ESC201A MidSem Part1

SAMYAK SINGHANIA

TOTAL POINTS

12.5 / 19

QUESTION 1

Q1 7 pts

1.1 1(a) **2 / 2**

✓ **+ 2 pts** *Completely Correct*

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts Region I/III correctly eliminated

+ 1 pts Ix calculated correctly, region assumption verified

1.2 1(b) **2.5 / 5**

+ 5 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 4 pts Four transformations correct

+ 3 pts Three transformations correct

+ 2 pts Two transformations correct

+ 1 pts One transformation correct

+ 2.5 *Point adjustment*

QUESTION 2

Q2 7 pts

2.1 2(a) **3 / 3**

✓ **+ 3 pts** *Completely Correct*

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts Zeq calculated correctly

+ 1 pts Resonance condition identified

+ 1 pts L value found correctly

2.2 2(b) **1 / 4**

+ 4 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

✓ **+ 1 pts** *irms correct*

+ 2 pts Power Factor calculated correctly

+ 1 pts Reactive power correct

QUESTION 3

3 Q3 **4 / 5**

+ 5 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*

✓ **+ 1.5 pts** *v_infinity calculation correct*

✓ **+ 1.5 pts** *Req calculated correctly*

+ 1 pts C calculated correctly

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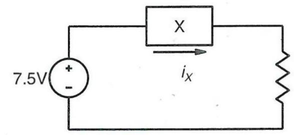
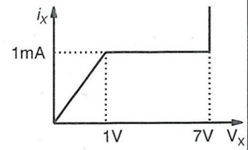
1 (a). Determine the current flowing in the circuit assuming that the current-voltage characteristics of element X is as shown below on the right. [2]





~~Since $V_s = 7.5$ V, Lets assume $V_x = 7$V.~~
~~$\therefore -7.5 + 7 + i_x(1k\Omega) = 0$~~
~~$i_x(1k\Omega) = 0.5$~~
~~$i_x = 0.5$ mA < 1mA~~
~~$\therefore$ Not possible~~

We can say that $i_x = (7.5 - V_x)$ mA.

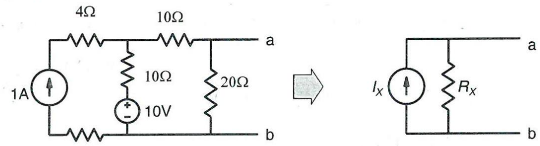
If $I_x > 1$mA $\Rightarrow V_x < 6.5$ V (Not possible)

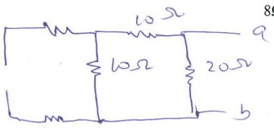
If $I_x < 1$mA $\Rightarrow V_x > 6.5$ V (Not possible)

$i_x = 1$mA $\Rightarrow V_x = 6.5$m A $\Rightarrow$ This satisfies the characteristics ~~from~~ of element X

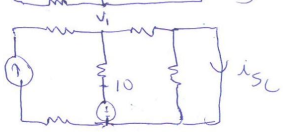
$\therefore i_x = 1$ mA.

1 (b). Using Source transformation only, show that the circuit below on the left can be transformed into the equivalent circuit shown on the right and determine Ix and Rx. [5]





$R_{Th} = 20 \| 20 = 10\Omega$.



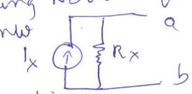
$\therefore$ Nodal analysis gives us

$$\frac{V_1 - 10}{10} + \frac{V_1}{10} = 1$$

$\Rightarrow V_1 = 10$

$\therefore i_{sc} = \frac{10}{10} = 1$A.

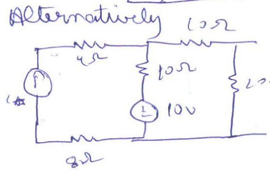
Using Norton equivalent, We can transform the circuit into

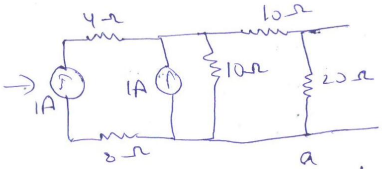


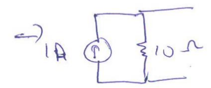
where $I_x = 1$A

$R_x = 10\Omega$.

Alternatively



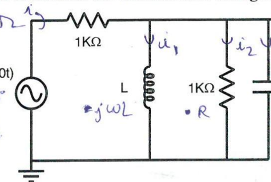




$I_x = 1$A

$R_x = 10\Omega$

2(a). For the circuit shown below, determine the value of inductor for the indicated voltages. [3]



Let current i be flowing in $1k\Omega$

$V_s = 10\angle 0°$, $jωL$, R, $\frac{1}{jωC}$, $i_3 = 5\angle 0°$

$\therefore i = \frac{V_s - V_o}{1k\Omega}$

$= \frac{10\angle 0° - 5\angle 0°}{1k\Omega} = 5\angle 0°$ mA

$i_2 = \frac{5\angle 0°}{1k\Omega} = 5\angle 0°$ mA.

$i_3 = \frac{5\angle 0°}{1/jωC} = 5ωC\,j = 5 \times 50 \times 10 \times 10^{-6} j = 25 \times 10^{-4} j$

$= 2.5$ mA j

$= 2.5\angle 90°$ mA

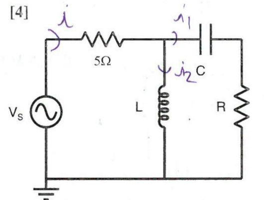
$\therefore i = i_1 + i_2 + i_3 \Rightarrow 5\angle 0° = i_1 + 5\angle 0° + 2.5\angle 90°$

$\Rightarrow i_1 = -2.5\angle 90° = -2.5j$ mA

$\therefore jωL = \frac{5\angle 0°}{-2.5j \times 10^{-3}} \Rightarrow L = \frac{5}{2.5 \times 10^{-3} \times 50} = 40$

$\boxed{\therefore L = 40\text{H}}$

2(b). For the circuit shown below , determine the reactive power taken from the supply if the power dissipated in each of the resistors is 5W and $V_S = 20Cos(5t)$. [4]



$5W = i^2 \cdot 5 \Rightarrow i = 1\,A$

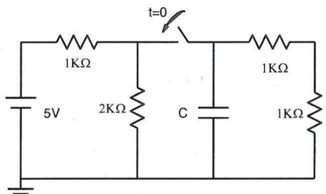
$i_1^2 R = 5W$

$R' = R + \frac{1}{j\omega C}$

$R'' = \dfrac{\left(R + \frac{1}{j\omega C}\right)(j\omega L)}{R + \frac{1}{j\omega C} + j\omega L}$

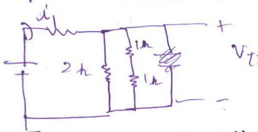
~~i is in phase with~~

3. A capacitor voltage of 1V was measured 2ms after the switch was closed in the circuit shown below. Determine the value of the capacitor assuming that switch had been open initially for a very long time. [5]



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

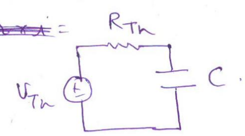
Drawing the Thevenin equivalent for the circuit



$R_{Th} = (1k) \| (2k) \| (2k) = \frac{1}{2}\,k\Omega$

$i_1 = \frac{5}{2}\,mA$

$V_{Th} = 1\,k\Omega \times \frac{5}{2}\,mA = \frac{5}{2}\,V.$



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

$V(\infty) = V_{Th} = \frac{5}{2}\,V$

$V(0) = 0\,V$

$\therefore V(t) = \frac{5}{2}\left(1 - e^{-\frac{t}{RC}}\right)\,V$

$V(2ms) = 1\,V = \frac{5}{2}\left(1 - e^{-\left(\frac{2ms}{RC}\right)}\right)$

$\Rightarrow 1V = \frac{5}{2}\left(1 - \left(1 - \frac{2ms}{RC}\right)\right)$

$\Rightarrow 1 = \frac{5}{2} \times \frac{2 \times 10^{-3}}{RC}$

$C = \dfrac{5 \times 10^{-3}}{\frac{1}{2} \times 10^{3}} = 10 \times 10^{-6} = 10\,\mu F.$

$C = 10\,\mu F$

Rough Work

$\frac{22 \times 20}{42 \cdot 21} = \frac{220}{21}$

$\frac{V}{10} + \frac{V-10}{10} = 1$

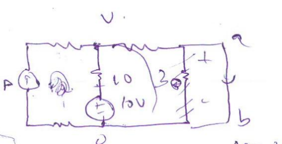
$2V - 10 = 10 \Rightarrow \boxed{2V = 20,\ V = 10}$

$\frac{V-10}{10} + \frac{V}{30} = 1.$

$3(V-10) + V = 30$

$3V - 30 + V = 30$

$4V = 60$ $\boxed{V = 15}$



$i_2 = 1$ $V = \frac{220}{21}$

$\frac{1}{2} + \frac{1}{2} + \frac{1}{1}$ $\boxed{\frac{1}{2}}\,k\Omega$

$\boxed{= 10}$

$\frac{2}{2}$

$-\frac{2 \times 10^{-3}}{RC} = -0.5$

$\frac{t}{RC}$