INDIAN INSTITUTE OF TECHNOLOGY HYDERABAD

ADDITIONAL SHEET

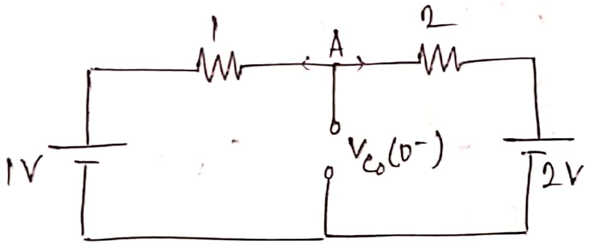
ROLL NO. :

1

When the switch is shifted from the position of P to Q, we will consider as $t = 0$.

From that point of view,

the equivalent ckt at $t = 0^-$ (At $t = 0^-$ the ckt will be in steady state so, capacitor will act as open ckt)



~~From the~~

$$V_{C_0}(0^-) = \frac{4}{3}\ V.$$

$$\therefore V_{C_0}(0^+) = \frac{4}{3}\ V.$$

As $t = 0^+$, abrupt change of voltage is not possible.

Using KCL at node A,

$$\frac{V_{C_0}(0^-) - 1}{1} + \frac{V_{C_0}(0^-) - 2}{2} = 0$$

$$\Rightarrow V_{C_0}(0^-) - 1 + \frac{V_{C_0}(0^-)}{2} - 1 = 0$$

$$\Rightarrow \frac{3}{2} V_{C_0}(0^-) = 2$$

$$\Rightarrow V_{C_0}(0^-) = \frac{4}{3}\ V.$$

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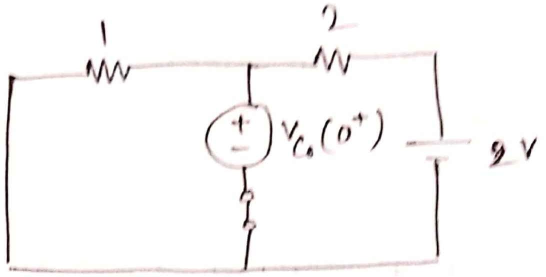
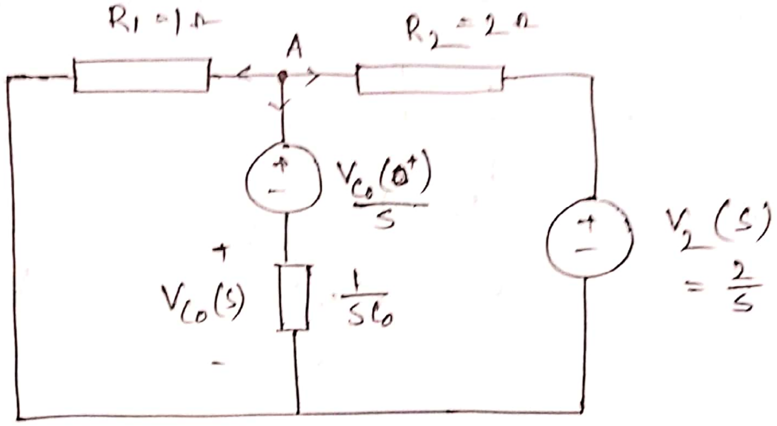
The equivalent ckt at $t=0^+$



At $t=0^+$, the capacitor will act as short ckt.

2. The s-domain equivalent ckt is–



$C_o = 1\mu F$

$V_{Co}(0^+) = \frac{4}{3}$

$$\cancel{\frac{V_A - 0}{1} + \frac{V_A - \frac{4}{3s}}{1/sC_o} + \frac{V_A - 2/s}{2} = 0}.$$

3. Applying KCL at node A,

$$\frac{V_{Co}(s) - 0}{1} + \frac{V_{Co}(s) - V_{Co}(0^+)}{1/sC_o} + \frac{V_{Co}(s) - V_2(s)}{2} = 0$$

$$\Rightarrow V_{Co}(s)\left(\frac{3 + 2sC_o}{2}\right) = \frac{3 + 4Cs}{3s}.$$

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ADDITIONAL SHEET

ROLL NO. :

2

$$\Rightarrow \cancel{V_{C_0}(s) = \frac{2(3+4Cs^2)}{3s(3+2C_0 s)} = \frac{6+8Cs^2}{}}$$

$$V_{C_0}(s) + sC_0 V_{C_0}(s) - sC_0 V_{C_0}(0^+) + \frac{V_{C_0}(s)}{2} - \frac{V_2(s)}{2} = 0.$$

$$\Rightarrow \frac{3}{2} V_{C_0}(s) + sC_0 V_{C_0}(s) - sC_0 \times \frac{4}{3\cancel{s}} - \frac{1}{s} = 0$$

$$\left[\text{As } V_{C_0}(0^+) = \frac{4}{3s} \right]$$

$$\Rightarrow \left(\frac{3}{2} + sC_0\right) V_{C_0}(s) = \frac{1}{s} + \frac{4C_0}{3}$$

$$= \frac{3+4C_0 s}{3s}$$

$$\Rightarrow V_{C_0}(s) = \frac{2(3+4C_0 s)}{3s(3+2sC_0)} = \frac{6+8C_0 s}{3s(3+2C_0 s)}$$

$$v_{C_o}(s) = \frac{\cancel{6}\,2}{\cancel{3}s(3+2C_o s)} + \frac{8C_o \cancel{s}}{3\cancel{s}(3+2C_o s)}$$

$$\frac{A}{\cancel{s}}$$

$$= \frac{\cancel{2}}{\cancel{2}C_o s\left(s+\frac{3}{2C_o}\right)} + \frac{8C_o}{9+6C_o s}$$

$$= \frac{A}{s} + \frac{B}{s+\frac{3}{2C_o}} + \frac{4\,\cancel{8}\cancel{C_o}}{3\cancel{6}\cancel{C_o}\left(s+\frac{\cancel{9}\,3}{\cancel{6}_{2}C_o}\right)}$$

$$= \frac{2/3}{s} - \frac{2/3}{s+\frac{3}{2}C_o} + \frac{4}{3}\cdot\frac{1}{\left(s+\frac{3}{2C_o}\right)}$$

$$A = \frac{1}{C_o\left(\frac{3}{2C_o}\right)} = \frac{2}{3}.$$

$$B = \frac{1}{C_o \times \left(-\frac{3}{2C_o}\right)} = -\frac{2}{3}.$$

4. $$\therefore v_{C_o}(t) = \frac{2}{3}u(t) - \frac{2}{3}e^{-3/2C_o\, t}u(t) + \frac{4}{3}e^{-\frac{3}{2C_o}t}u(t)$$

$$= \frac{2}{3}u(t) + \frac{2}{3}e^{-\frac{3}{2C_o}t}u(t)$$

$$v_{co}(t) = \frac{2}{3}\left(1 + e^{-1.5\times10^{6}t}\right)u(t)$$

5.

$$v_{co}(0^-) = v_{co}(0^+) = \lim_{t\to0^+} v_{co}(t)$$

$$= \frac{4}{3}\ V.$$

$$v_{co}(\infty) = \lim_{t\to\infty} v_{co}(t)$$

$$= \frac{2}{3}\ V.$$