WS 6

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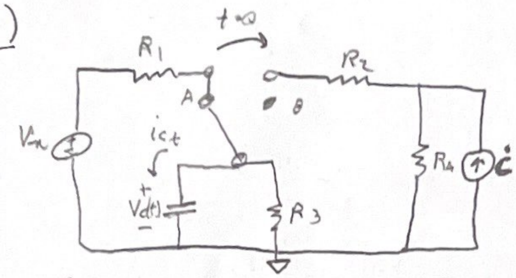
1)



$R_1 = 2\,k\Omega$, $R_2 = 2\,k\Omega$, $R_3 = 2\,k\Omega$, $R_4 = 4\,k\Omega$

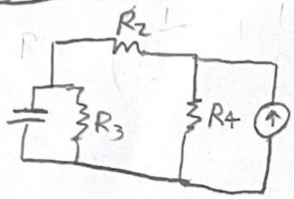
$C = 1\,\mu F$, $V_{in} = 10V$, $i = 6\,mA$

@ t=0

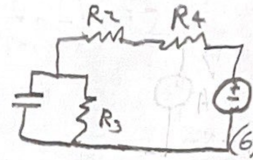
$\underline{V_c(0) = 5V} \Rightarrow V_{in} - i(R_1 + R_3) = 0 \Rightarrow i = \frac{V_{in}}{R_1 + R_3} = \frac{10}{4} = 2.5 \Rightarrow V_3 = i R_3 = 5 \Rightarrow V_3 \parallel V_c$

$\therefore V_c = 5V$

@ t=∞



$\Rightarrow$



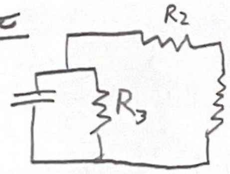
$V = iR_4 = (6)(4) = 24V$

$\Rightarrow R_{eq} = R_2 + R_3 + R_4 = 2 + 2 + 4 = 8$

$\hookrightarrow i = \frac{V}{R_{eq}} = \frac{24}{8} = 3\,mA$

$\therefore V_3 = iR_3 = (3)(2) = 6\,V$ $\quad \therefore \underline{V_c(\infty) = 6V}$

τ



$\Rightarrow R_{eq} = \left(\frac{1}{R_3} + \frac{1}{R_2 + R_4}\right)^{-1} = \left(\frac{1}{2} + \frac{1}{2+4}\right)^{-1} = \frac{3}{2} = 1.5\,k\Omega$

$\tau = R_{eq} C = (1.5)(1) = 1.5\,ms$ ($k\Omega$, μF)

$\Rightarrow V_c = A\exp(-t/\tau) + B \Rightarrow V_c(0) = 5 = A + B \longrightarrow 5 = A + 6 \quad \therefore A = -1$

$\hookrightarrow V_c(\infty) = 6 = 0 + B \quad \therefore B = 6$

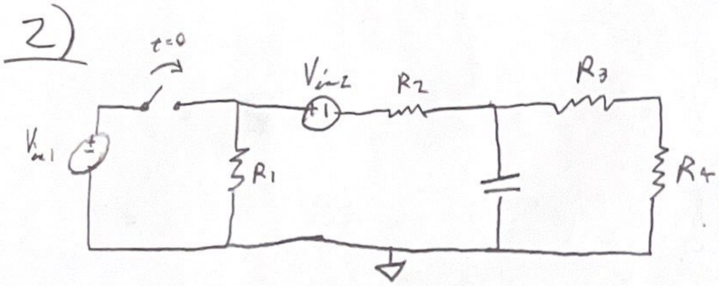
$$\boxed{\therefore V_c = 6 - \exp(-t/1.5ms)}$$

$i_c = C\frac{dV}{dt} = C\left[\frac{1}{\tau}\exp(-t/\tau)\right] \Rightarrow C\tau = (1\mu F)\left(\frac{1}{1.5\,ms}\right) = (1e{-6})(\tfrac{2}{3}e3)$

$= \frac{2}{3}e{-3}\,A = \frac{2}{3}\,mA$

$$\boxed{\therefore i_c = \frac{2}{3}\,mA\,\exp(-t/1.5ms)}$$

2)



$$\left.\begin{aligned} R_1 &= 1\,k\Omega \\ R_2 &= 1\,k\Omega \\ R_3 &= 1\,k\Omega \\ R_4 &= 1\,k\Omega \end{aligned}\right\} = R$$

$C = 1\,\mu F$

$V_{in1} = 8V$

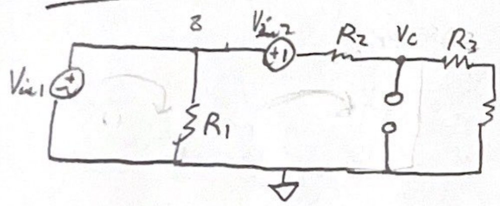
$V_{in2} = 4V$

t = 0

$$R_{eq} = R_3 + R_4 + R_1 + R_2 = 4\,k\Omega \;;\quad i = \frac{-V_{in2}}{R_{eq}} = \frac{4}{4} = -1\,mA$$

$$V_{34} = (1\,mA)(2\,k\Omega) = -2\,V = V_C(0)$$

t = ∞

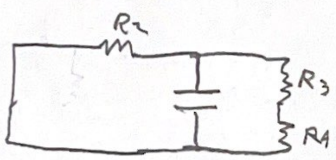


$$\frac{V_C}{R_3+R_4} = \frac{8-4-V_C}{1} \Rightarrow \frac{V_C}{2} = 4 - V_C \Rightarrow V_C = 8 - 2V_C$$

$$\Rightarrow V_C = 8/3\ V$$

τ

Thevenin =>



$$\Rightarrow R_{eq} = \left(\frac{1}{2R} + \frac{1}{R}\right)^{-1} = \frac{2}{3}\,k\Omega$$

$$\tau = R_{eq}C = \left(\frac{2}{3}\,k\Omega\right)(1\,\mu F) = \frac{2}{3}\,ms$$

$$V_C(t) = A\exp\left(\frac{-t}{\tau}\right) + B$$

$$\to V_C(0) = -2 = A + B \Rightarrow A = -2 - \frac{8}{3} \quad \therefore A = \frac{-14}{3}$$

$$\to V_C(\infty) = \frac{8}{3} = 0 + B \quad \therefore B = \frac{8}{3}$$

$$\boxed{\therefore V_C(t) = \frac{8}{3} - \frac{14}{3}\exp\left(-\frac{3t}{2\,ms}\right)}$$