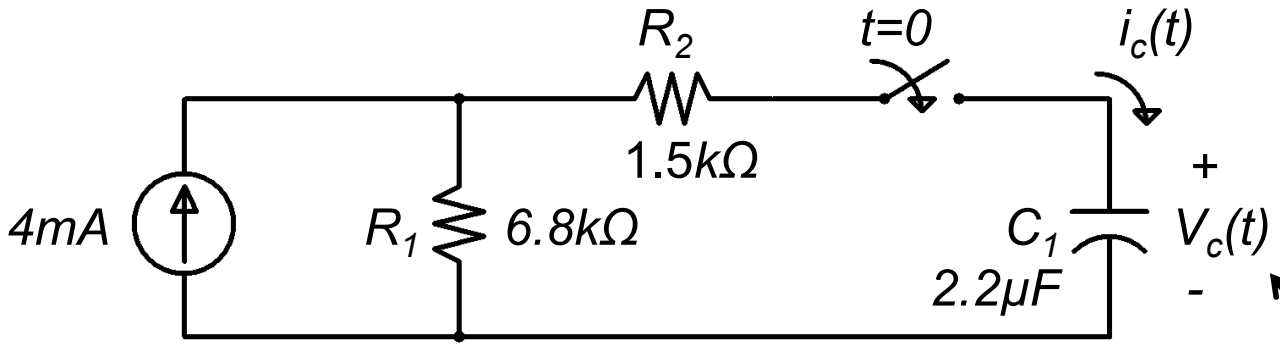
Electrical Engineering Technology

Capacitor Charging – Initial Values

Initial Values

(Example) a) Find $V_c(t)$ & $i_c(t)$ for $t > 0$
b) Sketch $V_c(t)$ & $i_c(t)$



$V_c(t) = 2V$
@ $t = 0^-$ (Initial Charge)

What's our first step??

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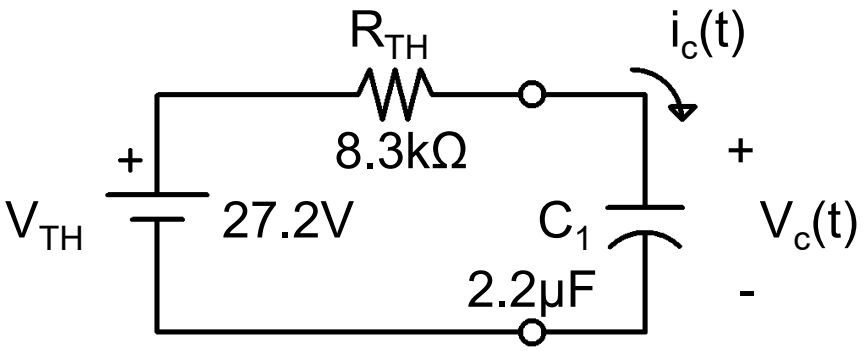
∴ We have:



Given

@ $t = 0 : V_C = 2V$

$\tau = (R_{TH})(C_1) = \underline{18.26ms}$

$$@\ t = 0^+ : i_c(t) = i_{cmax} = \frac{V_{TH} - 2V}{R_{TH}} = \frac{(27.2 - 2)V}{8.3k\Omega} = \underline{3.036\ mA}$$

∴ $i_c(t) = 3.036 \times 10^{-3}\, e^{-t/\tau}$ A, $t > 0$

$\tau = 18.26ms$

If there was no initial charge on C1:

$$V_c(t) = V_{TH}\left(1 - e^{-t/\tau}\right) V, t \geq 0$$

→ From 0V to V_{TH} over time

$$V_c(t) = V_{TH} - V_{TH} * e^{-t/\tau}$$

Final value

Transient period

	V_C	
$t = 0:$	0	*(Initial)*
$t = \infty:$	V_{TH}	*(Final)*

$$V_c(t) = V_F + (0 - V_F)\, e^{-t/\tau}$$

Initial vc

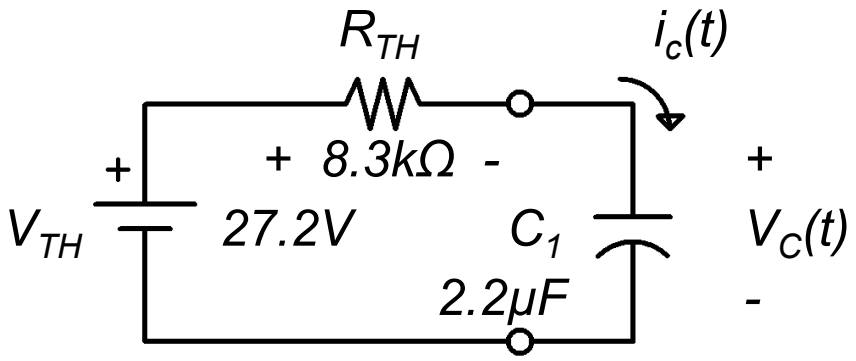
V_{TH} $2V$

General charge eq.

With: $V_C(0) = 2V : VC(t) = V_F + (V_I - V_F)\, e^{-t/\tau}$

Becomes: $V_C(t) = 27.2 + (2 - 27.2)e^{-t/18.26x10^{-3}} V, t \geq 0$

* Alternate determination of $V_C(t)$:



$$i_c(t) = 3.036 \times 10^{-3}\, e^{-t/\tau}$$
$$\tau = 18.26 \text{ ms}$$
$$\& \quad V_c(0) = 2V$$

Use **KVL:**

$$V_{TH} - i_c(t)R_{TH} - V_c(t) = 0$$
$$\therefore \; V_c(t) = V_{TH} - i_c(t)R_{TH}$$

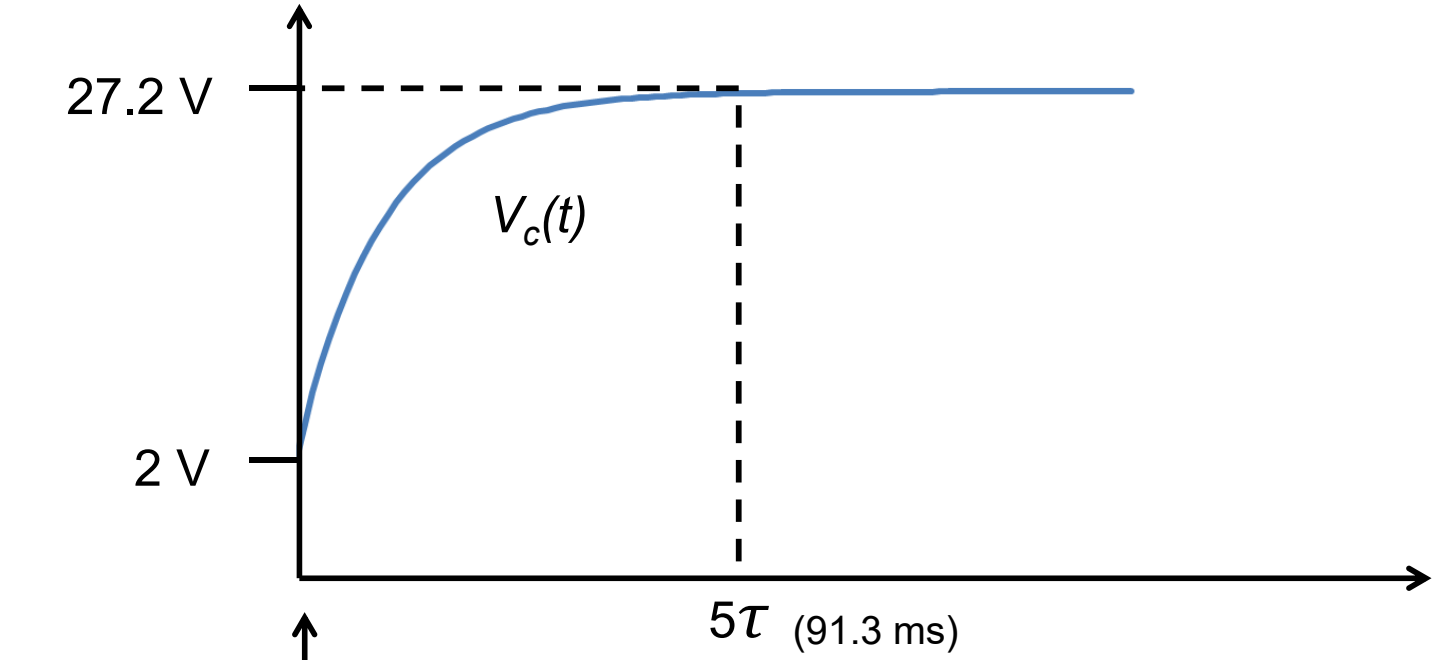
$$\therefore V_C(t) = 27.2 - \left(3.036 \cdot 10^{-3} \cdot e^{-t/\tau}\right)\left(8.3 \cdot 10^{3}\right)$$

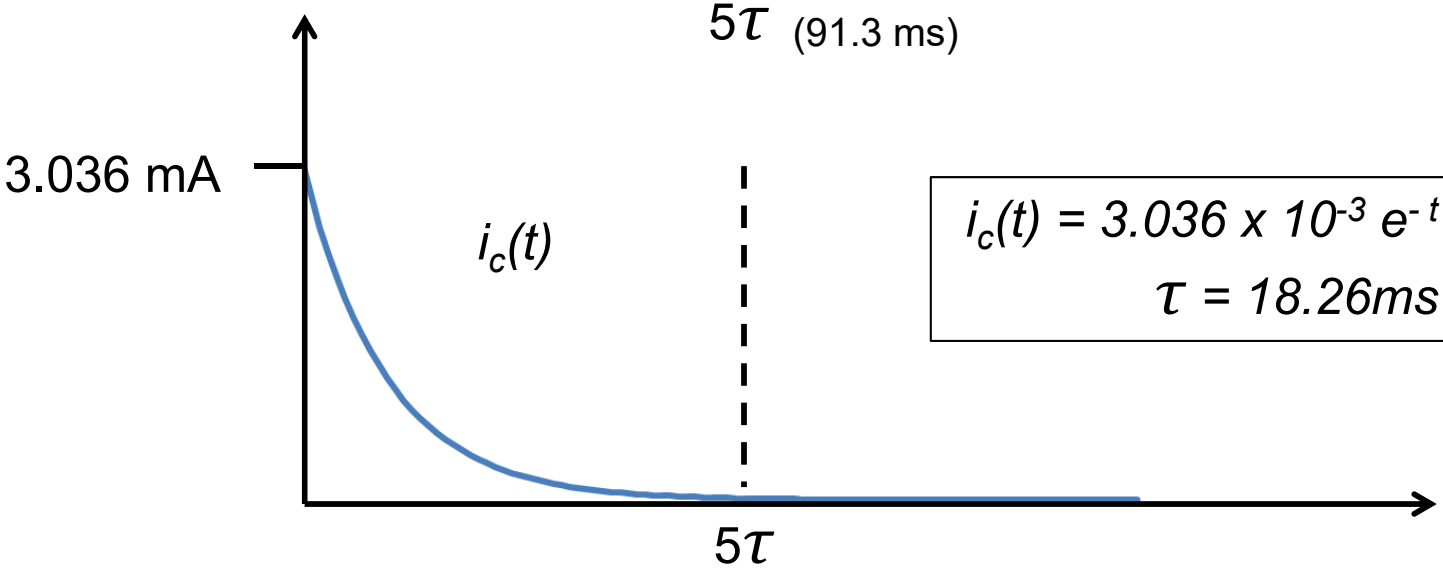
$$V_C(t) = 27.2 - 25.2 \cdot e^{-t/18.26 \cdot 10^{-3}} V, t \geq 0$$

Same as:

$$V_C(t) = 27.2 + (2 - 27.2)e^{-t/18.26x10^{-3}} V, t \geq 0$$

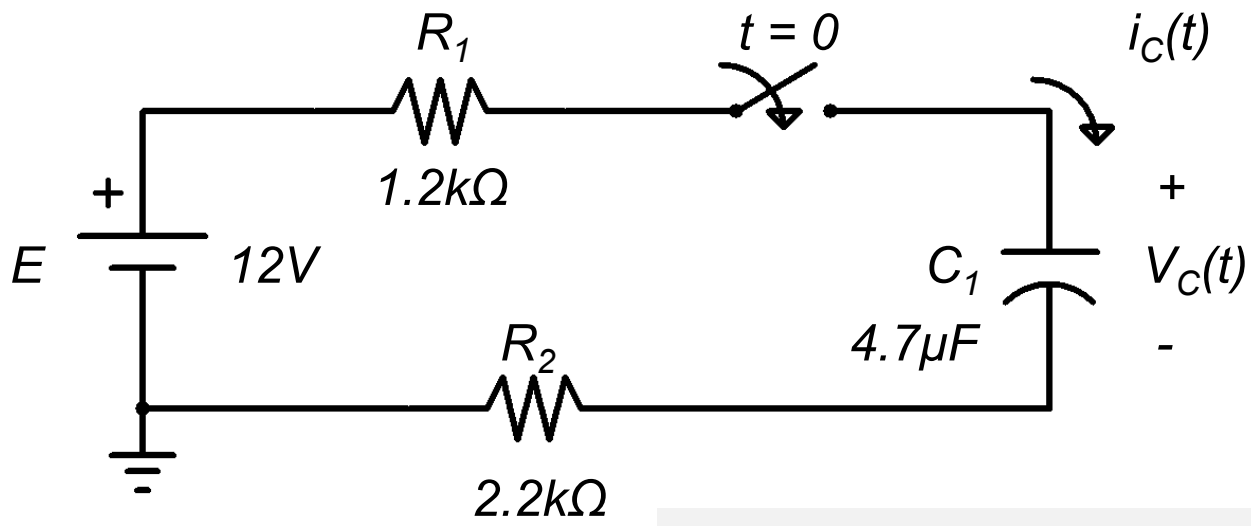
$$V_C(t) = 27.2 - 25.2 \cdot e^{-t/18.26 \cdot 10^{-3}} V, t \geq 0$$





$i_c(t) = 3.036 \times 10^{-3} e^{-t/\tau}$ A, $t > 0$

$\tau = 18.26$ms



Given: $V_C(0) = 4V$, initial charge
(a) Find $V_C(t)$, $t \geq 0$
(b) $i_C(t)$, $t > 0$
(c) Sketch $V_C(t)$ & $i_C(t)$

(b)

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