ECE 113
↳ Basic Electronics

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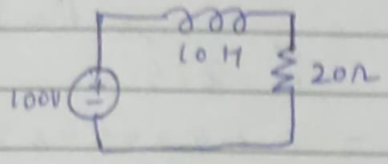
Assignment -3

A1)



~~at t = 0.5 s~~
t = 0.5 s

~~(a)~~ $L\frac{di}{dt} + i \times 20 = 100$

$\frac{di}{dt} + 2i = 10$
⇓
$i e^{2t} = \int 10 e^{2t} \, dt$
$i e^{2t} = 5 e^{2t} + c$
at $t = 0$, $i = 0$ ⇒ $c = -5$

$\boxed{i = 5(1 - e^{-2t})}$ A

at $t = 0.5$ s
$i = 5(1 - e^{-1}) \approx 3.16060028$ A

(a) $P_{in} = i V_0 = 500(1 - e^{-1}) = 316.06028$ W
↑ (1)

(b) $P_R = i^2 R = 500(1 - e^{-1})^2 = 199.7882$ W
↑ (2)

~~Difference b/w a & b is stored in ... is the sum of the energy stored in inductor and heat ener~~

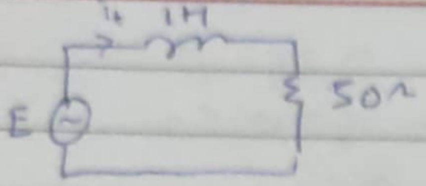
~~Some power is stored in~~

Difference b/w a & b is the ~~...~~ power that is stored in inductor

↳ $P_{stored} = \frac{d}{dt}\frac{1}{2}Li^2 = 500(1 - e^{-1})e^{-1}$
≈ 116.272074 W
↑ (3)

we can see that (2) + (3) = (1)
∴ Our statement is proved

A2)



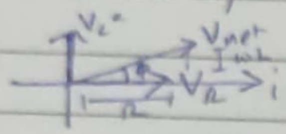
$E = 141 \sin 314t$

$\omega = 314 \quad f = 50\,Hz$

$(i_t)_0 = \dfrac{141}{\sqrt{(50)^2 + (314)^2}} \simeq 0.44345762$

$Z = \sqrt{(50)^2 + (314)^2}$
$= 317.955972$

$\phi = \tan^{-1}\left(\dfrac{\omega L}{R}\right) = \tan^{-1}(2\pi)$
$\simeq 80.4564389^\circ$



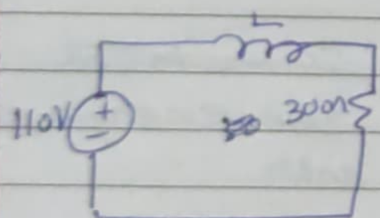
$\therefore \; i_t = (i_t)_0 \sin(314t - \phi)$

$i_t = \dfrac{141}{\sqrt{(50)^2 + (314)^2}} \sin(314t - 80.4564384$

$\therefore \; \boxed{i_t = (0.44345762) \sin(314t - \tan^{-1}(6.28))}$

80.4569389°

A3)



$t = 0.002\,s$
at $i = 63.2\,\%$ of i_0

(a) $\tau = 0.002\,s$ (at $t=\tau$, $i = \frac{63.2}{100} i_0$)

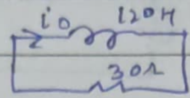
(b) $\tau = \dfrac{L}{R} = 0.002$

$L = 300 \times 0.002 = 0.6\,H$

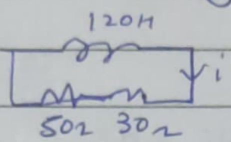
(c) at $t = \infty$, $i = i_0 = \dfrac{110}{300} = \dfrac{1.1}{3} \approx 0.3667\,A$

(d) $\dfrac{di}{dt} = \dfrac{i_0}{\tau} e^{-t/\tau} \quad \therefore \left.\dfrac{di}{dt}\right|_{t=0} = \dfrac{V_0 \cdot R}{R \cdot L} = \dfrac{110}{0.6} = 183.3334\,A/s$

A4) at $t=0 \Rightarrow i_0 = 5A$ and ~~circuit~~ circuit was



at $t>0 \Rightarrow$ circuit was $\Downarrow$



(Discharging circuit with $i(0) = 5A$)

$\therefore \; i = i_0 e^{-t/\tau}$ where $\tau = \frac{120}{80} = 1.5\,s$

$\Rightarrow$ and $i_0 = 5A$

$\therefore \; i = 5e^{-2t/3}$

req t $\Rightarrow$ at $t=0 \Rightarrow i = 5A$

at $t=t \Rightarrow i = 1.0\,A$

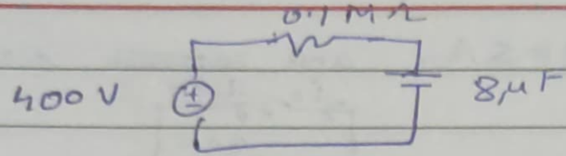
$\therefore \; \Downarrow$

$$e^{-t/\tau} = \frac{1}{5}$$

$$t/\tau = \ln 5$$

$$t = \tau \ln 5 \approx 2.41415686865\ s$$

A 5)



$v_c = v_0 \left(1 - e^{-t/\tau}\right)$ where $v_0 = 400$ V

$\tau = 8 \times 10^{-6} \times 0.1 \times 10^{6}$

$= 0.8$ s

at $t = 0$ $v_c = 0$

at $t' = t$ $v_c = 300$ V

$\therefore$ req $t \Rightarrow \frac{3}{4} = 1 - e^{-t/\tau}$

$\therefore t = 0.8 \ln 4$

$\therefore t = 1.6 \ln 2 \approx 1.1090354889$ s

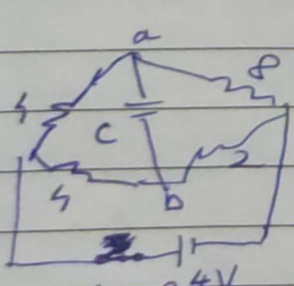
$E_t = \frac{1}{2} C V_t^2$

$E_\infty = \frac{1}{2} C V_0^2$

req Fraction $= \frac{E_t}{E_\infty} = \left(\frac{V_t}{V_0}\right)^2 = \frac{9}{16}$

$\therefore$ req Fraction $= \frac{9}{16}$

A6)



in steady state (b/w 8Ω & ...)
pd accross C is ~~opp~~
to pd Diffⁿ across
a & b (V₀)

finding V_0:

$V_0 = 24 \times \frac{4}{4+2} - \frac{24 \times 4}{4+8}$

$= 24 \times 4 \left(\frac{2}{12} - \frac{1}{12}\right) = 8$ V

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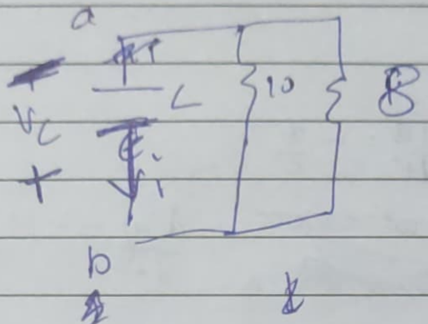
$\therefore$ pd ~~defeloped~~ developed across cappicitor $= 8V$

Now ~~at instant~~ S is opened I

$\therefore$



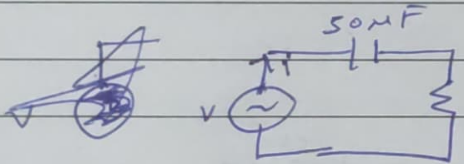
$V_C = 8V$

$\therefore i = \dfrac{8}{\frac{1}{10}+\frac{1}{8}} = \dfrac{\overset{4}{\cancel{8}}\times 80}{\cancel{18}\,9}$

$= \dfrac{320}{9} \simeq 35.55556\ A$

$\therefore \boxed{i \simeq 35.5556\ A}$

A7)

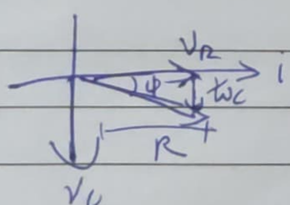


$v = 283 \sin 314t$

$\omega c = 0.0157$

$Z = \sqrt{(40)^2 + \left(\frac{1}{\omega c}\right)^2}$

$i_0 = \dfrac{V_0}{Z}$



$\phi = \tan^{-1}\left(\frac{1}{\omega c R}\right)$

$\therefore i = i_0 \sin(\omega t + \phi)$

$\therefore i = \dfrac{V_0}{Z}\sin(\omega t + \phi)$

$i = \dfrac{283}{\sqrt{1600 + \left(\frac{1}{0.0157}\right)^2}} \sin\left(\omega t + \tan^{-1}\left(\frac{1}{0.628}\right)\right)$

$\boxed{i = 3.762659\ 27224 \sin(314t + 1.0\ 1004261622)\ A}$

in radian

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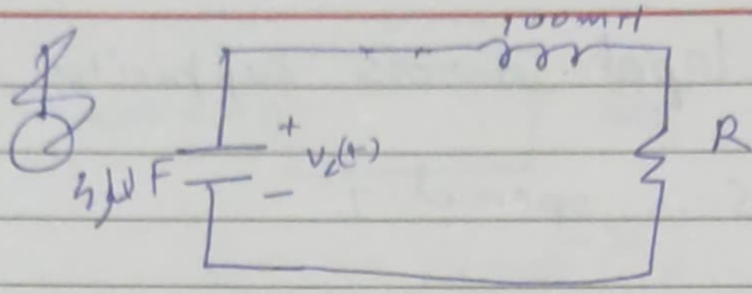
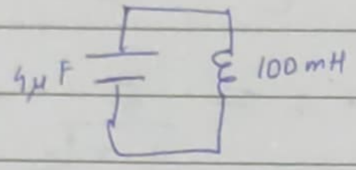
A8)



given $V_C(0) = 300\,V$

(a) If $R = 0\,\Omega$,



$L\frac{d^2q}{dt^2} = -\frac{q}{C}$ ⇒ $\frac{d^2q}{dt^2} = -\left(\frac{1}{LC}\right)q$

$$\omega^2 = \frac{1}{LC}$$

$$\omega = \sqrt{\frac{1}{LC}} = 2\pi f$$

$$\therefore f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{1}{400\times10^{-4}}} = \frac{\cancel{1000}^{\,250}}{\cancel{4}\pi}\sqrt{10}$$

$$= \frac{250\sqrt{10}}{\pi}$$

$$\therefore \boxed{f = \frac{250\sqrt{10}}{\pi} = 251.646060522\ Hz}$$

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(c) when $b^2 = \omega_0^2$

$$\Downarrow$$

$$\frac{R^2}{4L^2} = \frac{1}{LC} \Rightarrow R = 2\sqrt{L/C}$$

$$= 2\sqrt{25 \times 10^3}$$

$$= 100\sqrt{10}$$

$\therefore R = 100\sqrt{10} = 316.227766017$

(b) If $R = 1\Omega$,

$$q = \frac{q_0 \omega_0}{\omega} e^{-bt} \sin(\omega t + \alpha)$$ when $\alpha = \tan^{-1}(\omega/b)$

Now $A = \frac{q_0 \omega_0 e^{-bt}}{\omega}$

Now we are asked to find t when

$$A \le \frac{q_0}{10}$$

$$e^{-bt} \le \frac{\omega}{10\omega_0}$$

$$\Downarrow$$

$$e^{bt} \ge \frac{10\omega_0}{\omega}$$

$$t \ge \frac{1}{b} \ln \frac{10\omega_0}{\omega}$$

Now if $t = nf$,

then

$$n \ge \frac{1}{fb} \ln \frac{10\omega_0}{\omega}$$

$$\Downarrow$$

$$\therefore n = \left\lceil \frac{1}{fb} \ln \frac{10\omega_0}{\omega} \right\rceil$$ where $b = 0.2\ s^{-1}$, $\omega_0 = 500\pi\sqrt{10}$ Hz, $\omega = \sqrt{\omega_0^2 - b^2}$ Hz and $\lceil\ \rceil$ denotes ceil

$$\Downarrow$$

$\therefore n = \lceil 0.4575 \rceil$

$\therefore n = 1$ if n is min. integer else $\boxed{n = 0.4575 \text{ cycles}}$ Ans**