ESC201A Quiz1 Set B

SAMYAK SINGHANIA

TOTAL POINTS

12 / 12

QUESTION 1

1 Q1 **8 / 8**

✓ **+ 8 pts** *Completely Correct*

+ 0 pts Completely Incorrect

+ 0 pts Not attempted

+ 0 pts Copied

+ 0.5 pts v(t) formula correct

+ 0.5 pts v(0+) calculation correct

+ 2.5 pts v_infinity calculation correct

+ 2 pts Req calculated correctly

+ 1 pts v(t) calculated correctly

+ 1.5 pts Energy Calculated Correctly

- 1 pts for minor mistakes

1 Great work!

QUESTION 2

2 Q2 **4 / 4**

✓ **+ 4 pts** *Completely Correct*

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1.5 pts ix calculated correctly

+ 1.5 pts Zx calculated correctly

+ 1 pts Element Value Calculated Correctly

+ 0.5 pts Inductor Unit not written

+ 0.5 pts The element is not capacitor

+ 1 pts Simplified value of ix is required.

+ 1 pts A simplified value of zx is required.

ESC201A: Introduction to Electronics, Quiz -1 (Set-B) Date: 01.09.2022

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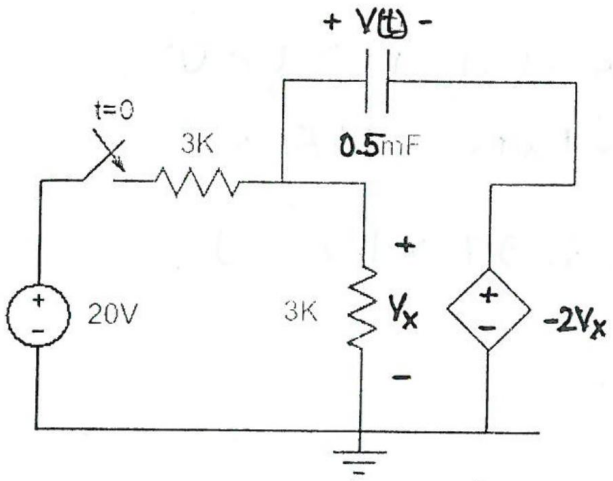
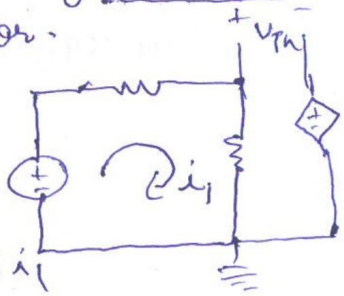
Q.1 Assuming that the capacitor does not have any initial charge, determine the voltage across the capacitor V(t) as a function of time after the switch is closed at t = 0. Also find the energy stored in the capacitor at t = 1 s. [8 Marks]



Solving the circuit by Thevinin across the capacitor.



$V_{Th} = V_x - (-2V_x)$

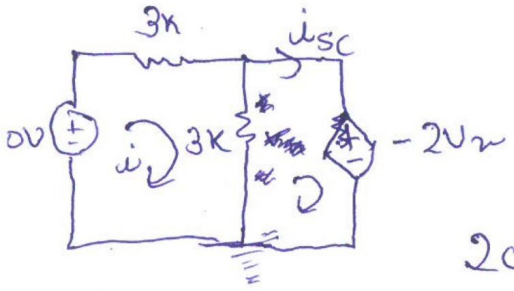
$= 3V_x$

$20 = 3K\,i_1 + 3K\,i_1$

$i_1 = \frac{20}{6000}\,A \Rightarrow V_x = \frac{3000}{6000} \times 20$

$V_x = 10V$

$\Rightarrow V_{Th} = 3 \times 10 = 30V$



To find i_{sc}, we use mesh analysis.

Let current i be flowing in mesh 1 & i_{sc} be flowing in mesh 2.

$20 = 3K\,i + 3K\,i - 3K\,i_{sc}$ — (1)

$-2V_x + 3K\,i_{sc} - 3K\,i = 0$

Also $V_x = 3K(i - i_{sc})$

$\Rightarrow 3K\,i_{sc} - 3K\,i = 6K\,i - 6K\,i_{sc}$

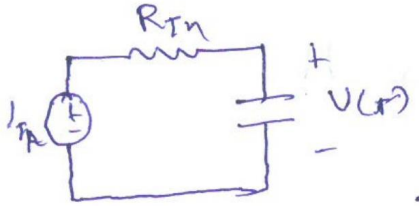
$\Rightarrow 9K\,i_{sc} = 9K\,i \Rightarrow i_{sc} = i$.

Putting this in eq (1), we get

$20 = 3K\,i_{sc} + 3K\,i_{sc} - 3K\,i_{sc} \Rightarrow i_{sc} = \frac{20}{3000}\,A$

$\therefore R_{Th} = \frac{V_{Th}}{i_{sc}} = \frac{30}{20} \times 3000\,\Omega = 4500\,\Omega = 4.5K\Omega$

Thevinin



∵ Capacitor do not have any initial charge

$V(0^-) = V(0^+) = V(0) = 0\,V$

$V(\infty) = V_{Th} = 30\,V$

$\tau = R_{Th}C = 4500 \times \frac{1}{2} \times 10^{-3} = 2.25$

$\therefore v(t) = v(\infty) + (v(0) - v(\infty)) e^{-\frac{t}{\tau}}$

$v(t) = 30 + (0 - 30) e^{-\frac{t}{2.25}} = 30 (1 - e^{-\frac{t}{2.25}})$

$\Rightarrow v(t) = 30 (1 - e^{-\frac{t}{2.25}})$ Volts.

At $t = 1$, $v(1) = 30 (1 - e^{-\frac{1}{2.25}}) = 10.76$ Volts.

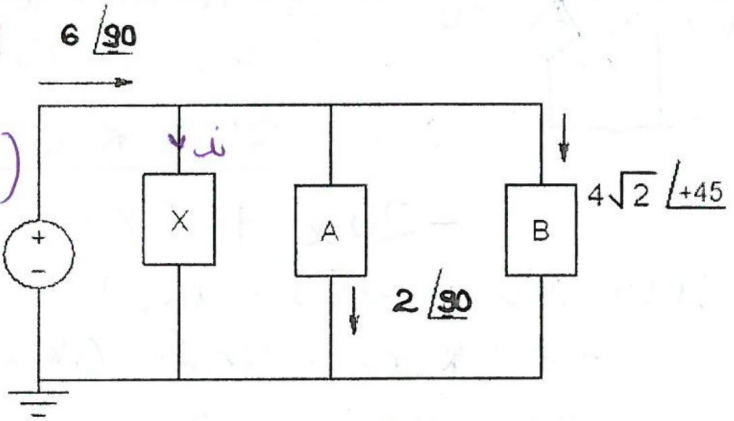
$\therefore$ Energy stored in capacitor at $t = 1 \Rightarrow \frac{1}{2} C v^2$

$= \frac{1}{2} \times \frac{1}{2} \times 10^{-3} \times 115.87$

$= 28.97 \times 10^{-3}$ J

1

Q.2 Determine the impedance of element X for the given currents and voltages in the circuit shown below. If ω = 5000 rad/s, find the element X value ? [4 Marks]



Let current i be flowing in X

By nodal analysis:

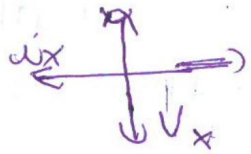
$6j = i + 2j + 4\sqrt{2}\left(\frac{1}{\sqrt{2}} + \frac{j}{\sqrt{2}}\right)$

$i = -4$ A

Let Z be the impedance

$\Rightarrow Z = \frac{8\angle -90}{-4} = \frac{-8j}{-4} = 2j = 2\angle 90\ \Omega$

$\Rightarrow$ The impedance is $2j\ \Omega$.



Clearly the potential across X is ahead of the current in phase by 90° $\Rightarrow$ X is inductor.

$\therefore Z = j\omega L = 2j \Rightarrow L = \frac{2}{\omega} = \frac{2}{5000}$

$L = 0.4 \times 10^{-3}$ H

$\Rightarrow$ Element X value is 0.4×10^{-3} H.