

1. The voltage across and the current through a capacitor are shown in Figure 1. Determine the value of the capacitance.

Hint: apply the capacitor law $i(t) = C \frac{dv(t)}{dt}$ to equate dv/dt and $i(t)$ during 0 – 5ms of figure 1, then find out C.

Ans: 0.5 μ F

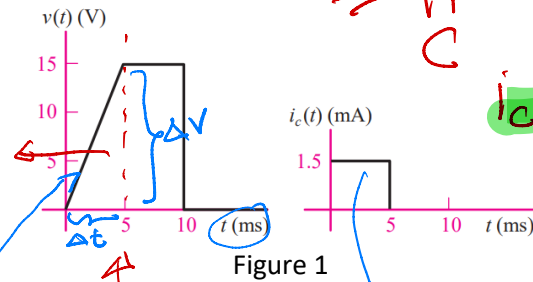


Figure 1

1.5mA

$$\left. \frac{dv(t)}{dt} \right|_{0 < t \leq 5\text{ms}} = 3000$$

At $0 < t < 5\text{ms}$

$$1.5 \times 10^{-3} = C \cdot 3000$$

$$C = \frac{1.5 \times 10^{-3}}{3000}$$

$$= 0.5 \times 10^{-6} \text{ F} = 0.5 \mu\text{F}$$

A

V/s

$$Q = CV$$

$i_c(t) \rightarrow \frac{dQ}{dt} = C \frac{dV}{dt}$

$$i_c(t) = C \frac{dv(t)}{dt}$$

$$C \left(\frac{\Delta V}{\Delta t} \right)$$

$$\frac{15 - 0}{5 - 0} = \frac{15}{5} = 3 \text{ V/ms}$$

$$= 3000 \text{ V/s}$$

2. Determine $v_c(t)$ for $t > 0$. The voltage across the capacitor in Figure 2 just before the switch is changed is given below.

Given:

$v_c(0^-) = -10V$, $R_1 = 100\ \Omega$, $I_o = 20\text{ mA}$, $R_2 = 10\ \Omega$, $C = 1\text{ mF}$

Hint: apply the capacitor law $i(t) = C \frac{dv(t)}{dt}$. I_o is a current source, so dv/dt is a constant. Also, the voltage across C must be continuous, i.e. $v_c(0^+) = v_c(0^-)$.

Ans: $v(t) = -10 + 20t\text{ V}$

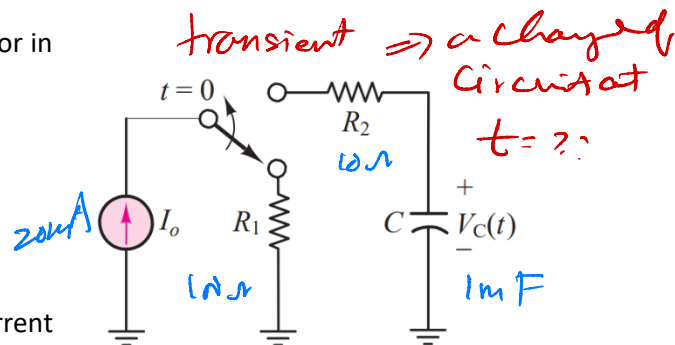
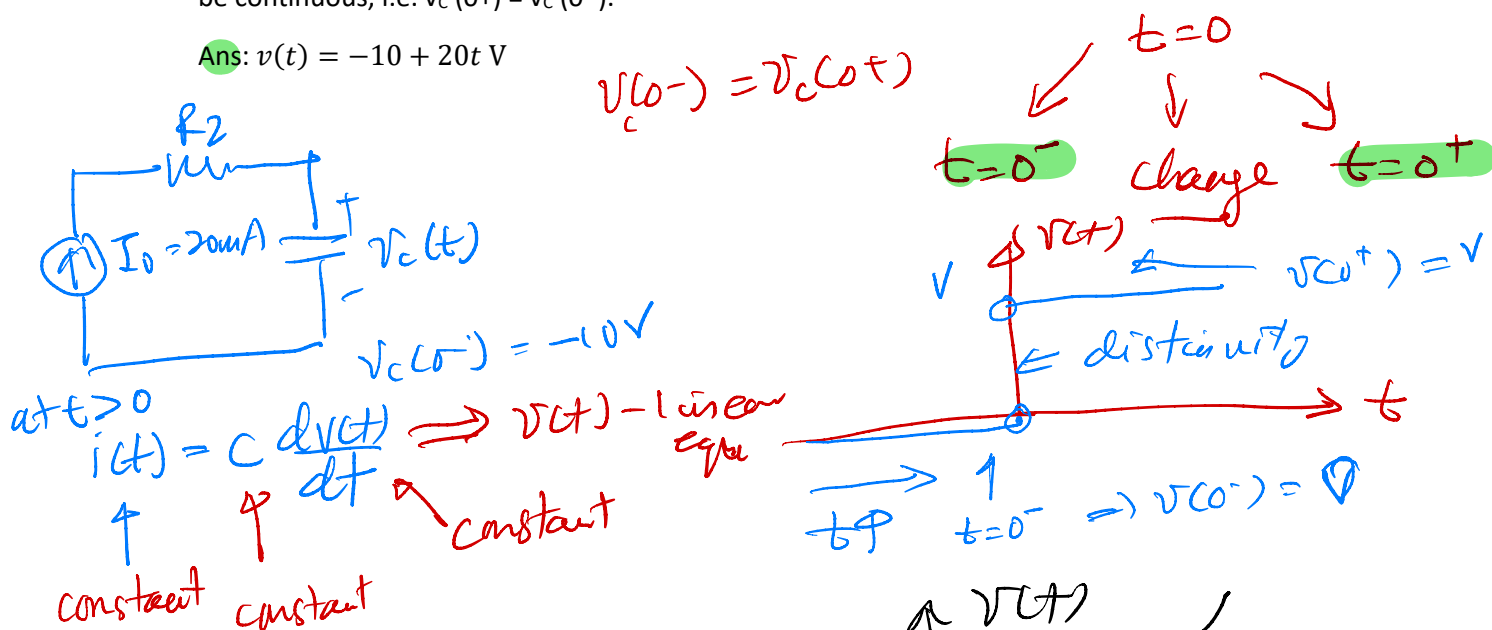


Figure 2



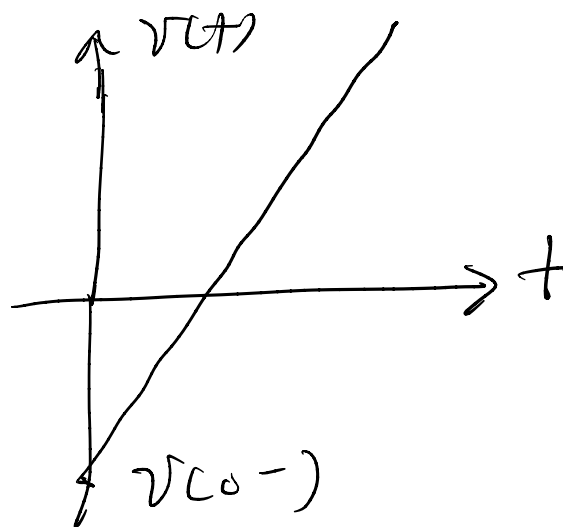
$$\frac{I_o}{C} = \frac{v(t) - v_c(0^+)}{t}$$

$$\frac{I_o}{C} = \frac{v(t) - (-10)}{t}$$

$$\frac{I_o t}{C} + (-10) = v_c(t)$$

$$v_c(t) = -10 + \frac{20 \times 10^{-3}}{10^{-3}} t$$

$$v_c(t) = -10 + 20t\text{ V}$$



$$i(t) = C \frac{dV(t)}{dt} \leftarrow V(t) \text{ must be continuous}$$

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