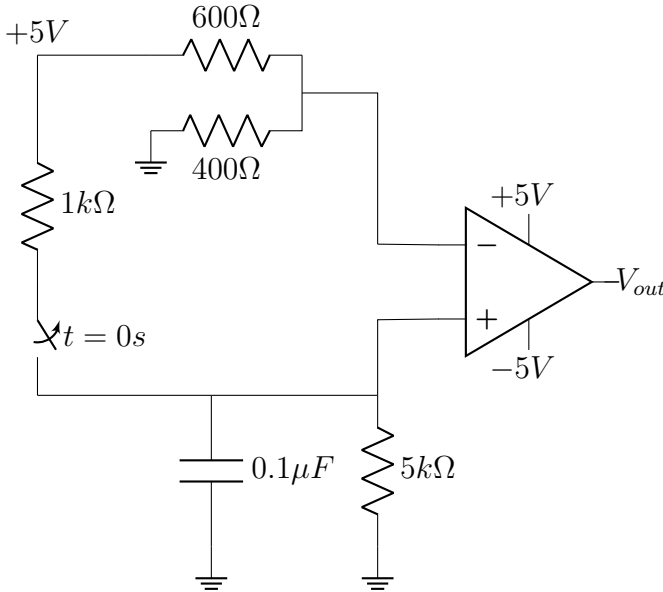


GATE 2022[IN]-64

EE23BTECH11066 - Yakkala Amarnath Karthik

Question:

In the circuit shown, the switch is initially closed. It is opened at $t = 0$ s and remains open thereafter. The time (in milliseconds) at which the output voltage V_{out} becomes LOW ($-5V$) is (round off to three decimal places)



Solution:

At $t = 0^-$, when the switch is closed, The voltage across the capacitor is:

$$V_c(0^-) = 5 * \frac{5}{5 + 1} \quad (1)$$

$$= \frac{25}{6} V \quad (2)$$

$V_c(0^-)$ is also the non inverting voltage of the OP-AMP

At $t = 0^+$, when the switch is open, The voltage across inverting terminal is:

$$V_I = 5 * \frac{600}{600 + 400} \quad (3)$$

$$= 2V \quad (4)$$

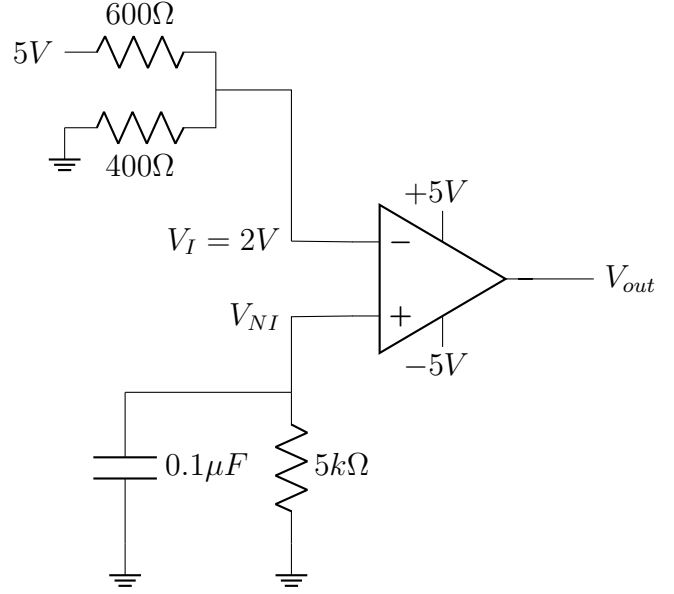


Fig. 1. circuit diagram at $t = 0^+$

Immediately after the switch is open, voltage across capacitor do not change.

So $V_{NI} > V_I$, Hence the output of OP-AMP is fixed to $+5V$. Later, Capacitor discharges into $5K\Omega$ resistor.

The discharging equation is as follows:

$$V_C(t) = V_C(0^-) e^{\frac{-t}{\tau}} \quad (5)$$

$$2 = \frac{25}{6} * e^{\frac{t_0}{RC}} \quad (6)$$

$$t = RC \ln\left(\frac{25}{12}\right) \quad (7)$$

$$= 0.1 * 10^{-6} * 5 * 10^3 \ln\left(\frac{25}{12}\right) \quad (8)$$

$$t = 0.367ms \quad (9)$$