$f := 50 \qquad \omega := 2 \cdot \pi \cdot f$

Расчет трансформатора

Система

$$E_m := 10500 \cdot \frac{\sqrt{2}}{\sqrt{3}} = 8.573 \times 10^3 \qquad \varphi := 0 \cdot \frac{\pi}{180}$$

$$Rs := 0.1 \qquad Xs := 0.4 \qquad Ls := \frac{Xs}{\omega} = 1.273 \times 10^{-3}$$

Трансформатор

$$U_{ном} := 6000 \qquad S_{ном} := 10^6 \qquad uk := 5.5 \qquad I_x := 1.2$$

$$L_\mu := \frac{1}{\omega} \cdot \left(\frac{100}{I_x} \cdot \frac{U_{ном}^2}{S_{ном}} \right) = 9.549 \qquad \Delta Pk := 10800$$

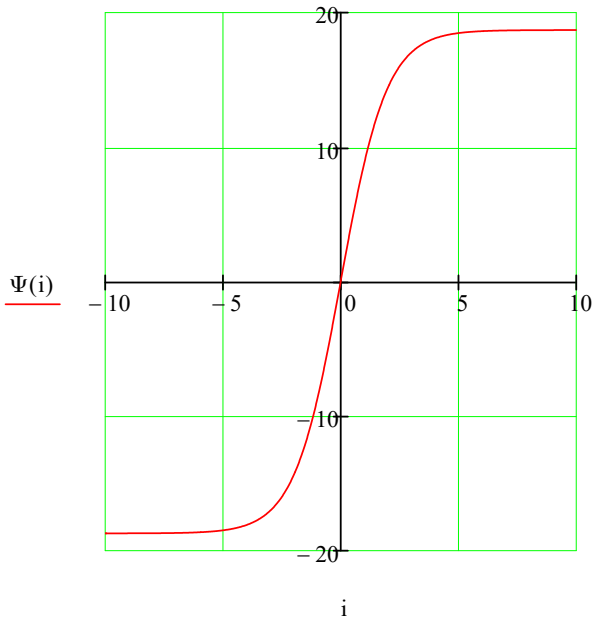
$$L_\sigma := \frac{1}{\omega} \cdot \left(\frac{1}{2} \cdot \frac{uk}{100} \cdot \frac{U_{ном}^2}{S_{ном}} \right) = 3.151 \times 10^{-3} \qquad R_t := \frac{1}{2} \cdot \Delta Pk \cdot \frac{U_{ном}^2}{S_{ном}^2} = 0.194$$

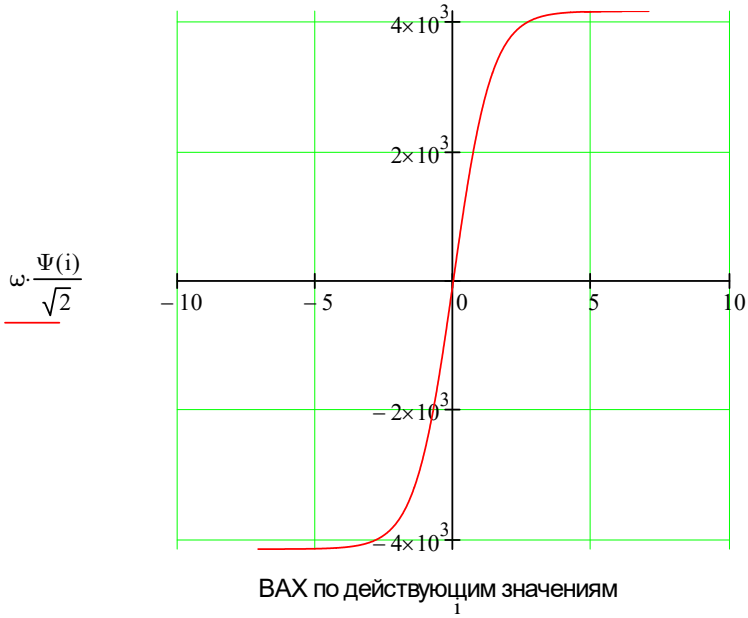
берется половина, т.к. в расчете только одна обмотка

$$R := Rs + R_t \qquad L := Ls + L_\sigma$$

$$\Psi_m := \frac{1}{\omega} \cdot \left(1.2 \cdot U_{ном} \cdot \frac{\sqrt{2}}{\sqrt{3}} \right) = 18.713$$

$$\Psi(i) := \Psi_m \cdot \tanh\left(\frac{L_\mu}{\Psi_m} \cdot i \right) \qquad d\Psi\_di(i) := L_\mu \cdot \left[1 - \tanh\left[\frac{i \cdot (L_\mu)}{\Psi_m} \right]^2 \right]$$





ВАХ по действующим значениям

Вычисления

$$u = R\cdot i + L\cdot\frac{d}{dt}i + d\Psi\_di(i)\cdot\frac{d}{dt}i$$

$$E_m\cdot\sin(\omega\cdot t + \varphi) = R\cdot i + (L + d\Psi\_di(i))\cdot\frac{d}{dt}i$$

$$D(t,i) := \frac{\left(E_m\cdot\sin(\omega\cdot t + \varphi) - R\cdot i\right)}{(L + d\Psi\_di(i))}$$

$t_{start} := 0 \qquad t_{end} := 0.4 \qquad NUM := 100001 \qquad dt := \frac{t_{end} - t_{start}}{NUM - 1}$

$K_r := 0.86$

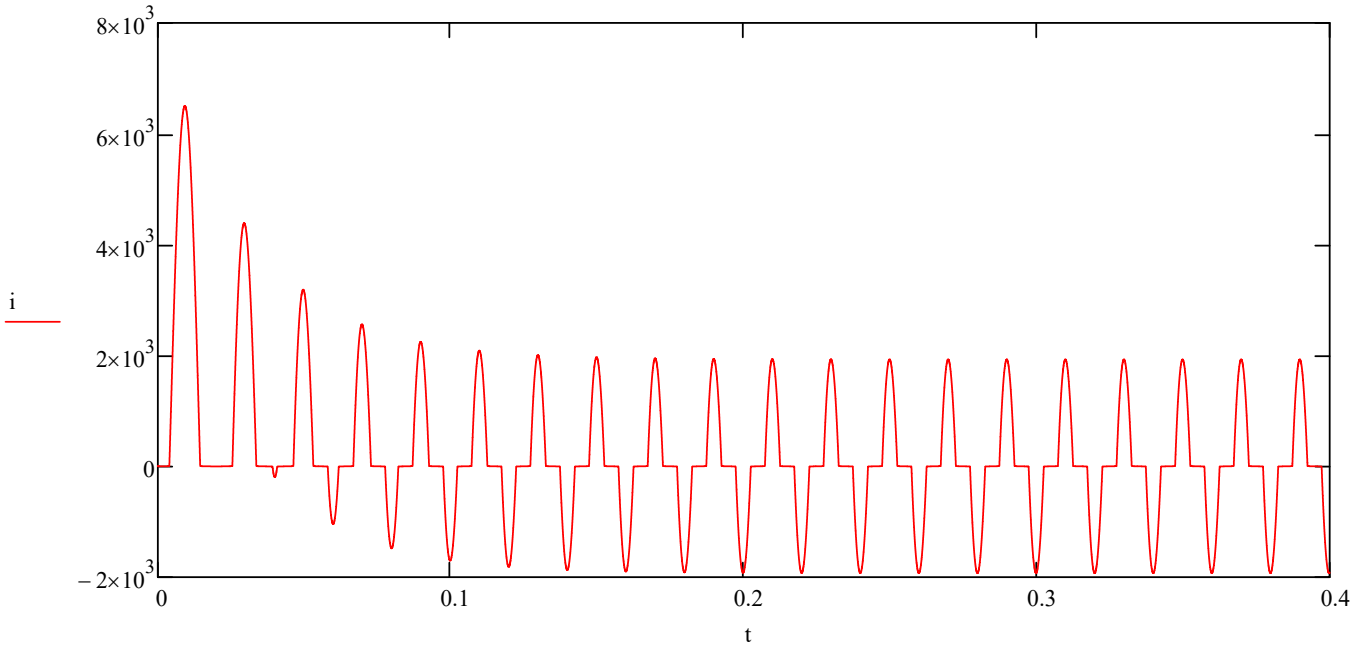
$i_0 :=$ | $i_0 \leftarrow 0$
| for $k \in 0..5$
| | $f_k \leftarrow \Psi(i_k) - K_r\cdot\Psi_m$
| | $df_k \leftarrow d\Psi\_di(i_k)$
| | $i_{k+1} \leftarrow i_k - \frac{f_k}{df_k}$
| return i_{k+1}

$i_0 = 2.534$

$i_0 := 0 \qquad n := 0, 1 .. NUM - 1$

$RES := rkfixed(i_0, t_{start}, t_{end}, NUM, D)$

$t_n := RES_{n,0} \qquad i_n := RES_{n,1}$



Расчет тока КЗ

$$j := \sqrt{-1}$$

$$E := \frac{E_m}{\sqrt{2}} = 6.062 \times 10^3$$

$$Z := R + 2 \cdot R_t + j \cdot \omega \cdot \left(Ls + 2 \cdot L_\sigma\right) = 0.683 + 2.38i$$

$$I_k := \frac{E}{Z} = 675.513 - 2.353i \times 10^3 \qquad \left|I_k\right| = 2.448 \times 10^3$$

Номинальный ток трансформатора

$$I_{ном} := \frac{S_{ном}}{\sqrt{3} \cdot U_{ном}} = 96.225$$

Фурье и среднеквадратичное

Формулы

$$N := \text{round}\left(\frac{1}{f \cdot dt}\right) = 5 \times 10^3$$

$$\text{DECIMATE}(f, k_{dec}) := \left| \begin{array}{l} n \leftarrow 0 \\ \text{for } k \in 0 .. \text{длина}(f) \\ \quad \text{if } \text{floor}\left(\frac{k}{k_{dec}}\right) \cdot k_{dec} = k \\ \quad\quad VAL_n \leftarrow f_k \\ \quad\quad n \leftarrow n + 1 \\ \text{return } VAL \end{array} \right.$$

$$\text{DFT}(v, t, N, f) := \left| \begin{array}{l} \text{for } n \in 0 .. \text{длина}(v) - 1 - N \\ \quad VAL_n \leftarrow \frac{2 \cdot j}{N} \cdot \sum_{k=n}^{n+N-1} \left(v_k \cdot e^{-j \cdot 2\pi \cdot f \cdot t_k}\right) \\ \text{return } VAL \end{array} \right.$$

$$\text{RMS}(v, t, N, f) := \left| \begin{array}{l} \text{for } n \in 0 .. \text{длина}(v) - 1 - N \\ \quad VAL_n \leftarrow \sqrt{\frac{1}{N} \cdot \sum_{k=n}^{n+N-1} \left[\left(v_k\right)^2\right]} \\ \text{return } VAL \end{array} \right.$$

$$\text{TIME}(t, N) := \left| \begin{array}{l} \text{for } n \in 0 .. \text{длина}(t) - 1 - N \\ \quad VAL_n \leftarrow t_n \\ \text{return } VAL \end{array} \right.$$

$$\text{ABS}(v) := \left| \begin{array}{l} \text{for } n \in 0 .. \text{длина}(v) - 1 \\ \quad VAL_n \leftarrow \left|v_n\right| \\ \text{return } VAL \end{array} \right.$$

$N_{req} := 20$ Число отсчетов на период

$k_{dec} := \text{floor}\left(\frac{N}{N_{req}}\right) = 250$ Шаг децимации

$$i_{dec} := \text{DECIMATE}(i, k_{dec})$$

$$t_{dec} := \text{DECIMATE}(t, k_{dec})$$

$$I_{DFT} := \frac{1}{\sqrt{2}} \cdot DFT\left(i_{dec}, t_{dec}, N_{req}, f\right) \qquad T_{DFT} := TIME(t, N) \qquad I_{RMS} := RMS\left(i_{dec}, t_{dec}, N_{req}, f\right)$$

$$I_{DFT.abs} := ABS\left(I_{DFT}\right) \qquad I_{RMS.abs} := ABS\left(I_{RMS}\right)$$