Solution

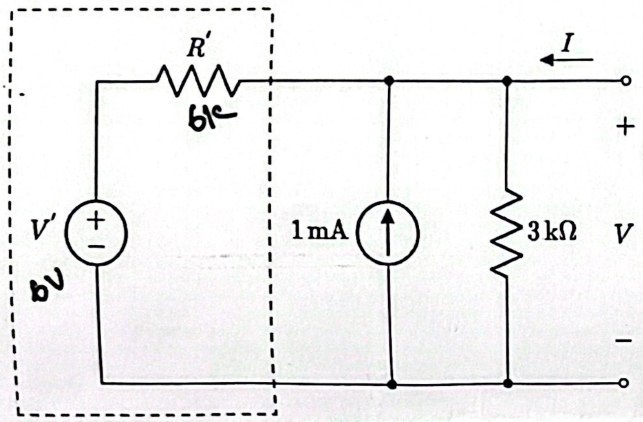
ID:	Name:

Brac University
Faculty : AQT
CSE250 Circuits and Electronics

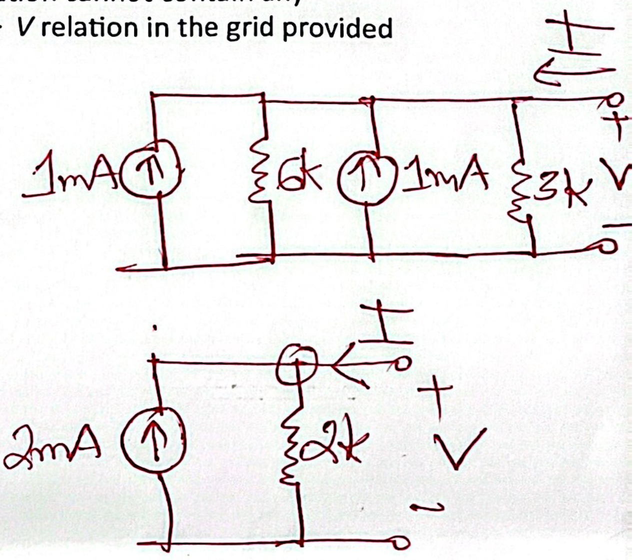
Quiz 2

Question 1 of 2 *[10 marks]*

Derive a **Current-Voltage Relationship** from *Circuit 2*. The $I - V$ equation cannot contain any variables other than I and V pointed out in the diagram. Plot the $I - V$ relation in the grid provided above.



Circuit 2

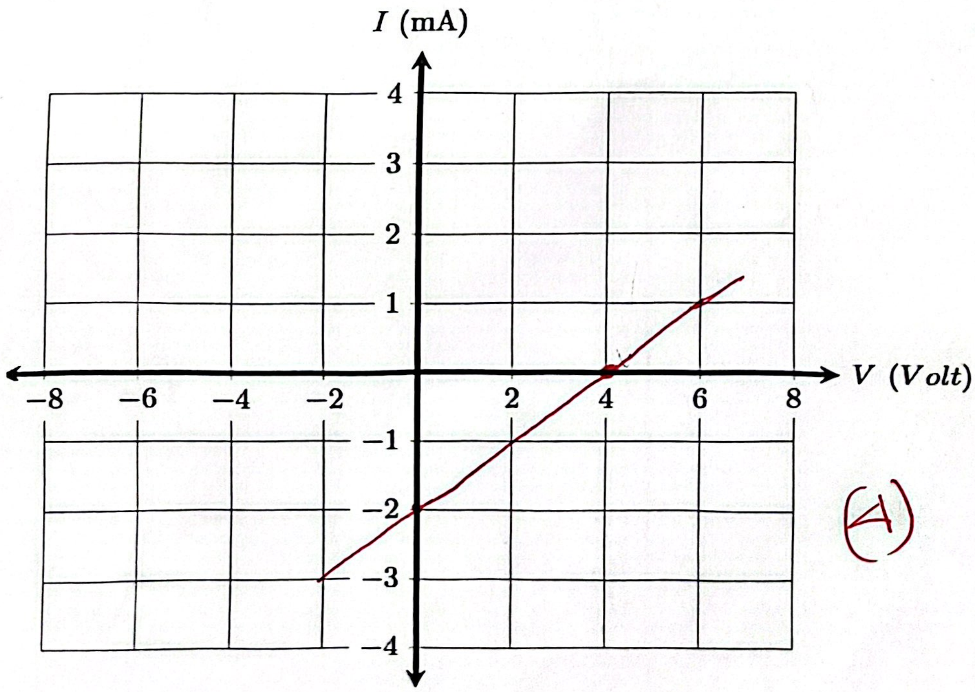


KCL:

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

$$\Rightarrow \boxed{I = \frac{V}{2} - 2}$$

(6)



(4)

Question 2 of 4 **[10 marks]**

When a voltage V = 5V is applied between terminals a and b of a linear two terminal circuit 'X', the circuit draws a current I = 2A as shown in Figure 1 below. When the terminals are shorted, 3A current flows as shown in Figure 2.

(a) [2 marks] Derive a relationship between I and V .

(b) [2 marks] Draw the relationship found in (a) on the grid provided below.

(c) [6 marks] If the circuit in Figure 1 is an alternative version of the circuit 'X', determine the voltage V' and the resistance R'.

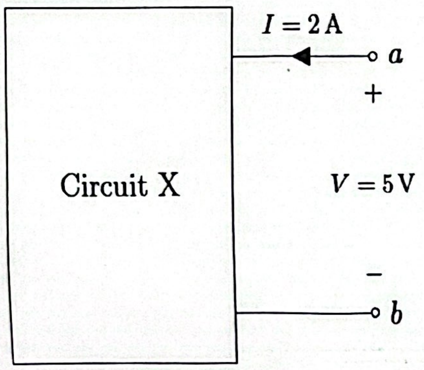


Figure 1

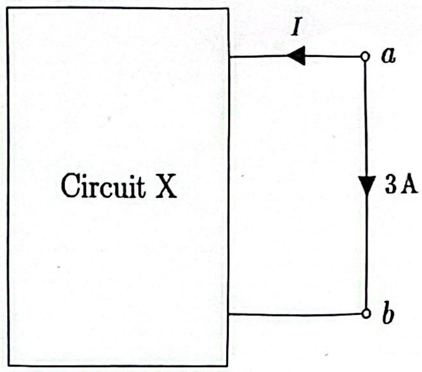


Figure 2

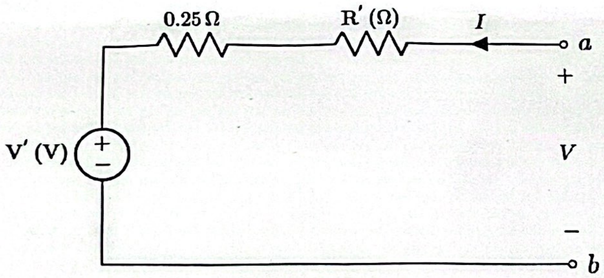


Figure 3

(V, I)

$(5, 2), (0, -3)$

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\Rightarrow \frac{y - 2}{-3 - 2} = \frac{x - 5}{0 - 5}$$

$$\Rightarrow y - 2 = x - 5$$

$$\Rightarrow y = x - 3$$

$$\therefore \boxed{I = V - 3}$$

$m = 1$

$R = 1\Omega$

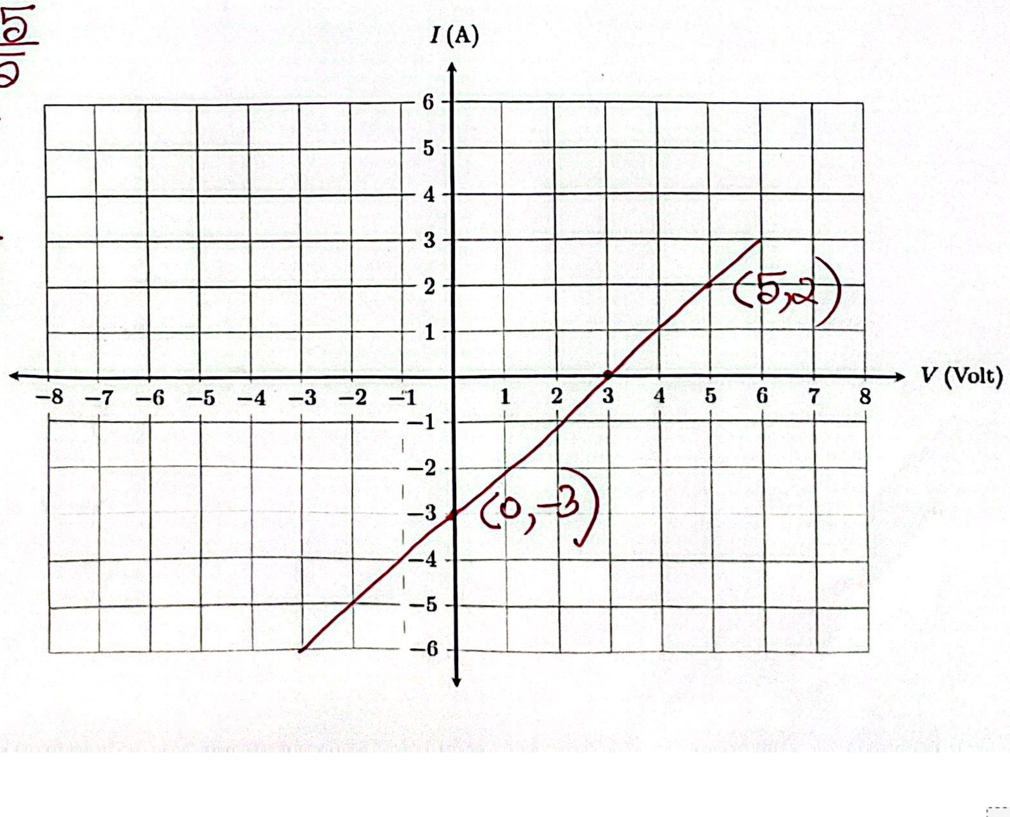
$R = 1\Omega$

Equivalent R,

$0.25 + R' = 1$

$\therefore R' = 0.75$

$V' = 3$



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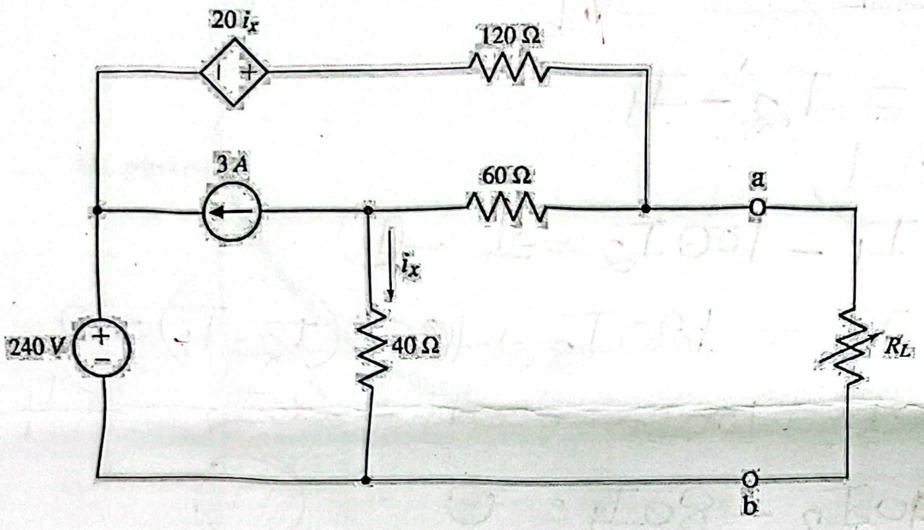
Quiz 3

(a) Obtain the Thevenin Equivalent circuit at terminals a-b. (12 marks)

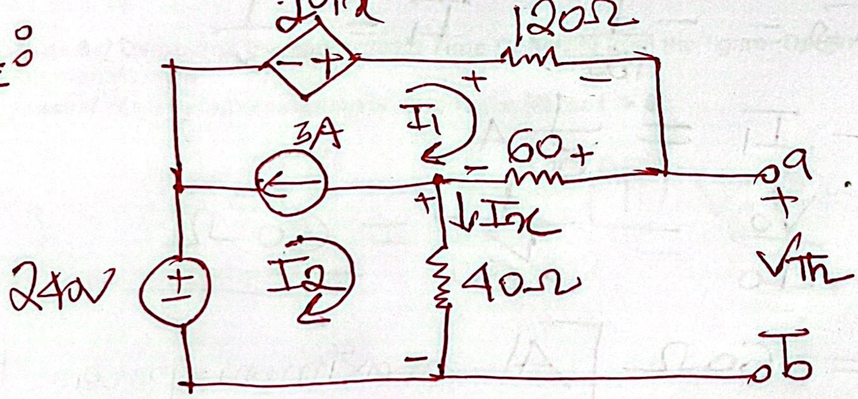
(b) Determine the value of R_L that will draw Maximum Power from the rest of the circuit. (3 marks)

(b) Determine that value of the Maximum Power. (5 marks)



$R_L = 60\Omega$
$V_{Th} = 30V$
$P_{max} = 3.75W$

(a) $\underline{V_{Th}:}$
(4)



~~$V_{40} = I_2 \times 40 = \frac{12}{7}$~~

Supermesh relations,

$I_1 - I_2 = 3$ —(1) $\boxed{I_2 = I_x}$

KVL at outer loop,

$-240 - 20i_x + 120I_1 + 60I_1 + 40I_2 = 0$

$\Rightarrow -20I_2 + 120I_1 + 60I_1 + 40I_2 = 240$

$\Rightarrow 180I_1 + 20I_2 = 240$ —(II)

$I_1 = 3/2A, I_2 = -\frac{3}{2}A$

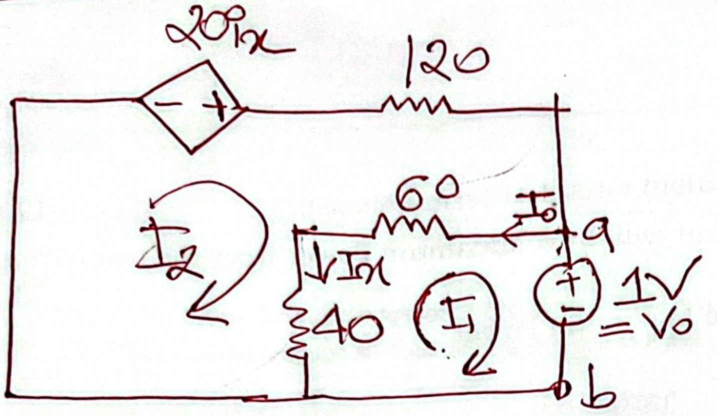
KVL at open loop,

$+V_{Th} - V_{40} - V_{60} = 0$

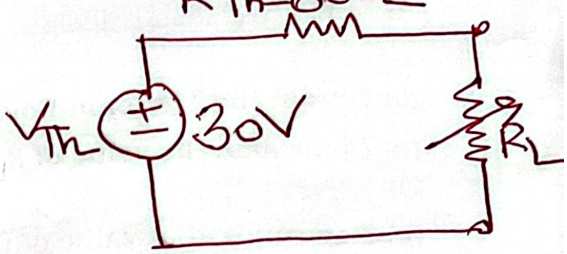
$\Rightarrow V_{Th} = I_x \times 40 + I_x$
$= \cancel{I_2 \times 40}$
$= -\frac{3}{2} \times 40$
$+ 60 \times \frac{3}{2}$
$= 30V$

R_{Th} (4)

Universal Method



(4) Thevenin Circuit



$$I_x = I_2 - I_1$$

KVL @ 1,

$$100I_1 - 100I_2 = -1 \quad \text{— (I)}$$

KVL @ 2, $20I_x + 120I_2 + 100(I_2 - I_1) = 0$

$$\Rightarrow 120I_2 + 100I_2 - 100I_1 = 20I_2 - 20I_1$$

$$\Rightarrow 200I_2 - 80I_1 = 0 \quad \text{— (II)}$$

$$I_2 = -\frac{1}{150} \qquad I_1 = -\frac{1}{60}$$

$$I_0 = -I_1 = \frac{1}{60}\text{ A}$$

$$R = \frac{V_0}{I_0} = \frac{1}{1/60} = 60\,\Omega$$

(b) $R_L = 60\Omega$ [At maximum power, $R_L = R_{Th}$] (3)

(c) $P_{max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{(30)^2}{4\times60} = 3.75\text{ W}$ (5)

Solution

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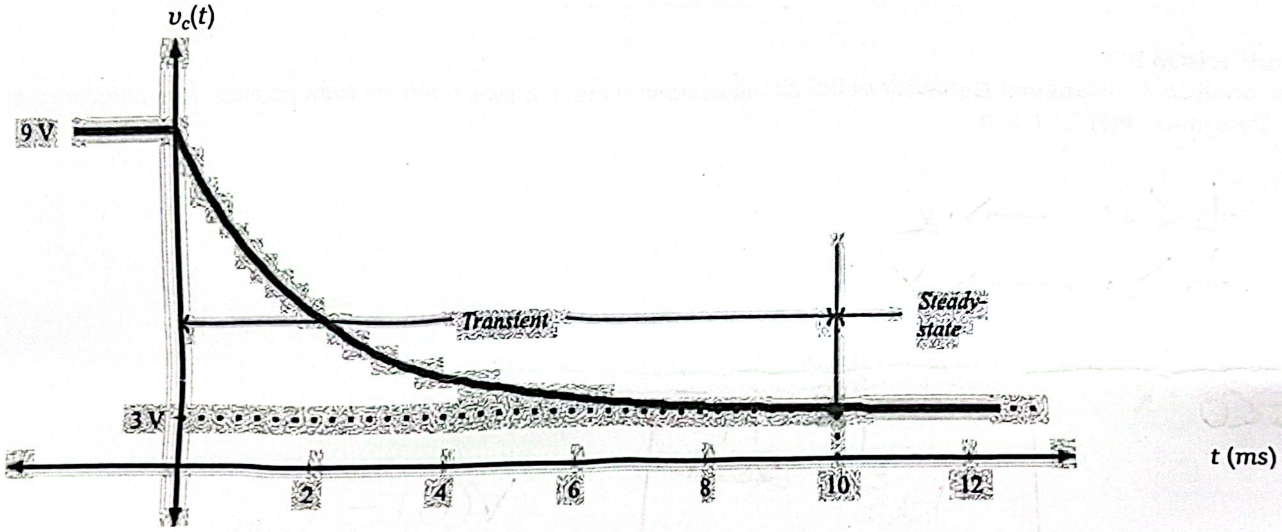
Circuits And Electronics
Faculty: AQT

Question 1 **[5 marks]**

The $v_c(t)$ vs t plot below shows the voltage response of a capacitor (C) in a series RC circuit to a sudden change in the DC voltage applied through an equivalent resistance of $2\ k\Omega$.



(i) *[3 marks]* **Determine** the approximate **Time Constant** from the figure. **Determine** C with appropriate units.

(ii) *[2 mark]* Write a mathematical expression of $v_c(t)$ for $t > 0$

(i) $R_{eq} = 2k\Omega$

$5\tau = 10ms$

$\therefore \tau = 2ms$

$\tau = RC$

$\Rightarrow 2\times10^{-3} = 2\times10^{3}\times C$

$\Rightarrow C = \frac{2\times10^{-3}}{2\times10^{3}}$

$\therefore C = 1\mu F$

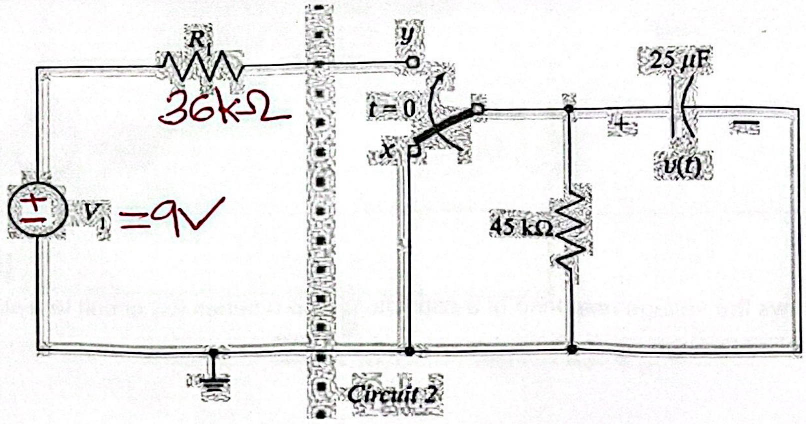
(ii) $v_c(t) = v(\infty) + [v(0) - v(\infty)]e^{-t/\tau}$

$= 3 + [9-3]e^{-t/2}$

$= 3 + 6e^{-t/2}$

Question 2

[8 marks]



Circuit 2

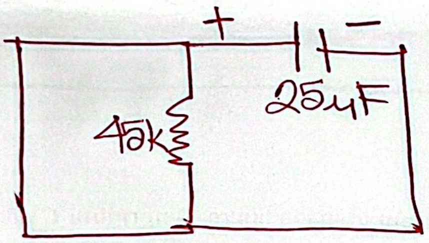
V1=9V, R1=36 kΩ

Now, **analyze** the **Transient Behavior** of the circuit assuming that the switch moves from position ***x*** to position ***y*** at ***t* = 0**. **Determine *v*(*t*)** for ***t* > 0**.

$t<0 \longrightarrow x$

$t>0 \longrightarrow y$

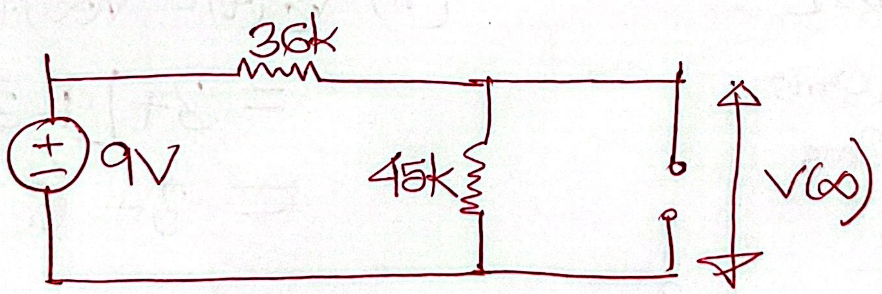
$t<0$



$V(0) = 0V$

Source free

$t>0$



$$v(\infty) = \frac{45}{45+36} \times 9V = 5V$$

$\tau,\ t>0$

$$R_{eq} = 36 \parallel 45 = 20k\Omega$$

$$\tau = RC = 20\times10^{3} \times 25\times10^{-6} = 0.5s$$

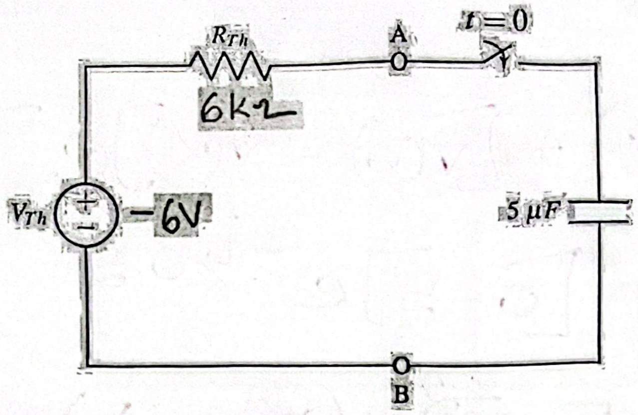
$$v(t) = v(\infty) + [v(0) - v(\infty)]e^{-t/\tau}$$

$$= 5 + [0 - 5]e^{-t/0.5}$$

$$= 5 - 5e^{-2t} \text{ (V)}, \quad t > 0$$

■ Question 3

[7 marks]

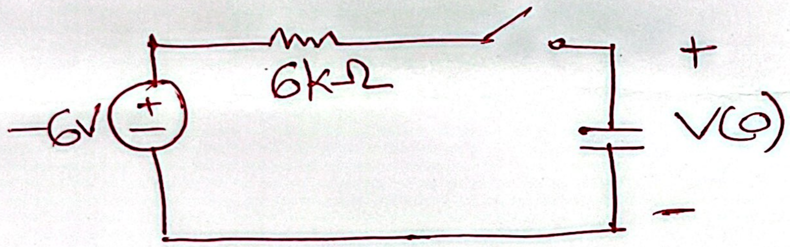


Perform transient analysis to determine $v(0)$, $v(\infty)$, *and* $v(t)$ for $t > 0$..

$t < 0$ Switch open

$t > 0$ Switch closed

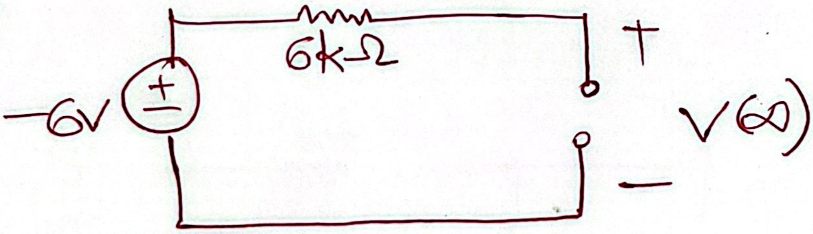
$t < 0$,



$V(0) = 0V$

Capacitor disconnected

$t > 0$



$V(\infty) = -6V$

τ, $t > 0$

$$\tau = RC$$
$$= 6000 \times 5 \times 10^{-6}$$
$$= 30ms = 0.03s$$

$$v(t) = V(\infty) + [V(0) - V(\infty)]e^{-t/\tau}$$
$$= -6 + [0 + 6]e^{-t/30}$$
$$= -6 + 6e^{-t/30}, \quad t > 0 \quad (t \rightarrow ms)$$

Solution

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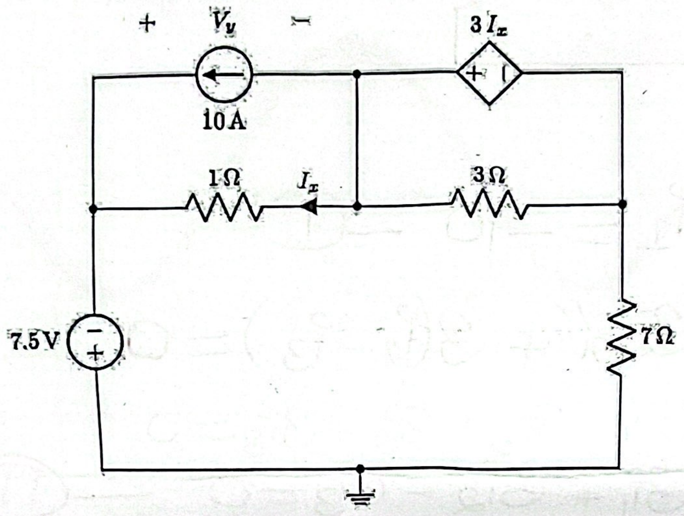
Quiz 5

Question 1 of 2

[CO3] [16 marks]

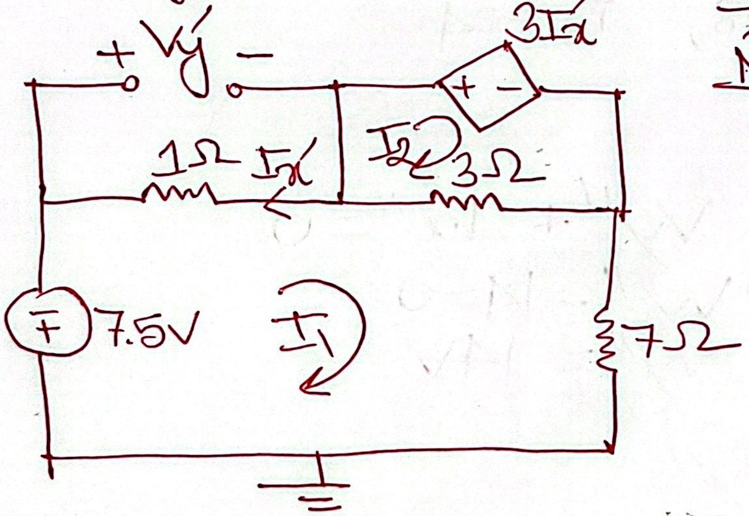


From the above circuit, answer the following questions-

(a) *[13 marks]* Find V_y using Superposition principle.
After applying Superposition principle you may use any analysis technique you prefer (Nodal, Mesh, Src Tx etc.).

(b) *[3 marks]* Find the power consumed/supplied by the current source (with proper ± sign and unit).

(a) Keeping 7.5V active,



$I_1 = -I_x'$

Mesh 1

$7.5 + I_1 + 3(I_1 - I_2) + 7I_1 = 0$

$\Rightarrow 11I_1 - 3I_2 = -7.5$ — (I)

Mesh 2

$3(I_2 - I_1) + 3I_x' = 0$

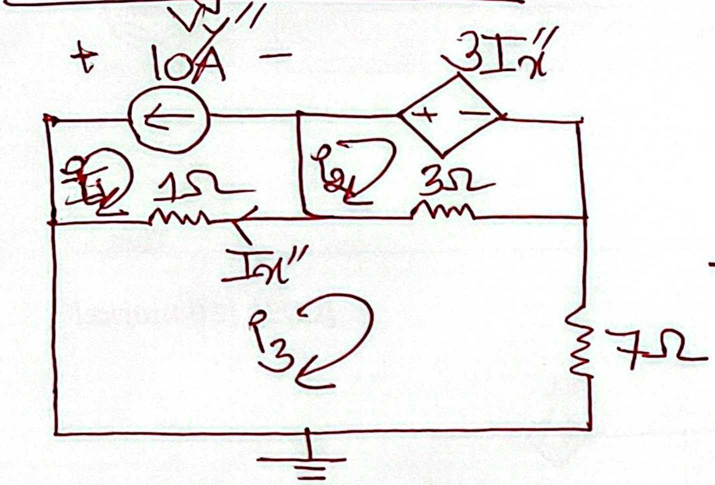
$\Rightarrow 3I_2 - 3I_1 - 3I_1 = 0$

$\Rightarrow -6I_1 + 3I_2 = 0$ — (II)

$I_1 = -1.5A, \; I_2 = -3A$

$V_y' = -I_x' \times 1 = +I_1 = \cancel{+1.5V}$
$= -1.5V$

Keeping 10A active



(b) Power = VI

$P_{10A} = V_y \times 10A$
$= 12.5 \times 10$
$= -125W$
(Supplying)

$I_x'' = i_1 - i_3$

Mesh 1: $i_1 = -10$ — (I)

Mesh 2: $3I_x'' + 3(i_2 - i_3) = 0$
$\Rightarrow 3i_1 - 3i_3 + 3i_2 - 3i_3 = 0$
$\Rightarrow 3i_1 + 3i_2 - 6i_3 = 0$ — (II)

Mesh 3: $i_3 - i_1 + 3(i_3 - i_2) + 7i_3 = 0$
$\Rightarrow -i_1 - 3i_2 + 11i_3 = 0$ — (III)

$i_1 = -10, \; i_2 = 18, \; i_3 = 4$

$I_x'' = -14A$

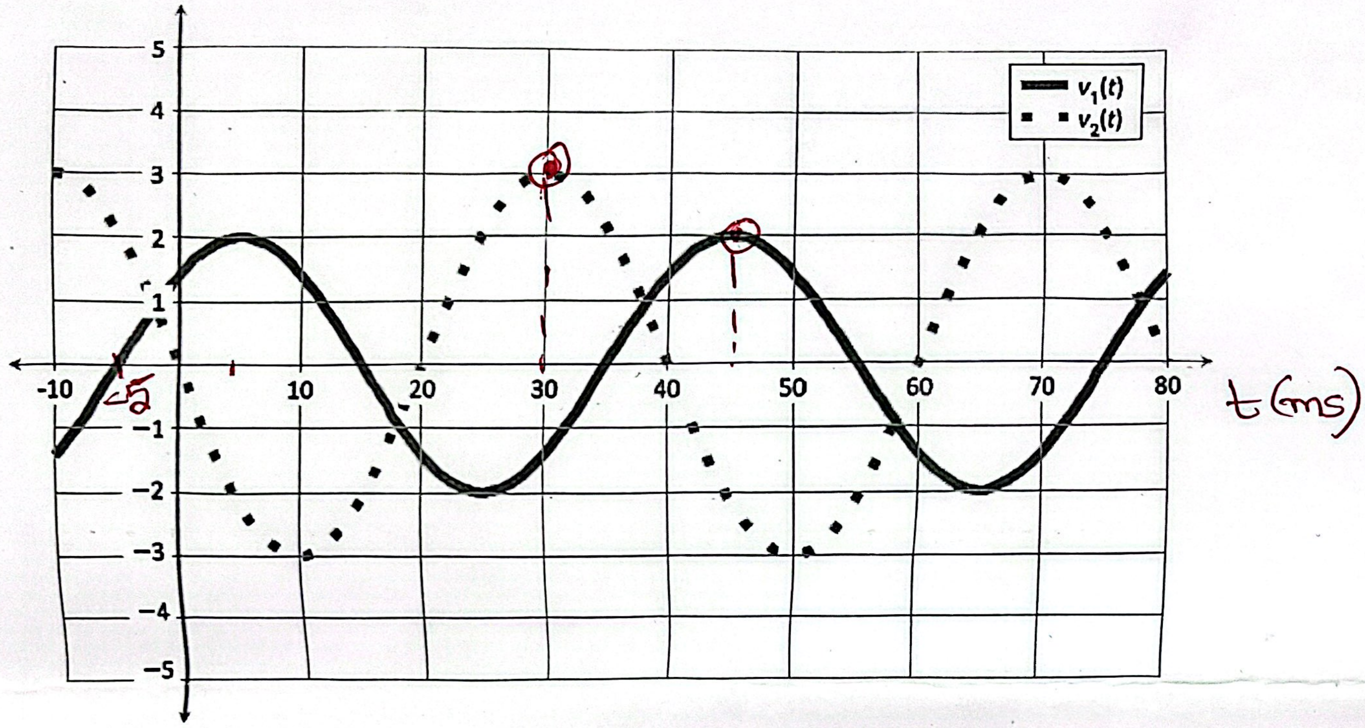
KVL in loop 1: $V_y'' + I_x'' = 0$
$\Rightarrow V_y'' - 14 = 0$
$\therefore V_y'' = 14V$

$V_y = V_y' + V_y''$
$= -1.5V + 14V$
$= \underline{\underline{12.5V}}$

 [8 marks]

Two ac voltage waveforms $v_1(t)$ and $v_2(t)$ from a circuit are plotted below as a function of time t.

$v_1(t)$, $v_2(t)$ (Volt)



(a) *[4 marks]* Determine the phase difference between the two and specify which one is leading.

(b) *[4 marks]* Write analytical expressions for both $v_1(t)$ and $v_2(t)$. From the expressions, verify the fact found in (a).

(a) $\Delta t = 45 - 30 = 15\,\text{ms}$

$T = 40\,\text{ms}$

$\Delta\phi = \frac{\Delta t}{T} \times 360^\circ = \frac{15}{40} \times 360^\circ = 135^\circ$

$V_2(t)$ is leading

$\frac{20}{40} \times 360 = 180^\circ$

$v_2(t) = 3\sin\left(\frac{2\pi}{40}t - 180^\circ\right)$

(b) $v_1(t) = 2\sin\left(\frac{2\pi}{40}t + 45^\circ\right)$

$\phi = \frac{5}{40} \times 360^\circ = 45^\circ$

$v_2(t) = -3\sin\left(\frac{2\pi t}{40}\right)$

$= 3\sin\left(\frac{2\pi}{40}t - 180^\circ\right)$