# 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 is (round off to three decimal places

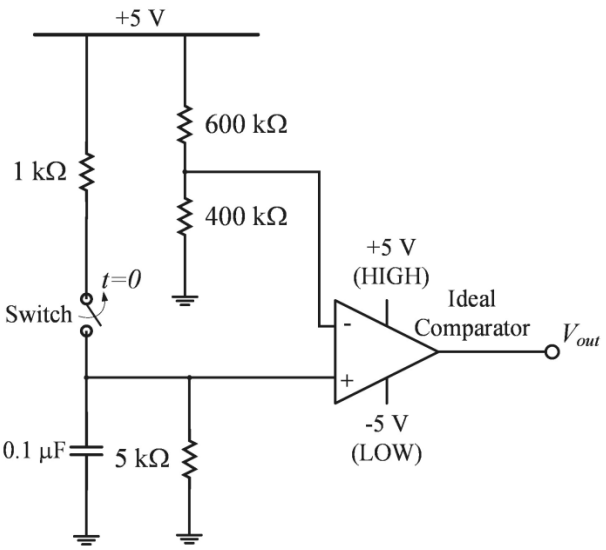


Fig. 1. circuit diagram

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

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

$$= \frac{25}{6}V \tag{2}$$

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

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

$$V_I = 5 * \frac{600}{600+400} \tag{3}$$

$$= 2V \tag{4}$$

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

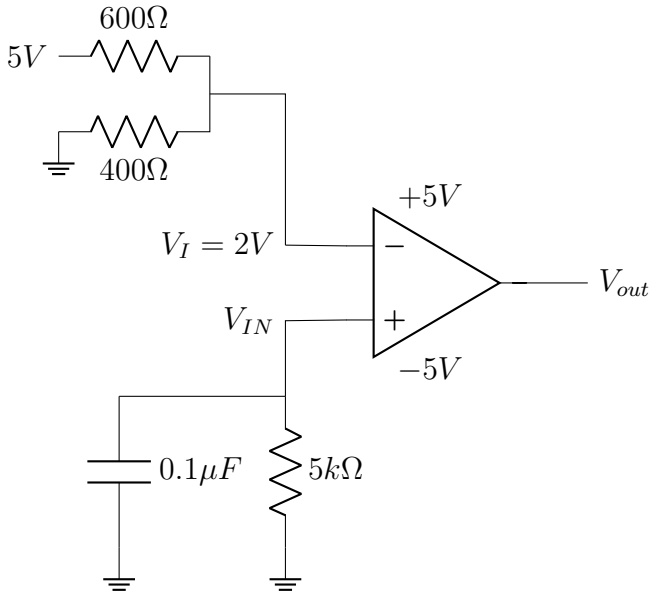


Fig. 2. circuit diagram at $t = 0^+$
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So $V_{NI} > V_I$,Hence the output of OP-AMP is fixed to 5V. Later, Capacitor discharges into 5KΩ resistor.
The discharging equation is as follows:

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

$$2 = \frac{25}{6} * e^{\frac{t_0}{RC}} \tag{6}$$

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

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

$$t = 0.367ms \tag{9}$$