Контрольная работа № 2, 8383, Кереев К.

1. Дата рождения : 09.07.2000

2. А = 9 ; М = 7 ; Г = 2 ;

М = 7 - нечетный => Вариант 1

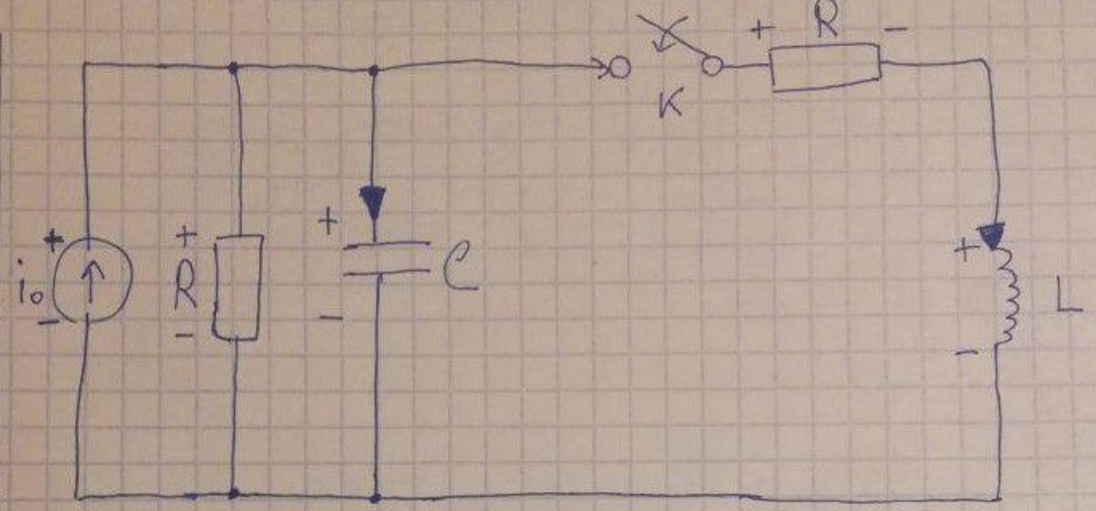
$i_0 = \frac{1}{9}$

$R = 9$

$L = 2$

$C = \frac{1}{2}$

$u_c(t), i_L(t)$?



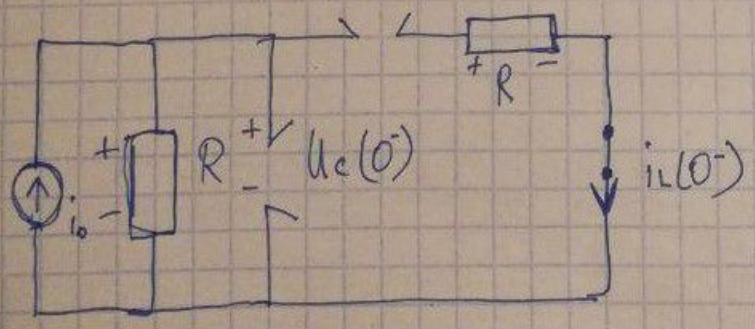
Часть 1 (Метод уравнений состояния)

$f_{нс}(t)$	$f_{нс}(0^+)$	$f'_{нс}(0^+)$	$f_{нс.вын}$	$p_{1,2}$
$u_c(t)$	1	0	1/2	−4,2518
$i_L(t)$	0	1/2	1/18	−0,4704

1) $t = 0^-$

$L = КЗ$

$C = XX$

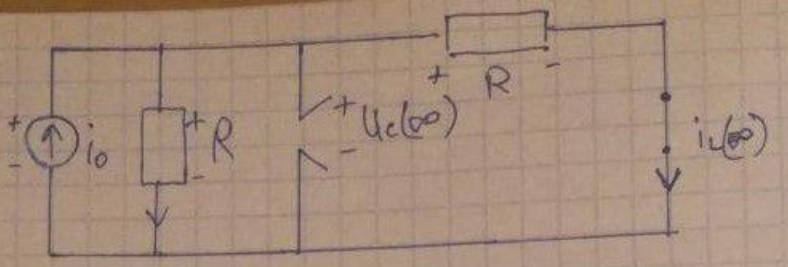


$u_c(0^-) = i_0 \cdot R = \frac{1}{9} \cdot 9 = 1$; $i_L(0^-) = 0$;

2) $t \to \infty$

L-КЗ

C-ХХ

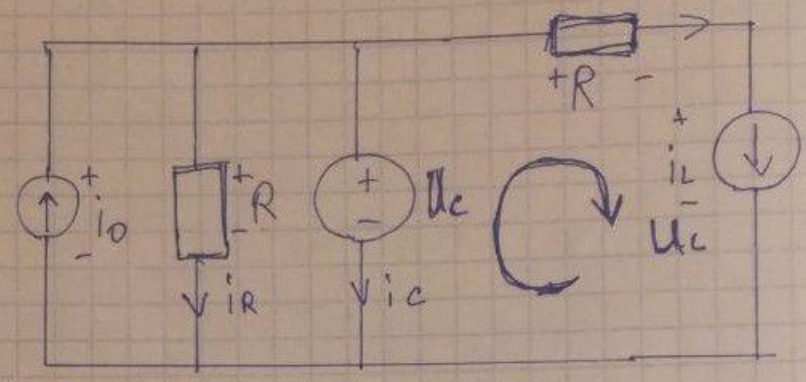


$$i_L(\infty) = \frac{R}{R+R} \cdot i_0 = \frac{\vartheta}{\vartheta+\vartheta} \cdot \frac{1}{\vartheta} = \frac{1}{18}, \quad u_c(\infty) = i_L(\infty) \cdot R = \frac{1}{18} \cdot \vartheta = \frac{1}{2}$$

3) $t > 0$

L-ИТ

C-ИН



$$i_R = \frac{u_c}{R} = \frac{u_c}{\vartheta}$$

<u>ЗТК:</u> $i_0 - i_R - i_c - i_L = 0$

$$i_c = -i_R - i_L + i_0 \Rightarrow \underline{i_c = -\frac{u_c}{\vartheta} - i_L + \frac{1}{\vartheta}}$$

<u>ЗНК:</u> $-u_c + i_L R + u_L = 0 \Rightarrow \underline{u_L = u_c - \vartheta \cdot i_L}$

$$\begin{cases} u_c' = \frac{i_c}{C} = -\frac{2}{\vartheta} u_c - 2 i_L + \frac{2}{\vartheta} \\ i_L' = \frac{u_L}{L} = \frac{1}{2} u_c - \frac{\vartheta}{2} i_L \end{cases}$$

$$\begin{vmatrix} -2/\vartheta - p & -2 \\ 1/2 & -\vartheta/2 - p \end{vmatrix} = \left(-\frac{2}{\vartheta} - p\right)\left(-\frac{\vartheta}{2} - p\right) + 1 = 1 + \frac{2}{\vartheta} p + \frac{\vartheta}{2} p + p^2 + 1 =$$

$$= p^2 + \frac{85}{18} p + 2 = 0 \;, \; D = 4633 \Rightarrow \begin{cases} p_1 = -4{,}2518 \\ p_2 = -0{,}4704 \end{cases}$$

4) $t = 0^+$

$u_c(0^+) = u_c(0^-) = 1$

$i_L(0^+) = i_L(0^-) = 0$

$$\begin{cases} u_c'(0+) = -\frac{2}{9} u_c(0+) - 2 i_L(0+) + \frac{2}{9} = 0 \\ i_L'(0+) = \frac{1}{2} u_c(0+) - \frac{9}{2} i_L(0+) = \frac{1}{2} \end{cases}$$

$$u_c(t) = u_c(\infty) + A_1 \cdot e^{-4{,}2518 t} + A_2 \cdot e^{-0{,}4704 t}, \quad t > 0$$

$$\begin{cases} u_c(0+) = \frac{1}{2} + A_1 + A_2 = 1 \\ u_c'(0+) = -4{,}2518 A_1 + (-0{,}4704) A_2 = 0 \end{cases} \Rightarrow \begin{cases} A_1 = -0{,}062 \\ A_2 = 0{,}562 \end{cases}$$

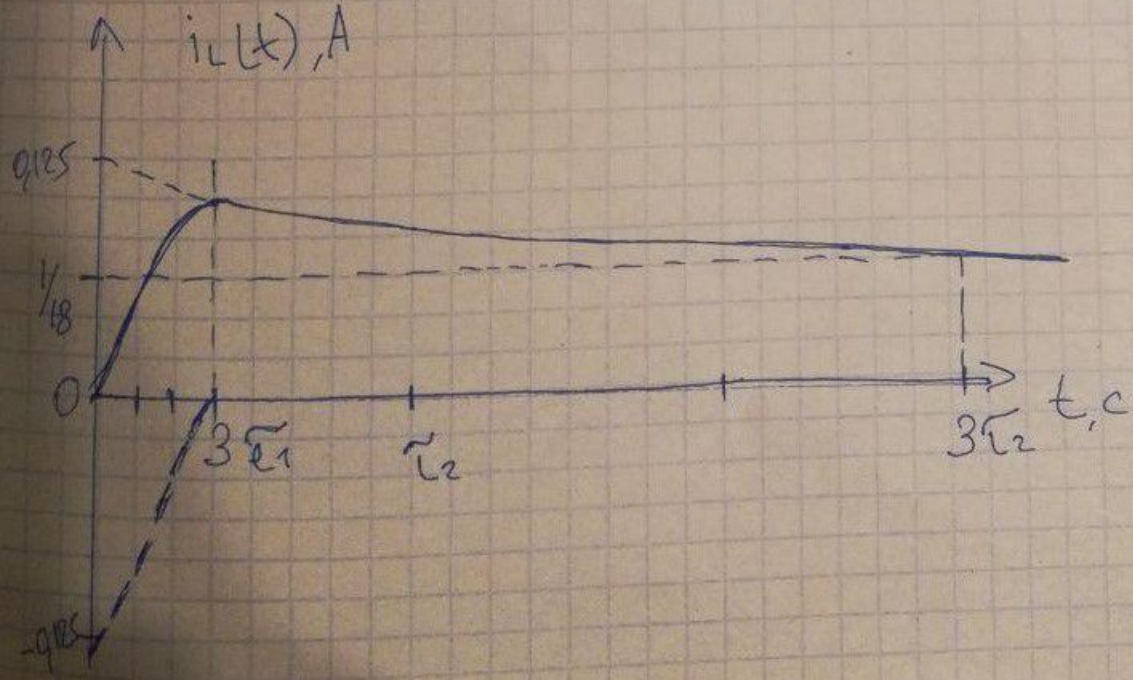
$$u_c(t) = \frac{1}{2} - 0{,}062 \cdot e^{-4{,}2518 t} + 0{,}562 \cdot e^{-0{,}4704 t}, \quad t > 0$$

$$i_L(t) = i_L(\infty) + B_1 \cdot e^{-4{,}2518 t} + B_2 \cdot e^{-0{,}4704 t}, \quad t > 0$$

$$\begin{cases} i_L(0+) = \frac{1}{18} + B_1 + B_2 = 0 \\ i_L'(0+) = -4{,}2518 B_1 - 0{,}4704 B_2 = \frac{1}{2} \end{cases} \Rightarrow \begin{cases} B_1 = -0{,}125 \\ B_2 = 0{,}07 \end{cases}$$

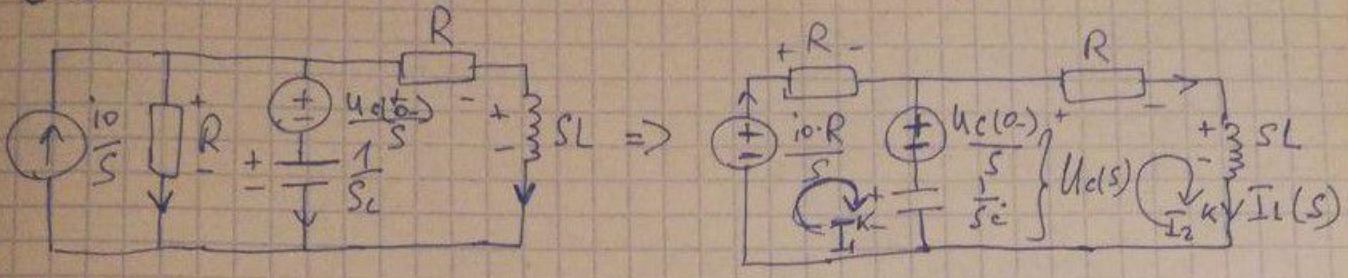
$$i_L(t) = \frac{1}{18} - 0{,}125 \cdot e^{-4{,}2518 t} + 0{,}07 \cdot e^{-0{,}4704 t}, \quad t > 0$$

$$\tau_1 = \frac{1}{4{,}2518} = 0{,}235 \quad ; \quad \tau_2 = \frac{1}{0{,}4704} = 2{,}126$$



Часть 2 (Операторный метод)

$t>0$



$$\begin{cases} \left(R+\frac{1}{sc}\right) I_1^K - \frac{1}{sc} I_2^K = \frac{i_0 R}{s} - \frac{u_c(0_-)}{s} \\ -\frac{1}{sc} I_1^K + \left(\frac{1}{sc} + R + sL\right) I_2^K = \frac{u_c(0_-)}{s} \end{cases} \Rightarrow \begin{cases} \left(9+\frac{2}{s}\right) I_1^K - \frac{2}{s} I_2^K = 0 \\ -\frac{2}{s} I_1^K + \left(\frac{2}{s}+9+2s\right) I_2^K = \frac{1}{s} \end{cases}$$

$$\begin{cases} I_1^K = \frac{2}{18s^3+85s^2+36s} \\ I_2^K = \frac{9s+2}{18s^3+85s^2+36s} \end{cases}$$

$$I_L(s) = I_2^K = \frac{9s+2}{18s^3+85s^2+36s} = \frac{\frac{1}{2}s+\frac{1}{9}}{s\left(s^2+\frac{85}{18}s+2\right)} = \frac{A}{s} + \frac{B}{s+4{,}252} + \frac{C}{s+0{,}47}$$

$$A = sI_L(s)\big|_{s=0} = 0{,}056 \left(\tfrac{1}{18}\right); \quad B = (s+4{,}252) I_L(s)\big|_{s=-4{,}252} = -0{,}125;$$

$$C = (s+0{,}47) I_L(s)\big|_{s=-0{,}47} = 0{,}07$$

$$i_L(t) = 0{,}056 - 0{,}125 e^{-4{,}252t} + 9{,}07 e^{-0{,}47t}, \; t>0 \text{ - верно}$$

$$i_L(0_+) = \lim_{s\to\infty} sI_L(s) = \lim_{s\to\infty} \frac{\frac{1}{2}s+\frac{1}{9}}{s^2+\frac{85}{18}s+2} = 0 \text{ - верно}$$

$$i_L(\infty) = \lim_{s\to 0} sI_L(s) = \lim_{s\to 0} \frac{\frac{1}{2}s+\frac{1}{9}}{s^2+\frac{85}{18}s+2} = \frac{1}{18} \text{ - верно}$$

$$U_c(s) = (I_1^K - I_2^K)\frac{1}{sc} + \frac{u_c(0_-)}{s} = \frac{18s^2+85s+18}{18s^3+85s^2+36s} = \frac{s^2+\frac{85}{18}s+1}{s\left(s^2+\frac{85}{18}s+2\right)} =$$

$$= \frac{A}{S} + \frac{B}{S+4,252} + \frac{C}{S+0,47}$$

$$A = U_c(S)S\Big|_{S=0} = 0,5 \; ; \; B = U_c(S)(S+4,252)\Big|_{S=-4,252} = -0,062;$$

$$C = U_c(S)(S+0,47)\Big|_{S=-0,47} = 0,562$$

$$U_c(t) = 0,5 - 0,062 \cdot e^{-4,252t} + 0,562 \cdot e^{-0,47t}, \; t > 0$$

$$U_c(0^+) = \lim_{S\to\infty} S U_c(S) = \lim_{S\to\infty} \frac{S^2 + \frac{85}{18}S + 1}{S^2 + \frac{85}{18}S + 2} = 1$$

$$U_c(\infty) = \lim_{S\to 0} S U_c(S) = \lim_{S\to 0} \frac{S^2 + \frac{85}{18}S + 1}{S^2 + \frac{85}{18}S + 2} = \frac{1}{2}$$

} верно