AE-20150916

① $v_C(t) = \frac{1}{C}\int i_C(t)\,dt$

$T = \frac{1}{f} = 20\mu s$; $\frac{T}{2} = 100\mu s$; $\int_0^{T/2} i_C(t)\,dt = \frac{I_m \cdot \frac{T}{2}}{2} = \frac{4\cdot 10^{-4}}{2} = 0{,}2\,mC.$

$t_1 = \frac{T}{2}$; $t_2 = T$; $t_3 = \frac{3T}{2}$

a) $v_C(t_1) = \frac{1}{C}\int_0^{t_1} i_C(t)\,dt = \frac{0{,}2\cdot 10^{-3}}{1{,}5\cdot 10^{-6}} = 133{,}3\,V$; $W_1 = \frac{1}{2}C\cdot v_C^2(t_1)$

$W_1 = \frac{1}{2}\cdot 1{,}5\cdot 10^{-6}\cdot 133{,}3^2 = 13{,}3\,mJ$

b) $v_C(t_2) = \frac{1}{C}\int_0^{t_1} i_C(t)\,dt + \frac{1}{C}\int_{t_1}^{t_2} i_C(t)\,dt = 133{,}3 - 133{,}3 = 0V$; $W_2 = 0$

c) $v_C(t_3) = \frac{1}{C}\int_0^{t_1} i_C(t)\,dt + \frac{1}{C}\int_{t_1}^{t_2} i_C(t)\,dt + \frac{1}{C}\int_{t_2}^{t_3} i_C(t)\,dt$

$v_C(t_3) = 133{,}3 - 133{,}3 + 133{,}3 = 133{,}3\,V$; $W_3 = W_1 = 13{,}3\,mJ$

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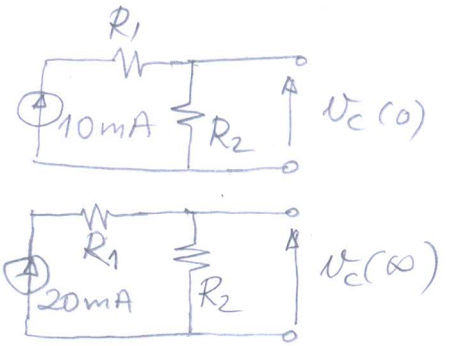
② $v_C(t) = v_C(\infty) + [v_C(0) - v_C(\infty)]\,e^{-t/\tau}$



$v_C(0) = R_2 I_{in_1} = 1\cdot 10^3\cdot 10\cdot 10^{-3} = 10\,V$;

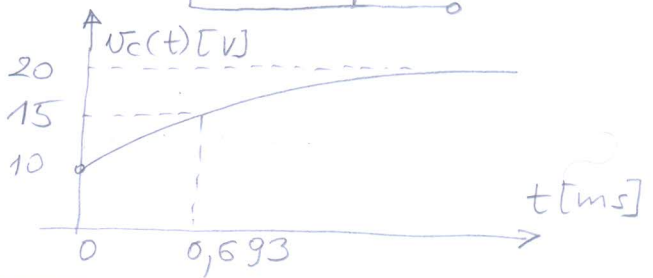
$v_C(\infty) = R_2 I_{in_2} = 1\cdot 10^3\cdot 20\cdot 10^{-3} = 20\,V$;

$\tau = R_2\cdot C = 1\cdot 10^3\cdot 1\cdot 10^{-6} = 1\,ms.$

$15 = 20 + [10-20]\,e^{-t_1/\tau}$

$5 = 10\cdot e^{-t_1/\tau}$

$t_1 = \tau\cdot \ln\frac{10}{5} = 10^{-3}\cdot \ln 2 = 0{,}693\,ms$



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③ $V_o = -\frac{R_f}{R_i}\cdot V_{cc} + \left(1+\frac{R_f}{R_i}\right)\cdot V_{ref}$

$\frac{2000}{R_i} = x$, $R_i = \frac{2000}{x}$

$0 = -\frac{2000}{R_i}\,12 + \left(1+\frac{2000}{R_i}\right)\cdot V_{ref} \Rightarrow 0 = -12x + (1+x)V_{ref}$

$-10 = -\frac{4000}{R_i}\cdot 12 + \left(1+\frac{4000}{R_i}\right)\cdot V_{ref}$ ← $V_{ref} = \frac{12x}{1+x}$

$-10 = -12\cdot 2x + (1+2x)\frac{12x}{1+x} \quad /\cdot(1+x)$

$-10(1+x) = -24x(x+1) + (1+2x)\,12x$

$-10 - 10x = -24x^2 - 24x + 12x + 24x^2 \Rightarrow -10 + 2x = 0 \Rightarrow x = 5$; $R_i = 400\Omega$

$V_{ref} = \frac{12\cdot 5}{1+5} = 10V$