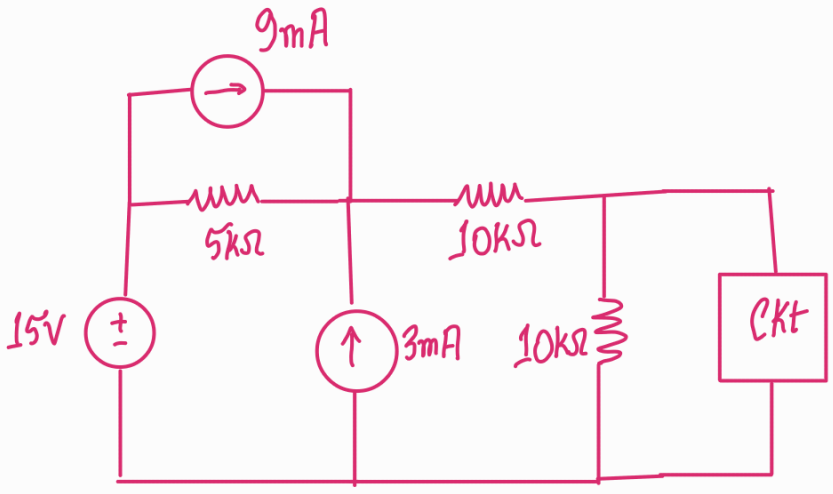
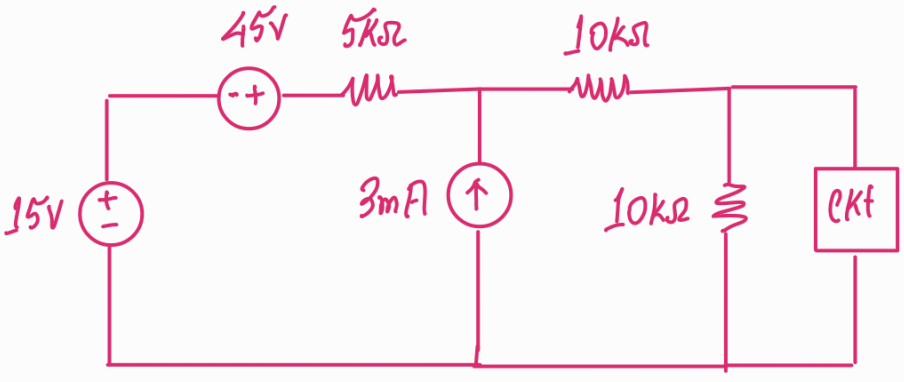
Set A

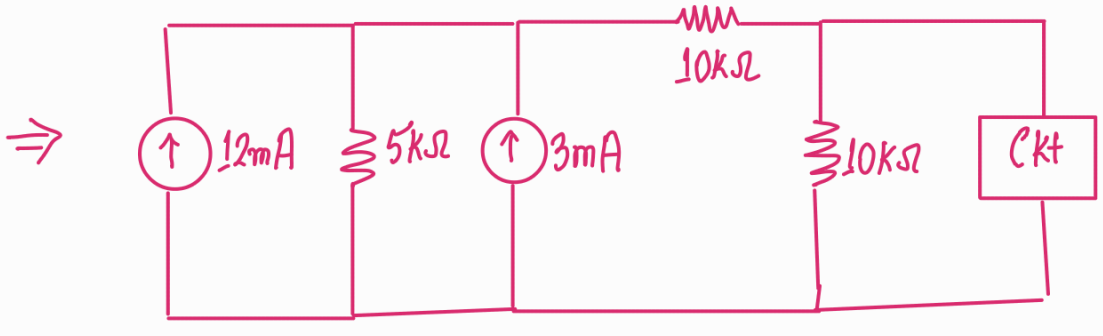
Q1

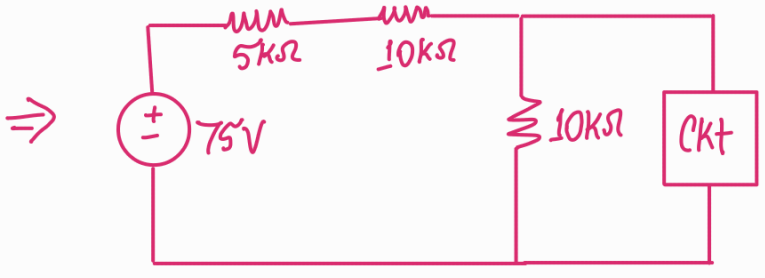
(a) Left hand side of the ckt —



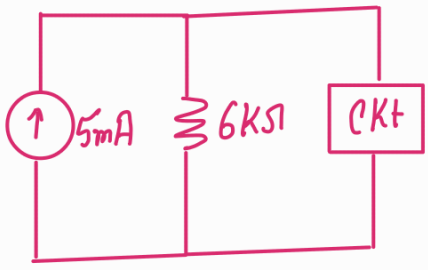
Simplifying —



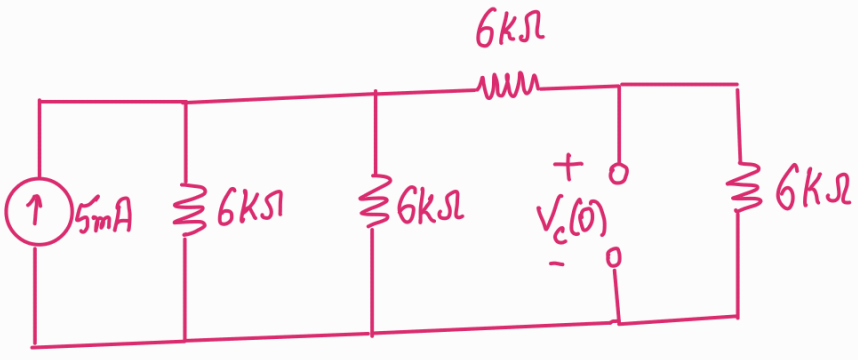




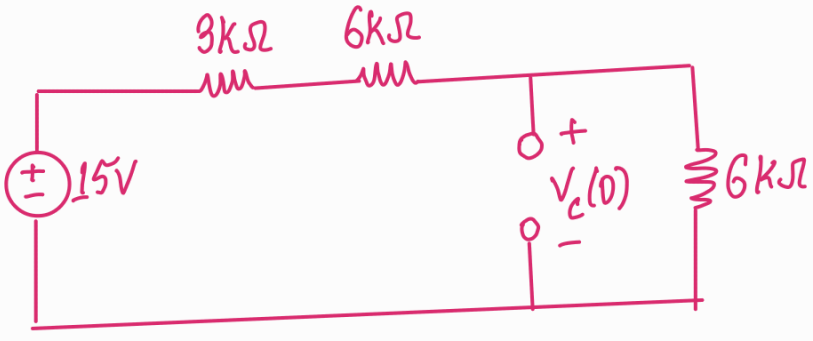
⇒



now $t=0^-$ ckt at capacitor steady state —



⇒

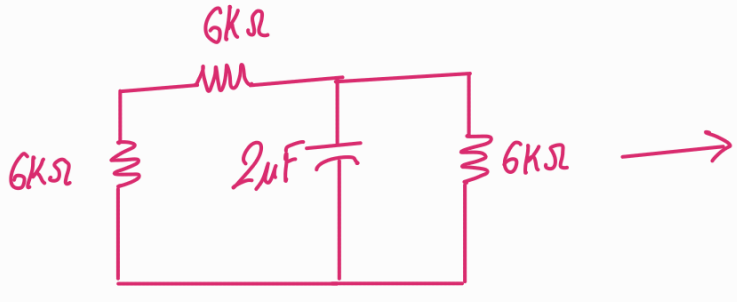


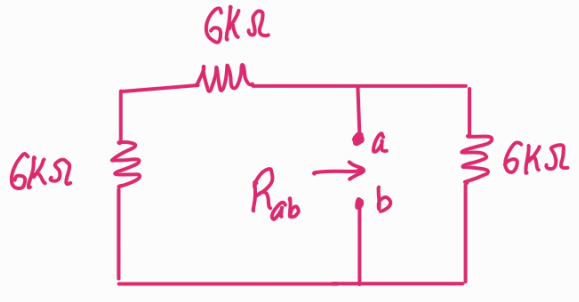
$$\therefore V_c(0) = \frac{6K}{3K+6K+6K} \times 15 \quad \text{[voltage divider]}$$

$$= 6V$$

Since the $t>0$ ckt doesn't have any srcs, $V_c(\infty) = 0V$

(b) $t>0$ ckt —





disconnecting load to calculate R_{Th} (R_{ab} in diagram)

$R_{Th} = R_{ab} = 6k \| (6K + 6K) = 4K\Omega$

$\therefore \tau = R_{Th} C = 4K \times 2\mu = 8ms$

(c) We know, for $t > 0$:

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

$$= 6e^{-t/8\times10^{-3}}$$

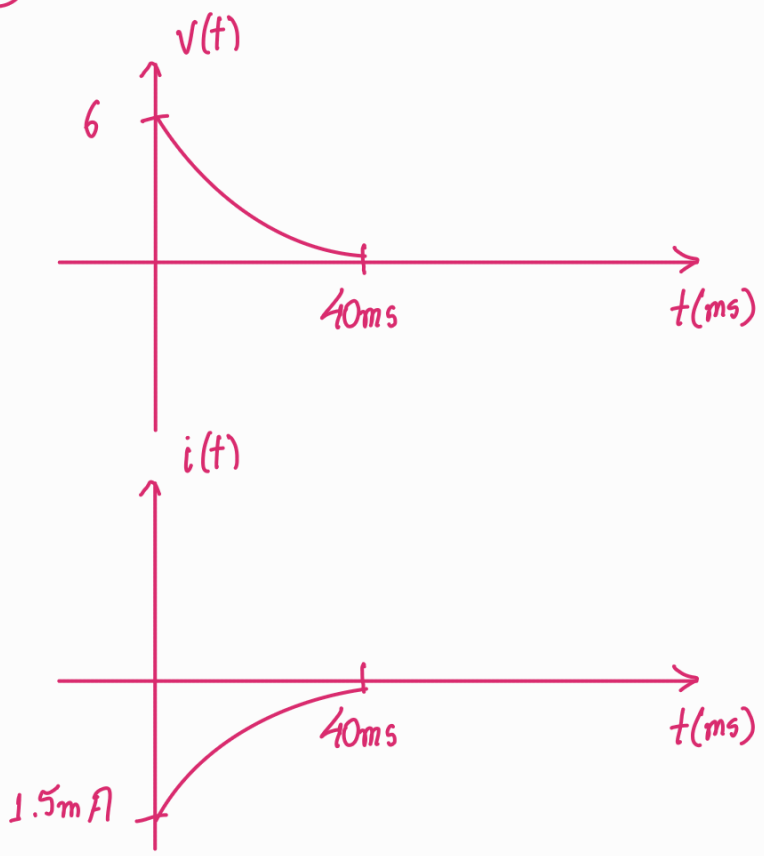
$$= 6e^{-125t} \quad V$$

(d) $i(t) = i_c(t) = C \frac{dv_c(t)}{dt}$

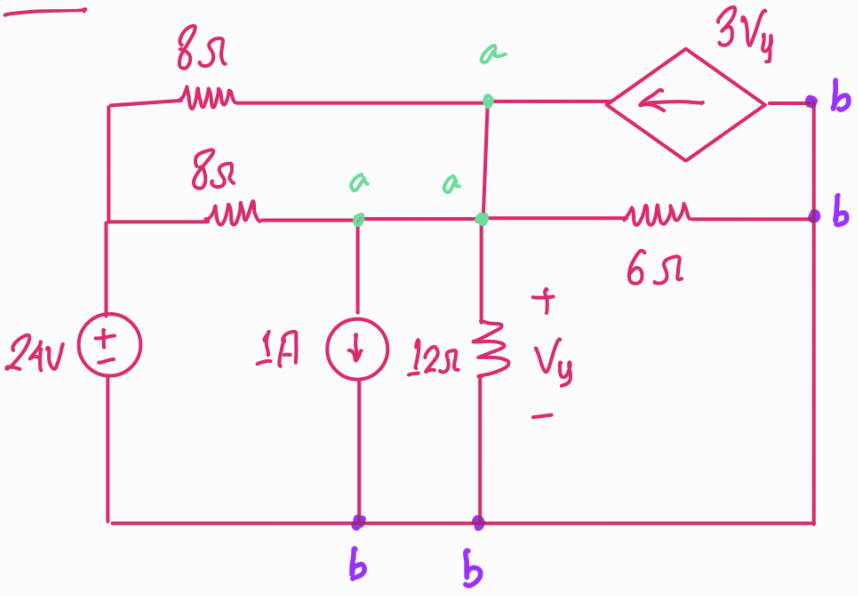
$$= 2\times10^{-6} \times 6e^{-125t} \times (-125)$$

$$= -1.5\, e^{-125t} \quad mA$$

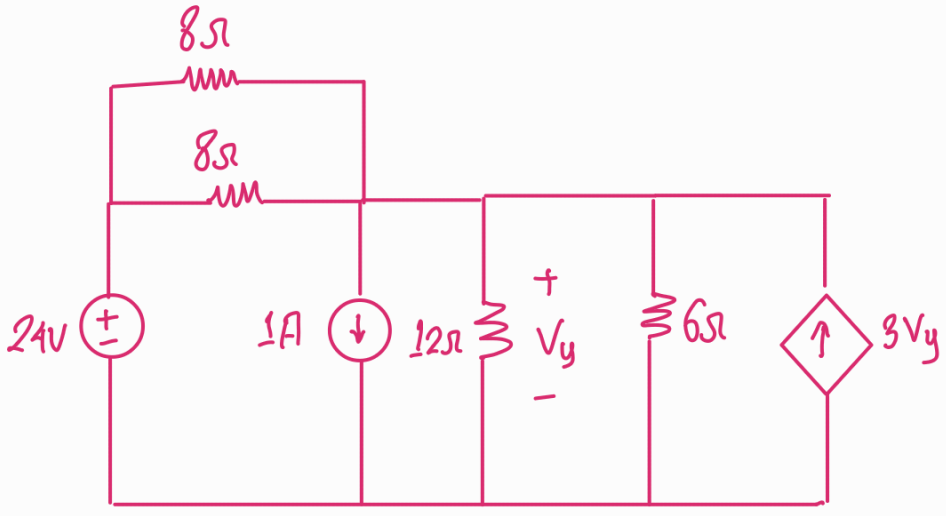
(e)

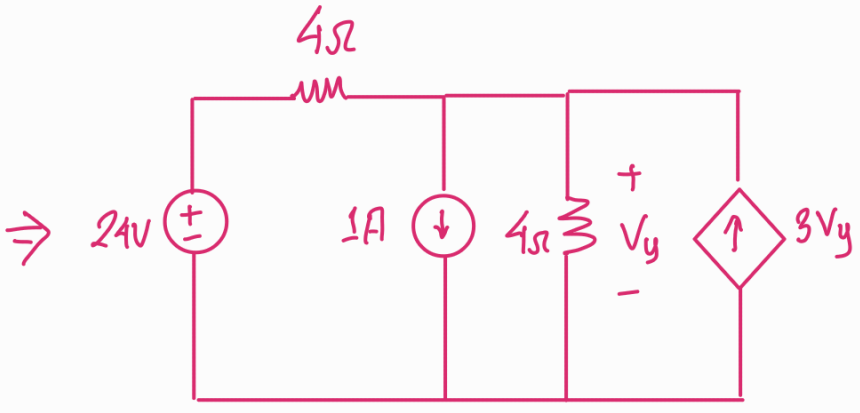


Q2

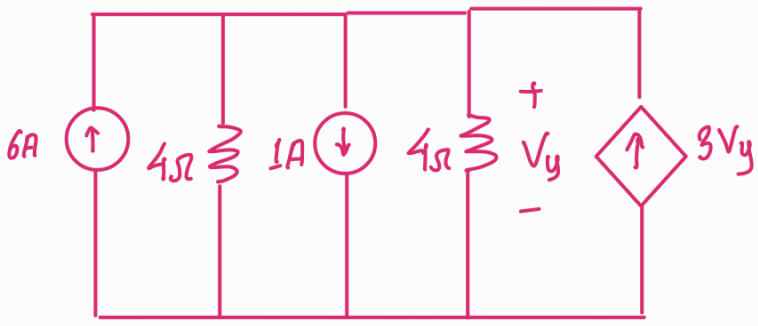


Redrawing —

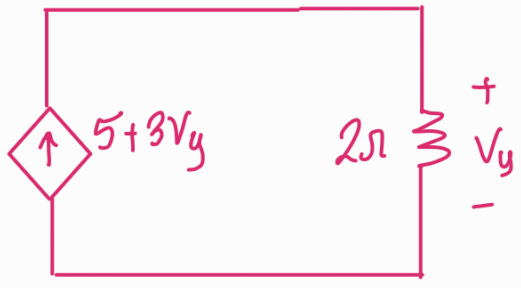




Solving by Src. transformation —



⇒

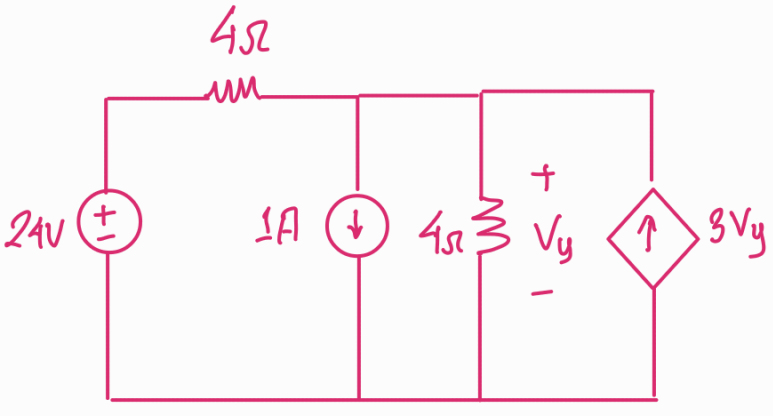


$\therefore V_y = 2\times(5+3V_y)$

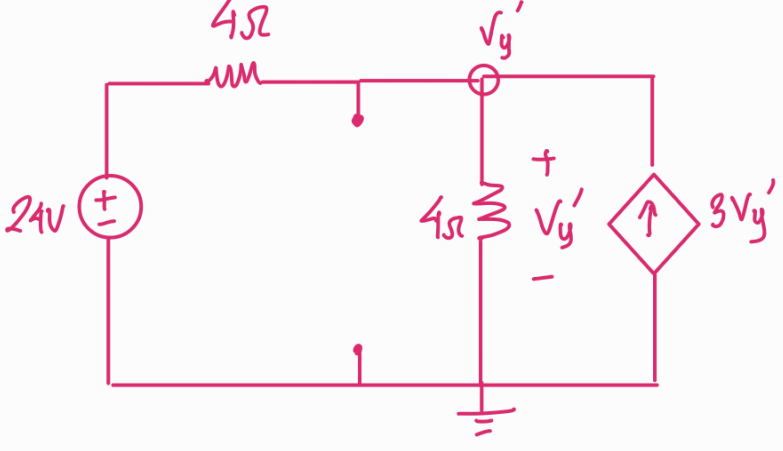
$\Rightarrow V_y = 10 + 6V_y$

$\Rightarrow -5V_y = 10 \Rightarrow V_y = -2V$

Solving by superposition —



Keeping the 24V src ON —



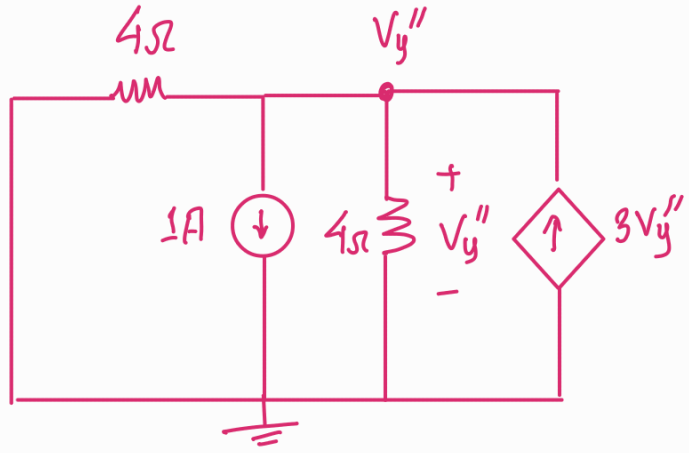
KCL @ node y' —

$$\frac{V_y'-24}{4} + \frac{V_y'}{4} - 3V_y' = 0$$

$$\Rightarrow V_y' - 24 + V_y' - 12V_y' = 0$$

$$\Rightarrow V_y' = -2.4V$$

Keeping the 1A src ON —



KCL @ node y'' —

$$\frac{V_y''}{4} + 1 + \frac{V_y''}{4} - 3V_y'' = 0$$

$$\Rightarrow V_y'' + 2 - 6V_y'' = 0$$

$$\Rightarrow V_y'' = 0.4V$$

$$\therefore V_y = V_y' + V_y'' = -2.4 + 0.4 = -2V$$

Q3

According to the Question —

V	I
2	3
-6	-1

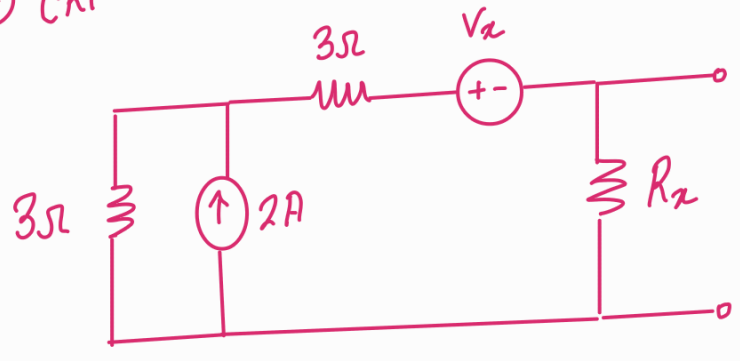
$$IV \rightarrow \frac{-6-2}{V-2} = \frac{-1-3}{I-3}$$

$$\Rightarrow 2I - 6 = V - 2$$

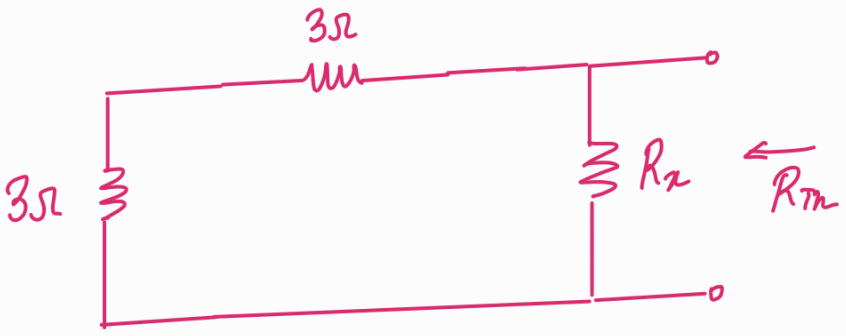
$$\Rightarrow I = \frac{V}{2} + 2$$

Comparing to $I = \frac{V}{R_{Th}} - \frac{V_{Th}}{R_{Th}}$, $R_{Th} = 2\Omega$ & $V_{Th} = -4V$

(a) Ckt —



Turning off all the srcs to find R_{Th} —



$$R_{Th} = R_x \,||\, (3+3)$$

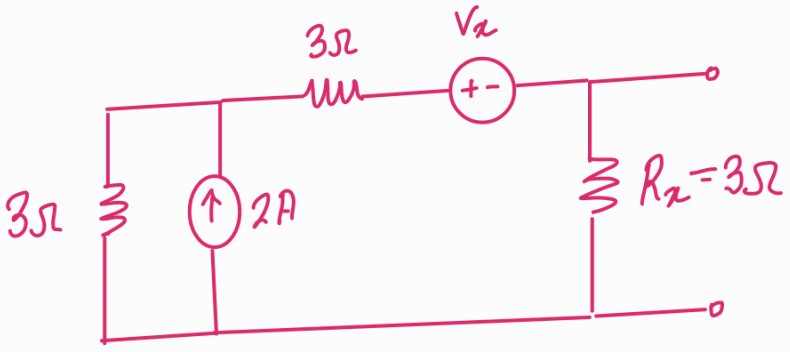
$$\Rightarrow 2 = \left(\frac{1}{R_x} + \frac{1}{6}\right)^{-1}$$

↑ found from IV

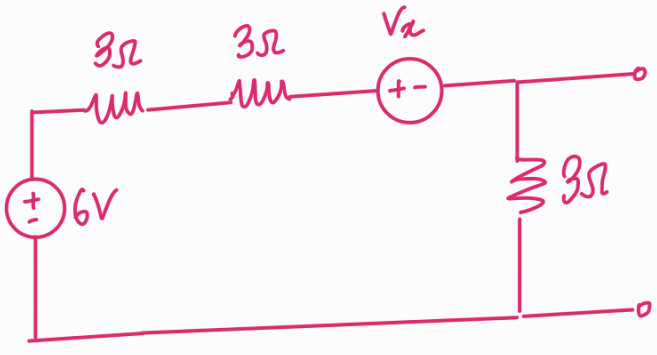
$$\Rightarrow \frac{1}{2} = \frac{1}{R_x} + \frac{1}{6}$$

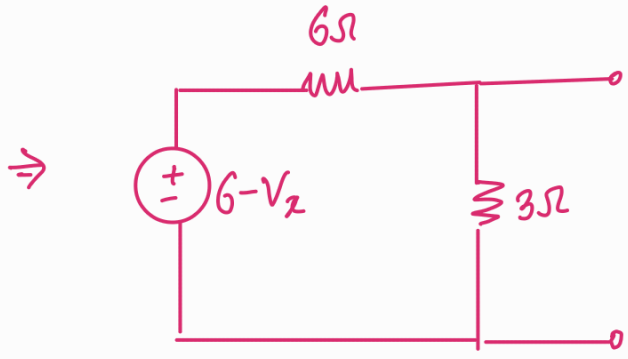
$$\Rightarrow \frac{1}{R_x} = \frac{3-1}{6} \Rightarrow R_x = 3\Omega$$

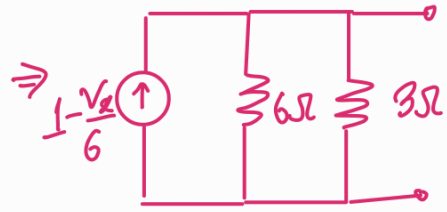
(b) Simplifying the ckt to match Thevenin's ckt —

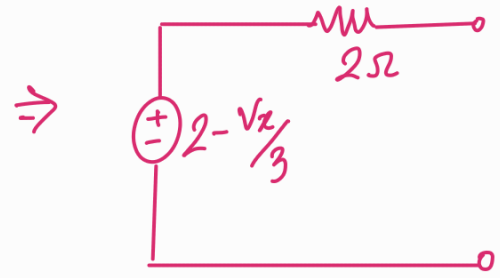


⇒









$$\therefore 2-\frac{V_x}{3}=V_{Th} \Rightarrow 2-\frac{V_x}{3}=-4$$

↑ found from IV

$$\Rightarrow V_x=18V$$

Q4

(a) V_1 leads V_2 by $\Delta t = 6ms$

$T = 16ms$

$$\therefore \Delta\phi = \frac{6}{16}\times 360^\circ = 135^\circ$$

(b) $V_1(t) = 8 \sin\left(2\pi \times \frac{1}{16\times10^{-3}} \times t + \frac{2}{16} \times 360^\circ\right)$ V

$= 8 \sin(125\pi t + 45^\circ)$ V

$V_2(t) = 6 \sin(125\pi t - \frac{4}{16} \times 360^\circ)$ V

$= 6 \sin(125\pi t - 90^\circ)$ V

$\phi_{V1} - \phi_{V2} = 45 - (-90) = 135^\circ$ [verified]

for cosine —

$V_1(t) = 8 \cos(125\pi t - \frac{2}{16} \times 360^\circ)$ V

$= 8 \cos(125\pi t - 45^\circ)$ V

$V_2(t) = 6 \cos(125\pi t - \frac{8}{16} \times 360^\circ)$ V

$= 6 \cos(125\pi t - 180^\circ)$ V

$\phi_{V1} - \phi_{V2} = -45 - (-180) = 135^\circ$ [verified]