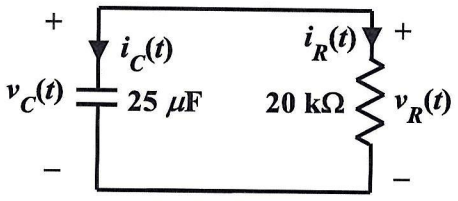
EE 2240

Homework Problem #064

The capacitor is initially charged so that $v_C(0) = 4$ V.



a. Determine the time constant, τ, for this circuit.

$\tau = RC = (20\text{k}\Omega)(25\mu\text{F}) = 0.5\text{ s}$

b. Determine $v_C(t)$ for $t \geq 0$.

$v_c(t) = v_c(0)\, e^{-t/\tau} = 4e^{-2t}$ V

c. Determine $i_C(t)$ for $t \geq 0$.

$i_c(t) = C\frac{dv_c}{dt} = (25\mu\text{F})(-2)4e^{-2t} = -200e^{-2t}\ \mu\text{A}$

d. Determine $v_R(t)$ for $t \geq 0$.

$v_R(t) = v_c(t) = 4e^{-2t}$ V

e. Determine $i_R(t)$ for $t \geq 0$.

$i_R(t) = \frac{v_R(t)}{R} = \frac{4\text{V}}{20\text{k}\Omega}e^{-2t} = 200e^{-2t}\ \mu\text{A}$

f. Determine the power absorbed by the resistor, $p_R(t)$, for $t \geq 0$.

$p_R(t) = Ri_R^2(t) = (20\text{k}\Omega)[200e^{-2t}\ \mu\text{A}]^2 = 800e^{-4t}\ \mu\text{W}$

g. Determine the charge, $q(t)$, stored in the capacitor for $t \geq 0$.

$q(t) = Cv_c(t) = 100e^{-2t}\ \mu\text{C}$

h. What is the final value, [i.e., $\lim_{t\to\infty} q(t)$], of the charge stored in the capacitor?

$\lim_{t\to\infty}[100e^{-2t}\ \mu\text{C}] = 0$

i. Approximately how long will it take for the capacitor charge to fall 99% of the way from its initial value to its final value?

$5\tau = 5(0.5\text{ s}) = 2.5\text{ s}$

j. What is the value of $q(t)$ at that point in time?

$q(2.5\text{s}) = 100e^{-2(2.5)}\ \mu\text{C} \approx 674\text{ nC}$