EE3 Fall 2020
Homework Problem 3

The switch has been in position a for a long time. At t=0, it moves instantaneously to positon b. Find:

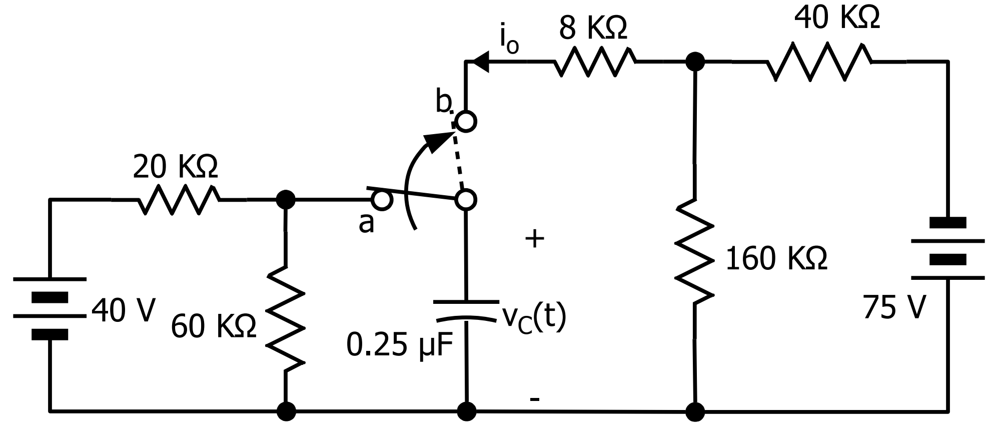
a. $v_c(0^-)$

b. $v_c(0^+)$

c. $i_o(0^-)$

d. $i_o(0^+)$

e. [EXTRA CREDIT] $v_c(t)$

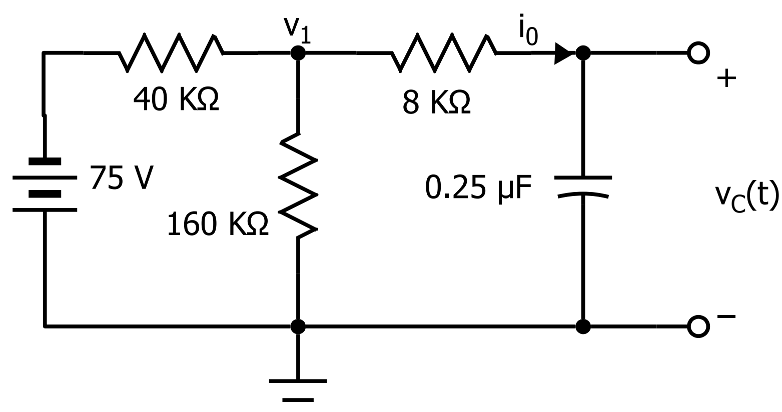


a. $v_C(0^-) = 40\left(\frac{60e3}{60e3+20e3}\right) = 30 \text{ V}$

b. $v_C(0^+) = v_C(0^-) = 30 \text{ V}$

c. $i_0(0^-) = 0$

d. Redraw the circuit as it is at $t = 0^+$:



$$\frac{v_1(0^+)-(-75)}{40e3}+\frac{v_1(0^+)-v_C(0^+)}{8e3}+\frac{v_1(0^+)}{160e3} = 0$$

$$\frac{25\, v_1(0^+)}{160e3} = \frac{600}{160e3} - \frac{300}{160e3}$$

$$v_1(0^+) = 12 \text{ V}$$

$$i_0(0^+) = \frac{v_1(0^+)-v_C(0^+)}{8e3} = \frac{12-30}{8e3} = -2.25 \text{ mA}$$

e. The key to this problem is to derive the differential equation in $v_C(t)$.

$$\frac{v_1-(-75)}{40e3}+\frac{v_1-v_C}{8e3}+\frac{v_1}{160e3} = 0$$

$$\frac{v_C-v_1}{8e3}+0.25\text{e-}6\,\frac{dv_C}{dt} = 0$$

$$v_1\left(\frac{25}{160e3}\right) = \frac{v_C}{8e3} - \frac{75}{40e3}$$

$$v_1 = \frac{20\, v_C - 300}{25} = 0.8\, v_C - 12$$

$$\frac{v_C-(0.8\, v_C-12)}{8e3}+0.25\text{e-}6\,\frac{dv_C}{dt} = 0$$

$$\frac{dv_C}{dt}+100\, v_C = -6000$$

Solve by integrating factor as in lecture video and notes.

$$v_C(t) = -60+90e^{-100t}$$