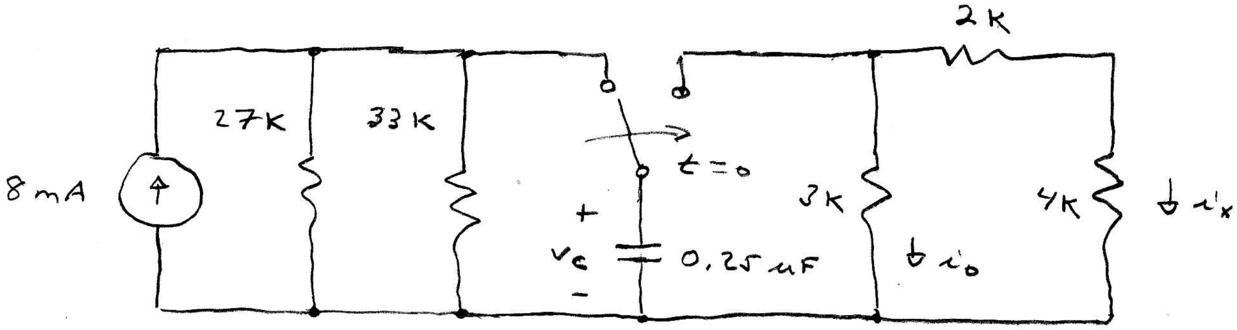
5.59



a) $i_o(t) = i_o(\infty) + [i_o(0+) - i_o(\infty)]\, e^{\frac{-t}{\tau}}$

$\tau = 0.25\ \mu F \times \underbrace{3K // (2K + 4K)}_{2K} = 0.5\ ms$

$i_o(\infty) = 0$ (capacitor discharged)

$v_c(0-) = 8\ mA \times 27K // 33K = 118.8\ V$

$v_c(0+) = v_c(0+)$ (capacitor voltage continuous)

$i_o(0+) = \frac{118.8V}{3K} = 39.6\ mA$

$\longrightarrow i_o(t) = (39.6\ mA)\, e^{\frac{-t}{0.5\ ms}}$.

b) $i_x(t) = (19.8\ mA)\, e^{\frac{-t}{0.5\ ms}}$

$p_x(t) = i_x^2 (4K) = 1.568\, e^{\frac{-t}{0.5\ ms}}$ watts

4-K resistor power dissipated

Let E_x = energy lost after 0.25 ms

$$E_x = \int_0^{0.25\,ms} 1.568\, e^{\frac{-t}{0.5\,ms}}\, dt \quad \text{(joules)}$$

$$= \left[-1.568 \times 0.5 \times 10^{-3}\, e^{\frac{-t}{0.5\,ms}} \right]_0^{0.25\,ms}$$

$$= 0.784 \left(1 - e^{-1/2} \right) \text{ mJ}$$

$$= 0.308 \text{ mJ}$$

Let E_s = initial stored energy

$$E_s = 1/2\, (0.25\, \mu F) \times (118.8)^2\, V^2$$

$$= 1.764 \text{ mJ}$$

% dissipation $= \frac{0.308}{1.764} \times 100 = \underline{17.5}$