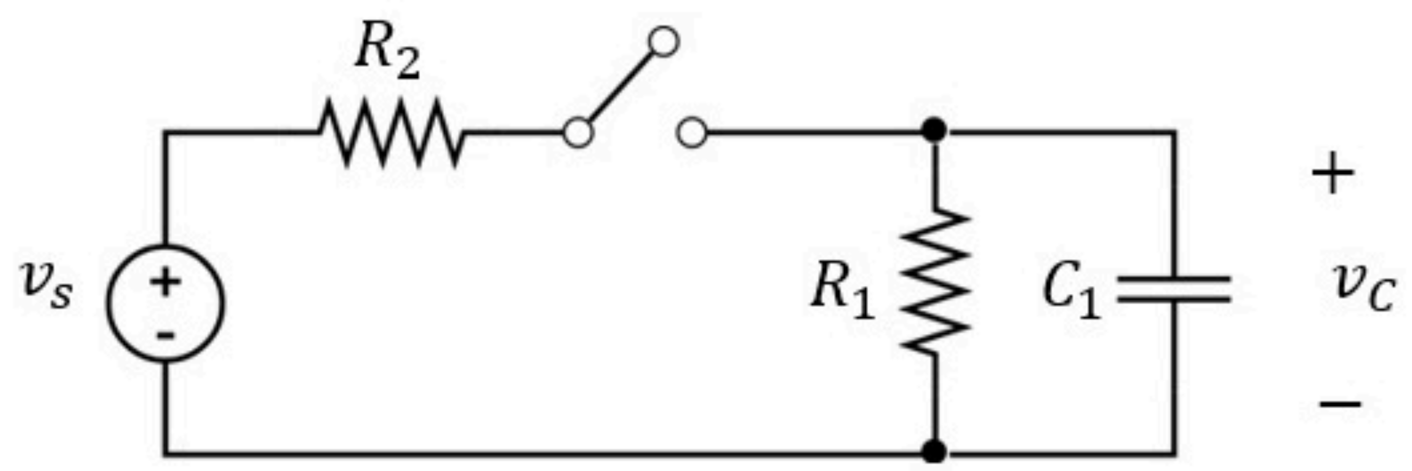
Phasors 011

Unlimited Attempts.

In the circuit below, $v_s(t) = A_1 \cdot \cos(25 \cdot 10^4 \cdot t)$.

The switch is closed for $t < 0$, and opens at time $t = 0$ s.



Find these voltages:

$$v_1 = v_C(0^+) \qquad v_2 = v_C(t_0)$$

Note, for your calculations, use: $e^{-1/1.5} \approx 0.5$

Solve without a calculator

Given Variables:

R1 : 6 kohm

R2 : 12 kohm

C1 : 1 nF

A1 : 12 V

to : 8 us

Calculate the following:

v1 (V) :

2

v2 (V) :

0.5

Hint: Solve steady state with phasors; use it to find the initial condition for the RC transient analysis.

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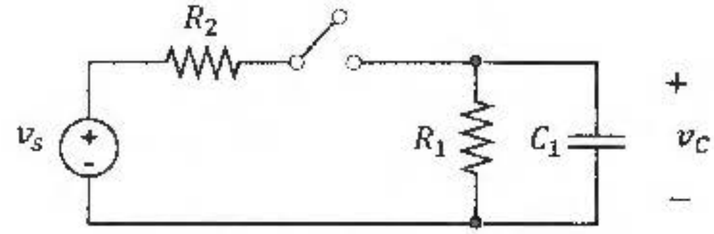

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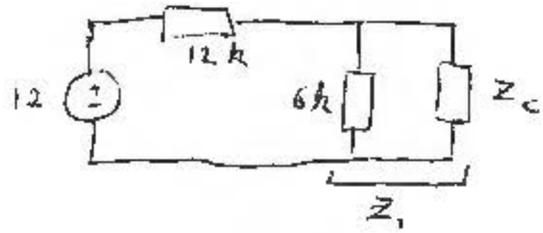
Solve without a calculator

(1) $t < 0$ ASSUME STEADY STATE @ $t = 0^-$



$$Z_c = \frac{1}{j\,25 \cdot 10^4 \cdot 10^{-9}} = -(4k) \cdot j$$

$$Z_1 = \frac{1}{\frac{1}{6k} + \frac{j}{4k}} = \frac{24k}{4 + 6j} = \frac{12k}{2 + 3j}$$

$$V_c = V_s \frac{Z_1}{Z_1 + R_2} = 12 \cdot \frac{12}{12 + 12(2 + 3j)} = \frac{12}{3 + 3j} = \frac{4}{1 + j} = \frac{4}{\sqrt{2}} e^{-j45°}$$

$$v_c(t) = \frac{4}{\sqrt{2}} \cos\left(25 \cdot 10^4 - \frac{\pi}{4}\right) \Rightarrow v_c(0^-) = \frac{4}{\sqrt{2}} \cos\left(-\frac{\pi}{4}\right) = \frac{4}{\sqrt{2}} \cdot \frac{\sqrt{2}}{2} = 2V$$

(2) $t = 0^+$ $\quad v_c(0^+) = v_c(0^-) = 2V \Rightarrow \boxed{v_1 = 2V}$

(3) $t > 0$: TRANSIENT RESPONSE OF RC CIRCUIT

$v_c(0^+) = 2V \qquad R_{TH} = R_1 \Rightarrow \tau = R_1 C = (6k) \cdot (1n) = 6\ \mu s$

$v_c(\infty) = 0\,V$

$$v_c(t) = 2 e^{-t/6\mu s} \quad \text{FOR } t > 0$$

$$v_c(t_0) = v_c(8\mu s) = 2e^{-8/6} = 2\left(e^{-\frac{1}{1.5}}\right)^2 = \frac{2}{4} = \frac{1}{2} V \qquad \boxed{v_2 = 0.5\,V}$$