

№ 2.3, В-13

151 - u $i_1 = 2$

215 - $R_2 = 1$

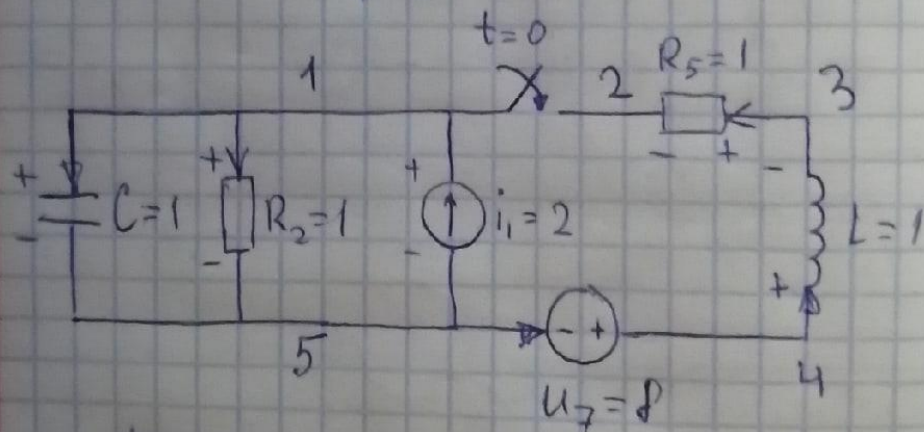
315 - $C = 1$

412 - K замыкается

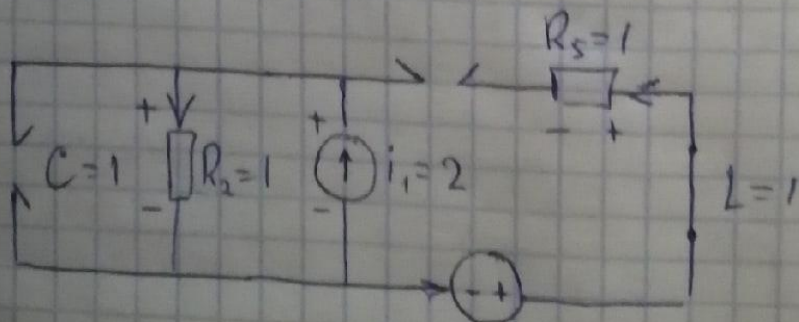
523 - $R_5 = 1$

643 - $L = 1$

745 - u $u_7 = 8$



1. $t = 0_-$



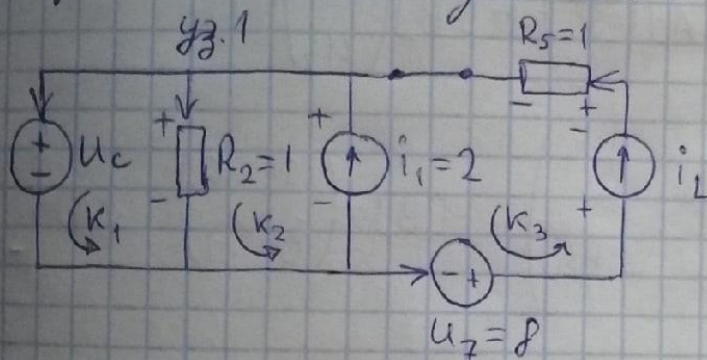
$$i_L(0-) = 0$$

no 3TK

$$i_1 = i_{R_2} \Rightarrow u_{R_2} = 2 \cdot 1 = 2$$

$$u_C(0-) = 2, i_L(0-) = 2$$

2. ype como enue que $t > 0$



$$K.1: \begin{cases} u_C = u_{R_2} \end{cases}$$

$$K.2: \begin{cases} u_{R_2} = u_{i_1} \end{cases}$$

$$K.3: \begin{cases} -u_{i_1} + u_7 = R_5 u_{R_5} + u_L \end{cases}$$

$$y3.1: \begin{cases} i_C + i_{R_2} = i_{R_5} + i_1 \end{cases}$$

$$\begin{cases} u_C = u_{R_2} \end{cases}$$

$$\begin{cases} u_C = u_{i_1} \end{cases}$$

$$\begin{cases} u_L = u_7 - u_C - i_L R_5 \end{cases}$$

$$\begin{cases} i_C = i_L + i_1 - \frac{u_C}{R_2} \end{cases}$$

$$\begin{cases} u_c'(t) = \frac{i_c(t)}{C} = \frac{i_L(t)}{C} - \frac{u_c(t)}{R_2 C} + \frac{i_1}{C} \\ i_L'(t) = \frac{u_L(t)}{L} = -\frac{u_c(t)}{L} - \frac{i_L(t)R_5}{L} + \frac{u_7}{L} \end{cases}$$

матричная форма

$$\begin{pmatrix} u_c'(t) \\ i_L'(t) \end{pmatrix} = [A] \begin{pmatrix} u_c \\ i_L \end{pmatrix} + [B] \begin{pmatrix} i_1 \\ u_7 \end{pmatrix}$$

$$[A] = \begin{pmatrix} -\frac{1}{R_2 C} & \frac{1}{C} \\ -\frac{1}{L} & -\frac{R_5}{L} \end{pmatrix} \quad [B] = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad [A] = \begin{pmatrix} -1 & 1 \\ -1 & -1 \end{pmatrix}$$

3. частоты собственных колебаний

$$\begin{aligned} \det(A - pE) &= \begin{vmatrix} -1-p & 1 \\ -1 & -1-p \end{vmatrix} = \\ &= (1+p)^2 + 1 = p^2 + 2p + 2 = 0 \end{aligned}$$

$p_1 = 0$ $p_2 = -2$
~~свободные~~ ~~вынужденные~~
 ~~$\begin{cases} u_{св}(t) = A_1 + A_2 e^{2t} \\ i_{св}(t) = B_1 + B_2 e^{-2t} \end{cases}$~~

4. Выводимые соотношения ($t \rightarrow \infty$)

$$u'_c = 0, \quad i'_L = 0$$

$$0 = -u_{\text{свн}} + i_{\text{Лвн}} + 2$$

$$0 = u_{\text{свн}} - i_{\text{Лвн}} + 8$$

$$u_{\text{свн}} = i_{\text{Лвн}} + 2$$

$$p_{1,2} = -1 \pm 1i$$

дополняющие соотношения

$$\begin{cases} u_{\text{свн}}(t) = A_1 e^{-t} \cos(t) + A_2 e^{-t} \sin(t) \\ i_{\text{Лвн}}(t) = B_1 e^{-t} \cos(t) + B_2 e^{-t} \sin(t) \end{cases}$$

4. Выводимые соотношения ($t \rightarrow \infty$)

$$u'_c = 0, \quad i'_L = 0$$

$$\begin{cases} 0 = -u_{\text{свн}} + i_{\text{Лвн}} + 2 \\ 0 = -u_{\text{свн}} - i_{\text{Лвн}} + 8 \end{cases}$$

$$u_{\text{свн}} = 5, \quad i_{\text{Лвн}} = 3$$

5. $u'_c(0+), i'_L(0+)$:

$$u_c(0+) = u_c(0-) = 2 \quad i_L(0+) = i_L(0-) = 0$$

$$\begin{cases} u_c'(0+) = 0 \\ i_L'(0+) = 6 \end{cases}$$

6. Onpegerunde A_1, A_2, B_1, B_2

$$\begin{cases} u_c(t) = u_{c\text{bun}} + A_1 e^{-t} \cos t + A_2 e^{-t} \sin t \\ u_c'(t) = -A_1 e^{-t} \cos t - A_1 e^{-t} \sin t - A_2 e^{-t} \sin t + A_2 e^{-t} \cos t \end{cases}$$

$$t = 0+ \Rightarrow$$

$$\begin{cases} 2 = 5 + A_1 \\ 0 = -A_1 + A_2 \end{cases} \Rightarrow A_1 = -3, A_2 = -3$$

$$\begin{cases} i_L(t) = i_{L\text{bun}} + B_1 e^{-t} \cos t + B_2 e^{-t} \sin t \\ i_L'(t) = -B_1 e^{-t} \cos t - B_1 e^{-t} \sin t - B_2 e^{-t} \sin t + B_2 e^{-t} \cos t \end{cases}$$

$$\begin{cases} 0 = 3 + B_1 \\ 6 = -B_1 + B_2 \end{cases}$$

$$\Rightarrow$$

$$B_1 = -3, B_2 = 3$$

$$\Rightarrow$$

$$u_c(t) = 5 - 3e^{-t} \cos t - 3e^{-t} \sin t$$

$$i_L(t) = 3 - 3e^{-t} \cos t + 3e^{-t} \sin t$$

7. найти

$$i_c(t) = -\frac{u_c(t)}{R_2} + i_L(t) + i_1$$

$$u_L(t) = -u_c(t) - i_L(t)R_5 + u_7$$

$$i_c(t) = -5 + \cancel{3e^{-t} \cos t} + 3e^{-t} \sin t + 3 - \cancel{3e^{-t} \cos t} + 3e^{-t} \sin t + 2 = \underline{6e^{-t} \sin t}$$

$$u_L(t) = -5 + \cancel{3e^{-t} \cos t} + \cancel{3e^{-t} \sin t} - 3 + \cancel{3e^{-t} \cos t} - \cancel{3e^{-t} \sin t} + 8 = \underline{6e^{-t} \cos t}$$

8. проверка

$$i_c(t) = C u_c'(t) = \cancel{3e^{-t} \cos t} + 3e^{-t} \sin t + \cancel{3e^{-t} \sin t} - 3e^{-t} \cos t = 6e^{-t} \sin t, +$$

$$u_L(t) = L i_L'(t) = \cancel{3e^{-t} \cos t} + \cancel{3e^{-t} \sin t} - \cancel{3e^{-t} \sin t} + 3e^{-t} \cos t = 6e^{-t} \cos t, +$$