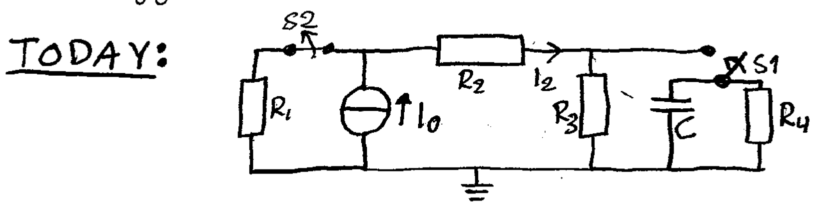
Inbyggd elektronik 2018-04-26 #11

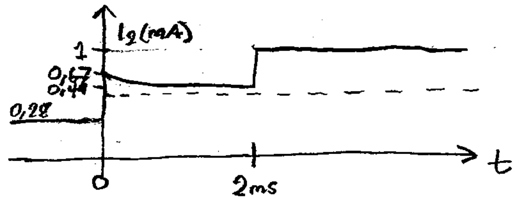


$R_1 = 1k\Omega$
$R_2 = 0{,}5k\Omega$
$R_3 = 2k\Omega$
$R_4 = 2k\Omega$
$C = 3\mu F$
$I_0 = 1mA$

S1 open and S2 closed for a long time.
At $t_0 = 0s$ S1 closes
At $t_1 = 2ms$ S2 opens
Determine the current I_2 in R_2 for all t.

Solution $t < 0s$

$$I_2 = I_0 \cdot \frac{R_1}{R_1+R_2+R_3}$$



$0<t<2ms$ Capacitor is now connected $V_c(t)$

What thevenin equivalent does the capacitor see?

$$V_c(t) = V_c(\infty) + (V_c(t_0) - V_c(\infty))e^{-\frac{(t-t_0)}{\tau}}$$

$$R_{TH} = (R_1+R_2)//R_3//R_4 = 0{,}6k\Omega$$

$$\tau = R_{TH} \cdot C = 1{,}8ms$$

$$t_0 = 0s \Rightarrow V_c(0) = 0V$$

$$V_c(\infty) = V_{TH}\frac{R_3//R_4}{(R_1+R_2)+R_3//R_4} = I_0 R_1 \frac{R_3//R_4}{R_1+R_2+R_3//R_4} = 0{,}4V$$

$$V_c(t) = 0{,}4 + (0-0{,}4)e^{-t/1{,}8ms} = 0{,}4(1-e^{-t/1{,}8ms})$$

$$I_2(t) = \frac{I_0R_1 - V_c(t)}{R_1+R_2} = \frac{I_0R_1}{R_1+R_2} - \frac{I_0R_1 \cdot R_3//R_4}{(R_1+R_2)(R_1+R_2+R_3//R_4)}\left(1-e^{-\frac{t}{R_{TH}\cdot C}}\right)$$

$$I_2(t=0) = \frac{I_0R_1}{R_1+R_2} = \frac{1}{1{,}5} = 0{,}67mA$$

$$I_2(\infty) = \frac{I_0 \cdot R_1}{R_1+R_2+R_3//R_4} = 0{,}4mA$$

$$I_2(t) = 0{,}67 - 0{,}267(1-e^{-\frac{t}{1{,}8ms}}) \quad I_2(t=2ms) = 0{,}67 - 0{,}267(1-e^{-\frac{2}{1{,}8}}) = 0{,}49mA$$

$t > 2ms$ S2 Opens

Current in R_2 is determined by current source $I_0 \Rightarrow I_2 = I_0 = 1mA$
(V_c is still continous and can be calculated for $t>2ms$.)

<u>P.7.41</u> $V_L = L\frac{di_L}{dt}$ $\left[\frac{V}{A/s}\right] = [\Omega \cdot s]$ $\tau[s]$ $\tau = \frac{L}{R} = \left[\frac{\Omega \cdot s}{\Omega}\right] = [s]$

$$i_L(t) = i_L(\infty) + (i_L(t_0) - i_L(\infty))e^{-\frac{(t-t_0)}{L/R_{TH}}}$$

Module 4: Sinusoidal R, L, C circuit in steady state

sin(t) cos(t) AC sources

$Z = R + \frac{1}{j\omega C}$

$Z = R + j\omega L$

Rectangular form $Z = a+jb$
Polar form $Z_0 e^{j\theta}$