed{V_c(t) = 10^6 e^{-t} - 10^6 e^{-3t}}$$

Q4



Solve for V(t) for t>0 (Use $V_p = A\cos(10t) + B\sin(10t)$)

$$\frac{V(t)}{10} + \frac{1}{L}\int V(t)dt + \cancel{i(0)} = 5\cos(10t)$$

$$\xRightarrow{\text{Derivative}} \frac{1}{10}\frac{dV(t)}{dt} + V(t) = -50\sin(10t)$$

$$\xrightarrow{\text{rearrange}} \frac{dV(t)}{dt} + 10V(t) = -500\sin(10t)$$

$$V_c(t) = V_{cp}(t) + V_{cH}(t)$$

$$V_{cH}(t) = \frac{dV_c(t)}{dt} + 10V(t) = 0 \rightarrow K_1 e^{-10t}$$

$$V_{cp}(t) = A\cos(10t) + B\sin(10t)$$

$$(V_{cp}(t))' = -10A\sin(10t) + 10B\cos(10t)$$

$$-10A\sin(10t) + 10B\cos(10t) + 10A\cos(10t) + 10B\sin(10t) = -500\sin(10t)$$

$$10\cos(10t)\underbrace{(B+A)}_{0} + 10\sin(10t)(B-A) = -500\sin(10t)$$

$B+A=0$
$B=-A$

$$\Rightarrow -20A\sin(10t) = -500\sin(10t) \rightarrow A = 25,\quad B = -25$$

$$V_c(t) = K_1 e^{-10t} + 25\cos(10t) - 25\sin(10t)$$

V(t) prior to t=0 ⟹ inductor current is zero. So, current 5cos(10t) flows 10 Ω resistor. And it's equal to;

$$5\cos(10.0).10 = 50$$

$$K_1 e^0 + 25\cos(0) - 25\sin(0) = 50 \rightarrow K_1 = 25$$

$$\boxed{V_c(t) = 25e^{-10t} + 25\cos(10t) - 25\sin(10t)}$$

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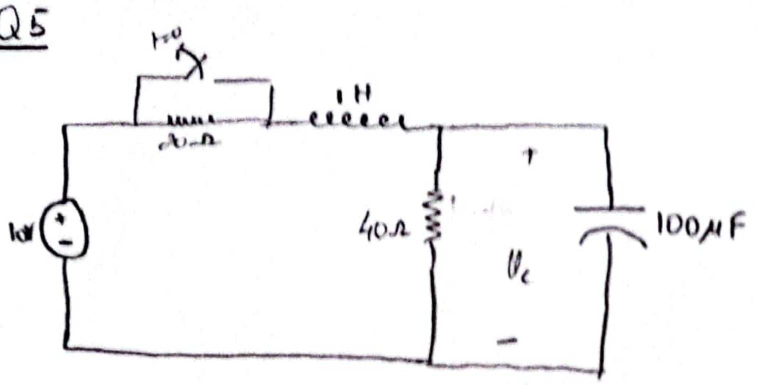
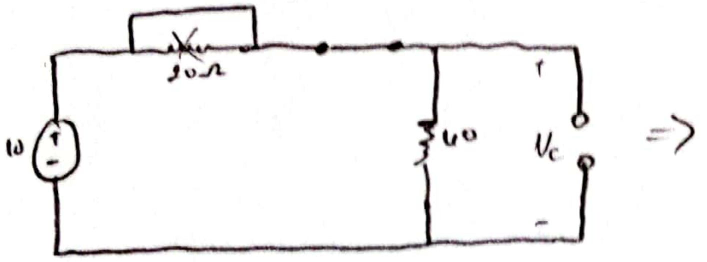
Q5



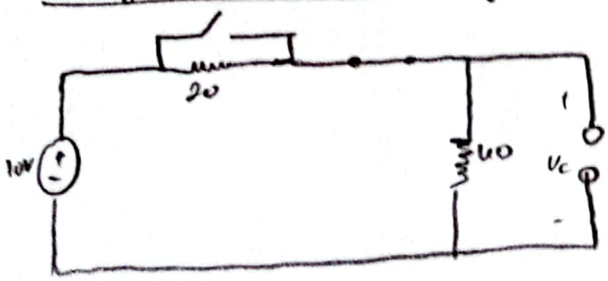
Find the value of V_c prior to t=0.
Find the steady state value of V_c

Prior to t<0



$V_c \Rightarrow 10$ Volt

steady state value of V_c



$$\frac{10-V_c}{\underset{(2)}{20}} = \frac{V_c}{40} \Rightarrow 20-2V_c = V_c \rightarrow V_c = \frac{20}{3} = 6{,}6V$$

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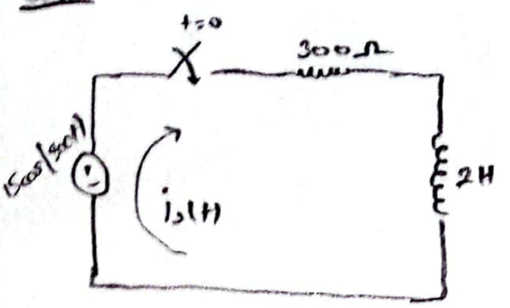
Q6



Write the dif. equ. for $i_s(t)$ and solve
(Use $i_{sp}(t) = A\cos(300t) + B\sin(300t)$)

$$-15\cos(300t) + 300\, i_s(t) + L.\frac{di_s(t)}{di} = 0$$

rearrange $\rightarrow$ $$\frac{di_s(t)}{di} + 150\, i_s(t) = \frac{15}{2}\cos(300t)$$

$$i_s(t) \Rightarrow i_{sp}(t) + i_{sH}(t)$$

$$i_{sH}(t) = \frac{di_s(t)}{di} + 150\, i_s(t) \Rightarrow K_1 e^{-150t}$$

$$i_{sp}(t) = A\cos(300t) + B\sin(300t)$$

$$(i_{sp}(t))' = -300A\sin(300t) + 300B\cos(300t)$$

$$-300A\sin(300t) + 300B\cos(300t) + 150A\cos(300t) + 150B\sin(300t) = \frac{15}{2}\cos(300t)$$

$$150\sin(300t)\underbrace{(-2A+B)}_{-2A+B=0} + 150\cos(300t)(2B+A) = \frac{15}{2}\cos(300t)$$

$B = 2A$

$$\Rightarrow 150\cos(300t).5A = \frac{15}{2}\cos(300t) \Rightarrow A = \frac{1}{100},\ B = \frac{2}{100}$$

$$i_s(t) = K_1 e^{-150t} + 0{,}01\cos(300t) + 0{,}02\sin(300t)$$

$$i_s(0+) = i_s(0-) = 0 \Rightarrow K_1 e^0 + 0{,}01 + 0 = 0 \rightarrow K_1 = -0{,}01$$

$$\boxed{i_s(t) = -0{,}01 e^{-150t} + 0{,}01\cos(300t) + 0{,}02\sin(300t)}$$

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