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Bonus Assignment

1) a| i) $V = 8\cos(\omega t - 70^\circ)$

$I = 4\cos(\omega t - 70^\circ)$

phase difference = 0

~~∴ V and I are imp~~

∴ V is in-phase with I.

ii) $V = 8\cos(\omega t - 70^\circ)$; $I = 4\cos(\omega t - 70^\circ)$

$V = V_m \angle \phi$

$= 8 \angle -70^\circ$

$I = I_m \angle \phi$

$= 4 \angle -70^\circ$

∴ Impedance, $Z = \frac{V}{I}$

$= \frac{8\angle -70^\circ}{4\angle -70^\circ} = 2$ (Ans.)

iii) $Z = 2 + j\omega L + \frac{1}{j\omega C}$

$Z = 2$

$L = 0.1$

$C = 0.1$

$\Rightarrow \frac{1}{j\omega C} - j\omega L = 2 - 2$

$\Rightarrow \frac{1}{j\omega C} = j\omega L$

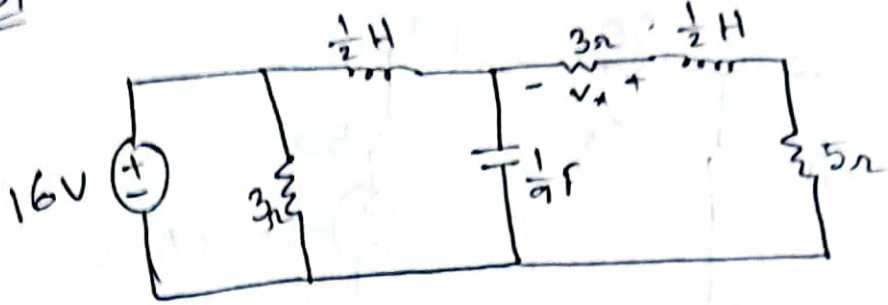
$\Rightarrow 10\,j = 0.1\,\omega^2 j$

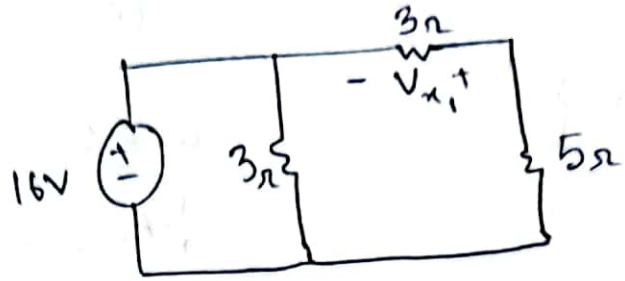
$\Rightarrow \omega^2 = \frac{j10}{j0.1}$

$\Rightarrow \omega^2 = 100$

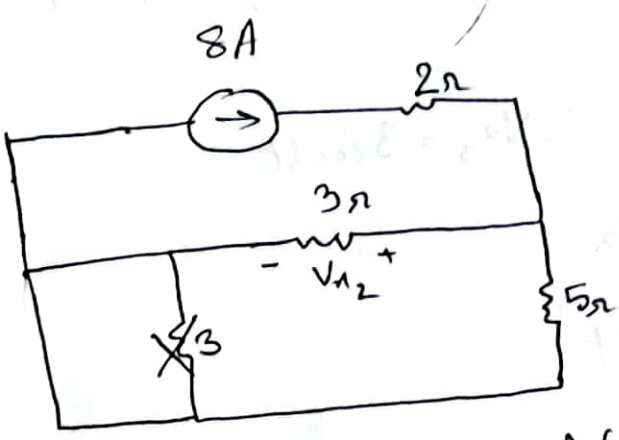
$\therefore \omega = 10 \text{ rads}^{-1}$ (Ans.)

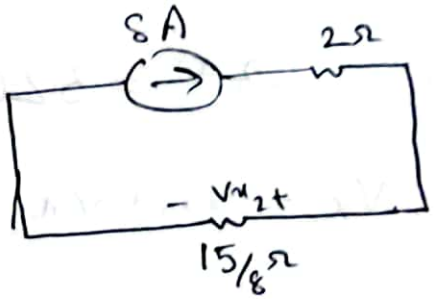
b)





$$V_{x_1} = -\frac{3}{3+5} \times 16 = -6\ V$$

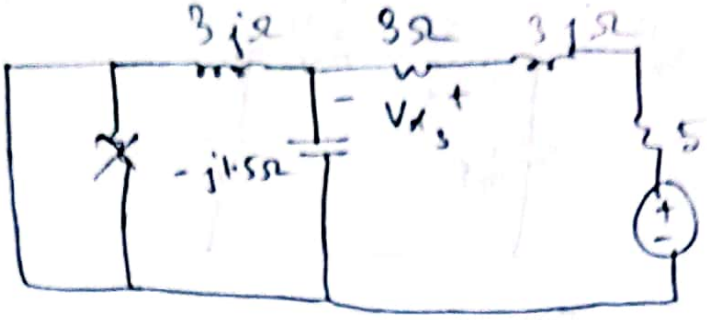




$$V_{x_2} = 8 \times \frac{15}{8} = 15\ V$$

$$2 \times 8 + V_{x_2} = 0$$

$$\Rightarrow V_{x_2} = -16\ A$$



$$Z_1 = \{(j3)^{-1} + (-j1.5)^{-1}\}^{-1}$$

$$= -j3$$

$\omega = 6$

$\frac{1}{9}F = \frac{-1}{\omega c} = \frac{-j}{6 \times \frac{1}{9}}$

$= -j1.5$

$\frac{1}{2}H = j \times 6 \times \frac{1}{2} = 3j$

$$V_{x_3} = \frac{3}{3 + (-j3) + (3j) + 5} \times 8\angle 0°$$

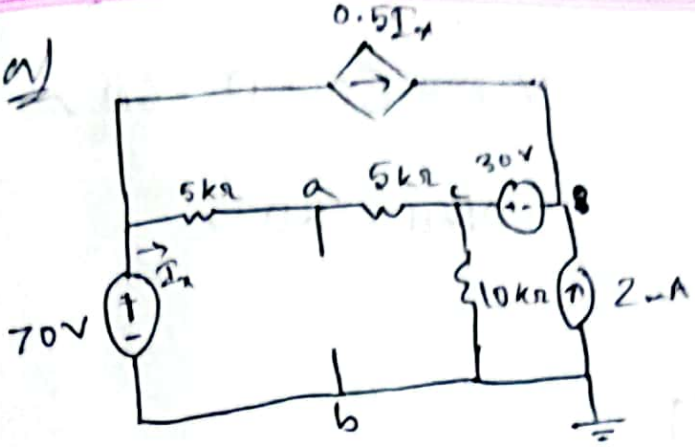
$= 3\angle 0°$ $\therefore V_{x_3} = 3\cos 6t$

$V_x = V_{x_1} + V_{x_2} + V_{x_3}$

$= -6 + 15 + 3\cos 6t$

$= 9 + 3\cos 6t$ V (Ans.)

2 | a)



$$\frac{70 - V_a}{5} = I_x$$

'V_a':

$$\frac{V_a - 70}{5} + \frac{V_a - V_c}{5} = 0$$

$$\Rightarrow 2V_a - V_c = 70 \quad \text{——— (1)}$$

'V_c':

~~Supernode at V_c, KCL;~~

$$\frac{V_c - V_a}{5} + \frac{V_c}{10} - 0.5I_x - 2 = 0$$

$$\Rightarrow \frac{V_c - V_a}{5} + \frac{V_c}{10} - 0.5\left(\frac{70 - V_a}{5}\right) = 2$$

$$\Rightarrow \frac{V_c - V_a}{5} + \frac{V_c}{10} - \frac{(70 - V_a)}{10} = 2$$

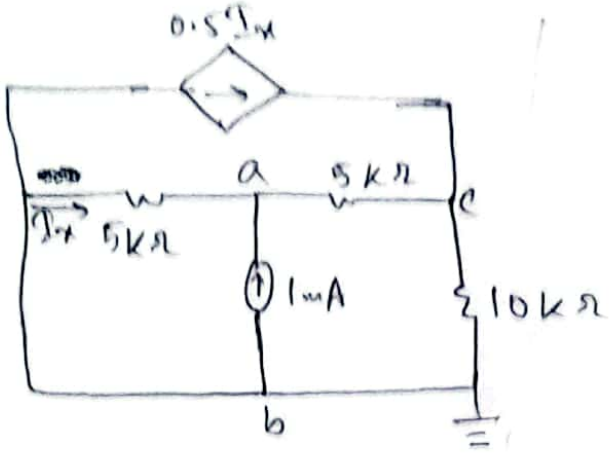
$$\Rightarrow \frac{V_c - V_a}{5} + \frac{V_c}{10} - 7 + \frac{V_a}{10} = 2$$

$$\Rightarrow \frac{2V_c - 2V_a + V_c + V_a}{10} = 9$$

$$\therefore -V_a + 3V_c = 90 \quad \text{——— (2)}$$

$\therefore V_a = 60\,V$ $\quad\therefore V_{ab} = 60 - 0 = 60\,V$

$V_c = 50\,V$ $\quad\therefore V_{TH} = 60\,V$



$$\frac{0 - V_a}{5} = I_x$$

$$\Rightarrow I_x = -\frac{V_a}{5}$$

'V_a':

$$\frac{V_a}{5} - 1 + \frac{V_a - V_c}{5} = 0$$

$$\Rightarrow \frac{V_a + V_a - V_c}{5} = 1$$

$$\Rightarrow 2V_a - V_c = 5 \quad \text{——— (1)}$$

'V_c':

$$-0.5I_x + \frac{V_c - V_a}{5} + \frac{V_c}{10} = 0$$

$$\Rightarrow \frac{V_a}{10} + \frac{V_c - V_a}{5} + \frac{V_c}{10} = 0$$

$$\Rightarrow \frac{V_a + 2V_c - 2V_a + V_c}{10} = 0$$

$$\therefore -V_a + 3V_c = 0 \quad \text{——— (2)}$$

$\therefore V_a = 3\,V$ $\quad V_{ab} = 3\,V$

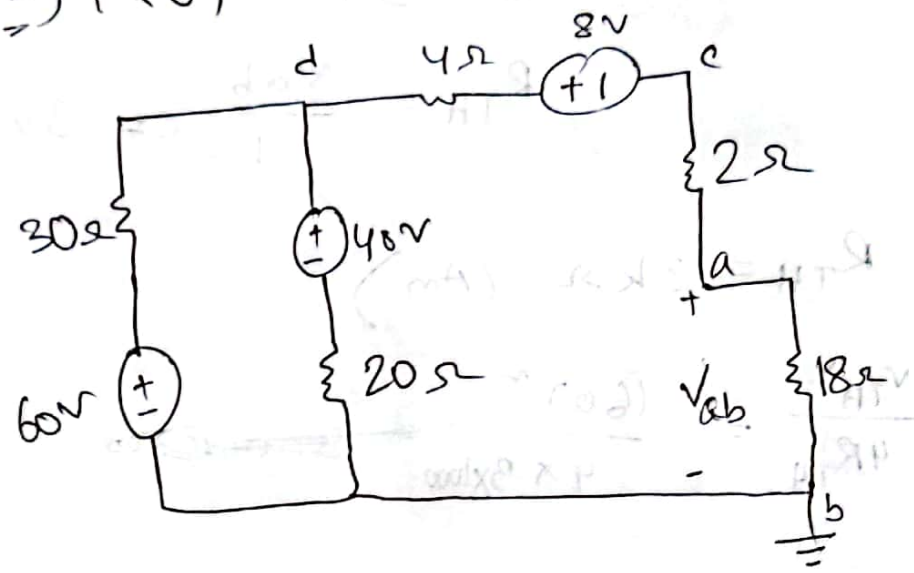
$\therefore V_c = 1\,V$ $\quad R_{TH} = \frac{V_{ab}}{1} = 3\,k\Omega$

$\therefore R_L = R_{TH} = 3\,k\Omega$ (Ans.)

b) $P_{max} = \frac{V_{TH}^2}{4R_{TH}} = \frac{(60)^2}{4 \times 3 \times 1000}$

$= 0.3\,W$

3| a) $t<0$,



'V_a':

$$\frac{V_a}{18} + \frac{V_a - V_c}{2} = 0$$

$$\Rightarrow \frac{V_a + 9V_a - 9V_c}{18} = 0$$

$$\Rightarrow 10V_a - 9V_c = 0 \quad \text{——} (1)$$

'V_c':

$$\frac{V_c - V_a}{2} + \frac{V_c - V_d + 8}{4} = 0$$

$$\Rightarrow \frac{2V_c - 2V_a + V_c - V_d + 8}{4} = 0$$

$$\Rightarrow -2V_a + 3V_c - V_d = -8 \quad \text{——} (2)$$

'V_d' :

$$\frac{V_d - V_c - 8}{4} + \frac{V_d - 40}{20} + \frac{V_d - 60}{30} = 0$$

$$\Rightarrow \frac{15V_d - 15V_c - 120 + 3V_d - 120 + 2V_d - 120}{60} = 0$$

$$\Rightarrow -15V_c + 20V_d = 360 \quad \text{---------} (3)$$

$\therefore V_a = 20\ V$ $\quad V_c = \frac{200}{9}\ V$ $\quad V_d = \frac{104}{3}\ V$

$\therefore V_{ab} = 20\ V$

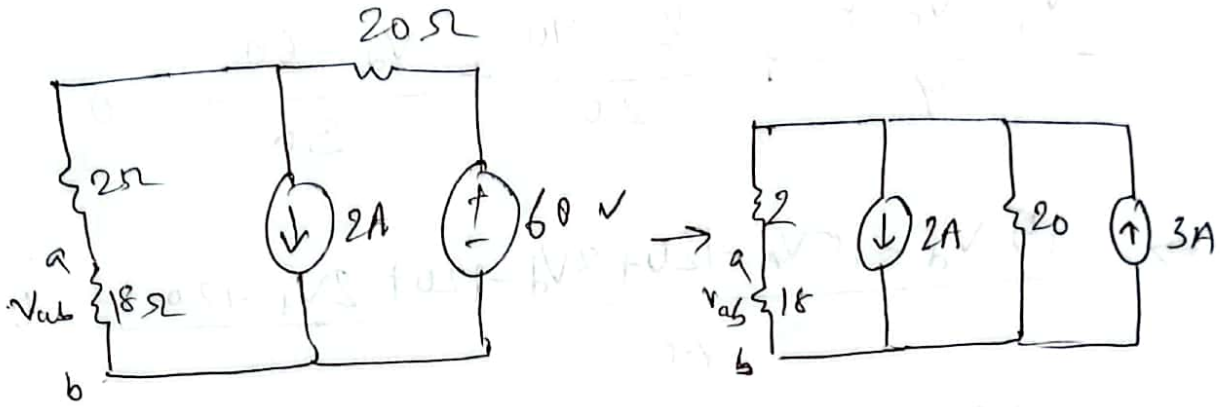
$1 + V_c = V_{ab}$

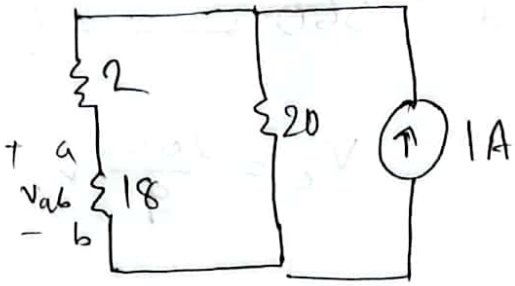
$\Rightarrow V_c = V_{ab} - 1 = 20 - 1 = 19\ V$

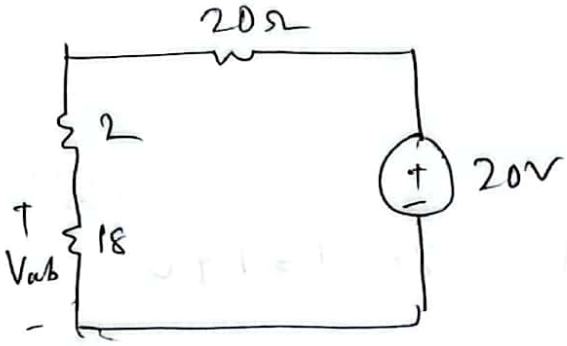
$\therefore V_c(0) = 19\ V$

$i_c = 0\ A$

$t > 0$,



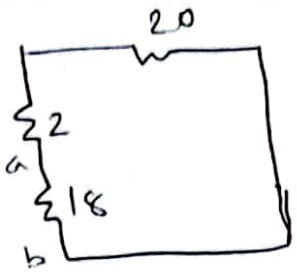




$$V_{ab} = \frac{18}{18+2+20} \times 20 = 9\ V$$

$$V_c = V_{ab} - 1 = 9 - 1 = 8\ V$$

$\therefore V_c(\infty) = 8\ V$



$$R_{eq} = (20+2) \| 18$$

$$= 9.9\ \Omega$$

$$\tau = RC = 9.9 \times 16 \times 10^{-6}$$

$$= 1.584 \times 10^{-4}\ s$$

$$V_c(t) = V_c(\infty) + [V_c(0) - V_c(\infty)]\, e^{-t/\tau}$$

$$= 8 + (19 - 8)\, e^{-t/1.584 \times 10^{-4}}$$

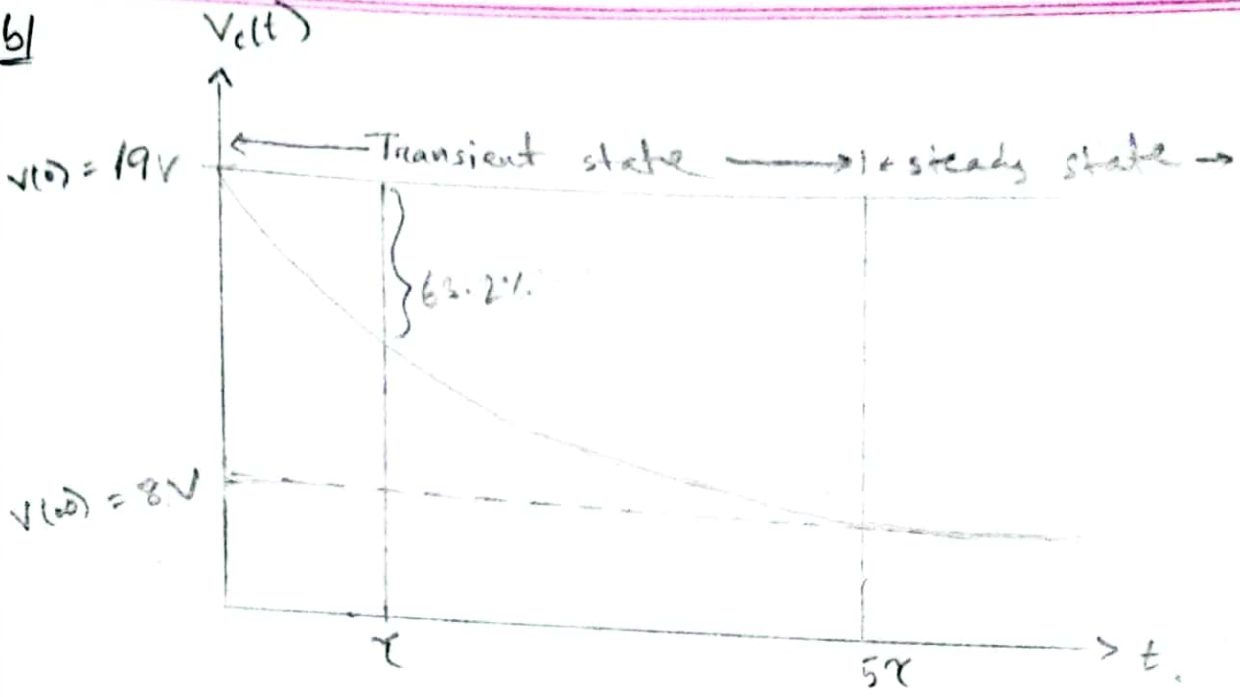
$$= 8 + 11\, e^{-10000t/1.584} \quad V$$

$$I_c(t) = C \frac{dv}{dt}$$

$$= 16 \times 10^{-6} \left[0 + 11\, e^{-10000t/1.584} \times \left(-\frac{10000}{1.584} \right) \right]$$

$$= -1.111\, e^{-10000t/1.584} \quad A$$

b)



$\tau = 1.584 \times 10^{-4}$ s = time cons

$5\tau = 7.92 \times 10^{-4}$ s

∴ Capacitor is discharging.

time constant, $\tau = 1.584 \times 10^{-4}$ s

~~Disch~~ Fully discharged point, $5\tau = 5 \times 1.584 \times 10^{-4}$ s

$= 7.92 \times 10^{-4}$ s

c) $V_x(t) = 9 + (20 - 9)e^{-t/1.584\times10^{-4}}$

$= 9 + 11e^{-10000t/1.584}$

$I_x(t) = C\frac{dv}{dt}$

$= 16\times10^{-6}\left[11e^{-10000t/1.584} \times \left(-\frac{10000}{1.584}\right)\right]$

$= -1.1118e^{-1000t/1.584}$

$\therefore I_x(0.1) = 0$ A (Ans.)