ANSWER on Question #72344 – Math – Calculus

QUESTION

Here is the information about the circuit :

$$Capacitor\ =\ 100\,nF \to C = 100 \cdot 10^{-9}F \equiv 10^{-7}F \to \boxed{C = 10^{-7}F}$$

$$Resistor\ =\ 47\ k\Omega \to \boxed{R = 47 \cdot 10^{3}\Omega}$$

$$Supply\ voltage\ =\ 5\ V \to V_0 = 5V$$

Investigate the meaning of 'time constant' and from your graph estimate a value. Compare this with your calculated one.

SOLUTION

Charging characteristic for a series capacitive circuit is

$$V(t) = V_0\left(1 - e^{-\frac{t}{T}}\right),\ \ where$$

$$T = RC - is\ called\ the\ time\ constant.$$

In our case,

$$T = 47 \cdot 10^{3} \cdot 10^{-7} = 47 \cdot 10^{-4} = 4.7 \cdot 10^{-3} \equiv 4.7\ (ms)\ (miliseconds)$$

To find this given constant from the experimental data, we transform the initial formula.

$$V(t) = V_0\left(1 - e^{-\frac{t}{T}}\right) \to 1 - e^{-\frac{t}{T}} = \frac{V(t)}{V_0} \to -e^{-\frac{t}{T}} = \frac{V(t)}{V_0} - 1 \to e^{-\frac{t}{T}} = 1 - \frac{V(t)}{V_0}$$

$$-\frac{t}{T} = \ln\left(1 - \frac{V(t)}{V_0}\right)$$

Now we are plotting the graph: on the Ox axis, we set aside time (in milliseconds); on the Oy axis, we set off this value $\ln\left(1 - \frac{V(t)}{V_0}\right)$.

In such coordinates, the graph will be a straight line, and in order to find a "$time\ constant$" we need evaluate :

$$T = \frac{-1}{the\ slope\ of\ the\ straight\ line}.$$

Answer provided by https://www.AssignmentExpert.com