VINNITSA NATIONAL AGRARIAN UNIVERSITY

Department of General Engineering Sciences and Labour Safety

CALCULATION OF CURRENTS IN NON-SINUSOIDAL CIRCUITS

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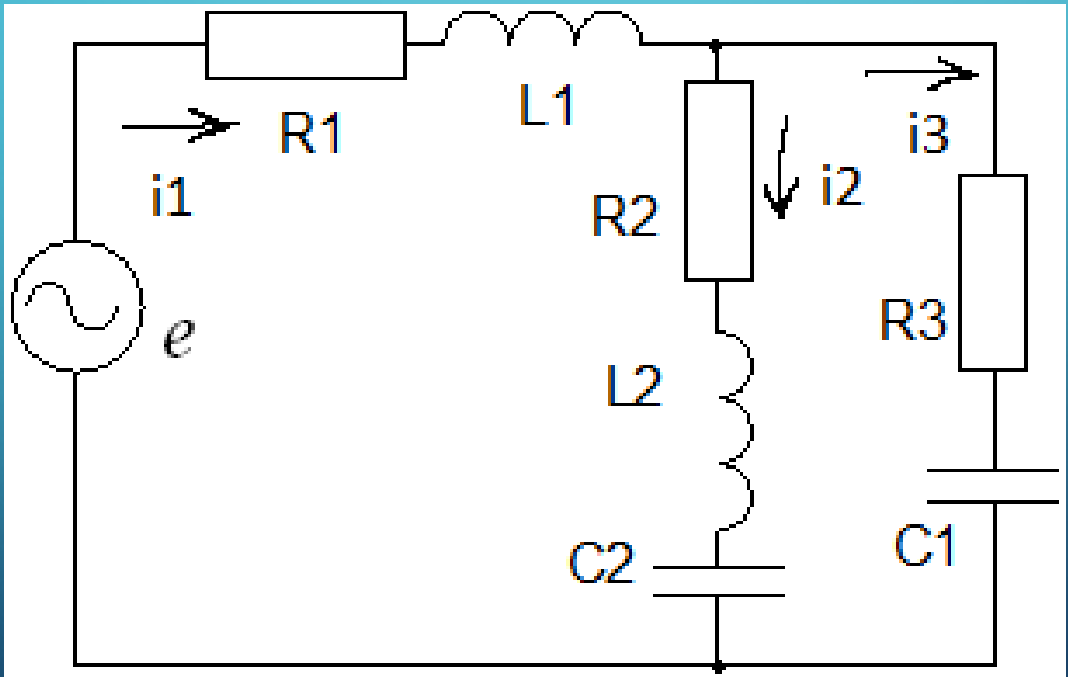
TASK

Calculate the currents in a given electrical circuit

Output data:

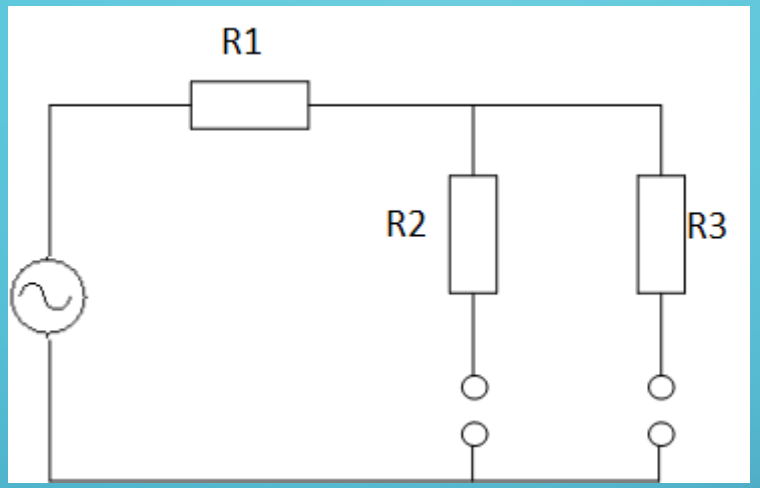
$$e(t) = 80 + 260\sin(\omega t) + 180\sin(3\omega t + 35\text{deg})\ \text{V}$$

R_1 Ом	R_2 Ом	R_3 Ом	L_1 мГн	L_2 мГн	C_1 мкФ	C_2 мкФ
4	12	10	10	20	50	10



SOLUTION

Calculation of the zero harmonic currents



Resistance is infinite

Result

$$I10 := 0 \qquad I20 := 0 \qquad I30 := 0$$

Calculation of the first harmonic currents

Cyclic frequency

$$w := 2 \cdot 3.14 \cdot f = 376.8$$

Complex voltage of the first harmonic

$$E1k := \frac{260}{\sqrt{2}} \cdot e^{j \cdot 0deg}$$

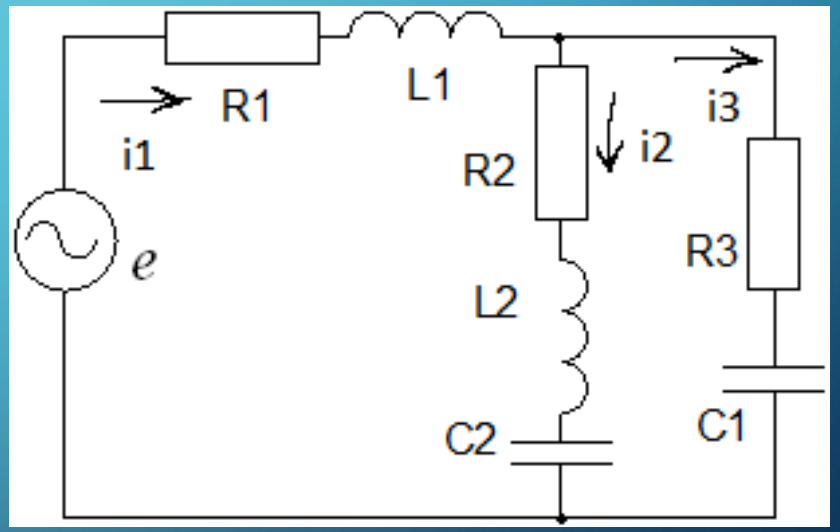
Resistance of reactive elements

$$XL11 := w \cdot L1 = 3.768$$

$$XL21 := w \cdot L2 = 7.536$$

$$XC11 := \frac{1}{w \cdot C1} = 53.079$$

$$XC21 := \frac{1}{w \cdot C2} = 265.393$$



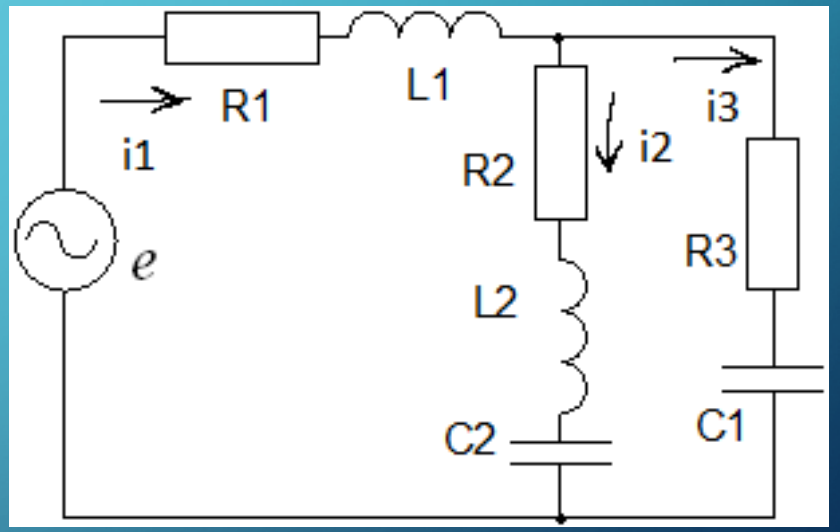
Calculation of the full equivalent resistance of the circuit

$$Z11k := R1 + j \cdot XL11 = 4 + 3.768i$$

$$Z21k := R2 + j \cdot XL21 - j \cdot XC21 = 12 - 257.857i$$

$$Z31k := R3 - j \cdot XC11 = 10 - 53.079i$$

$$Z1ek := Z11k + \frac{Z21k \cdot Z31k}{Z21k + Z31k} = 11.218 - 40.375i$$



Calculation of complex currents in branches

$$I11k := \frac{E1k}{Z1ek} = 1.175 + 4.227i$$

$$Uab1k := I11k \cdot \frac{Z21k \cdot Z31k}{Z21k + Z31k} = 195.078 - 21.335i$$

$$I21k := \frac{Uab1k}{Z21k} = 0.118 + 0.751i$$

$$I31k := \frac{Uab1k}{Z31k} = 1.057 + 3.476i$$

Result

$$i11(t) := |I11k| \cdot \sqrt{2} \cdot \sin(w \cdot t + \arg(I11k))$$

$$i21(t) := |I21k| \cdot \sqrt{2} \cdot \sin(w \cdot t + \arg(I21k))$$

$$i31(t) := |I31k| \cdot \sqrt{2} \cdot \sin(w \cdot t + \arg(I31k))$$

Calculation of the third harmonic currents

Complex voltage of the third harmonic

$$E3k := \frac{180}{\sqrt{2}} \cdot e^{j \cdot 35deg}$$

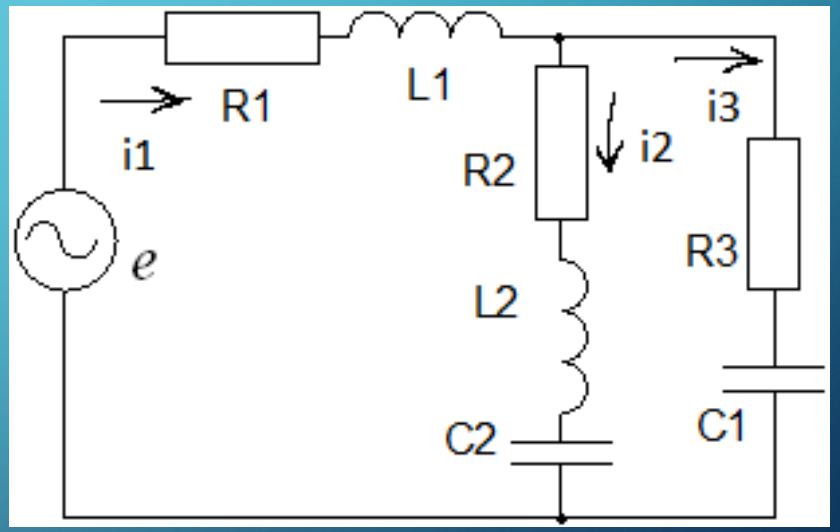
Resistance of reactive elements

$$XL13 := 3w \cdot L1 = 11.304$$

$$XL23 := 3 \cdot w \cdot L2 = 22.608$$

$$XC13 := \frac{1}{3 \cdot w \cdot C1} = 17.693$$

$$XC23 := \frac{1}{3 \cdot w \cdot C2} = 88.464$$



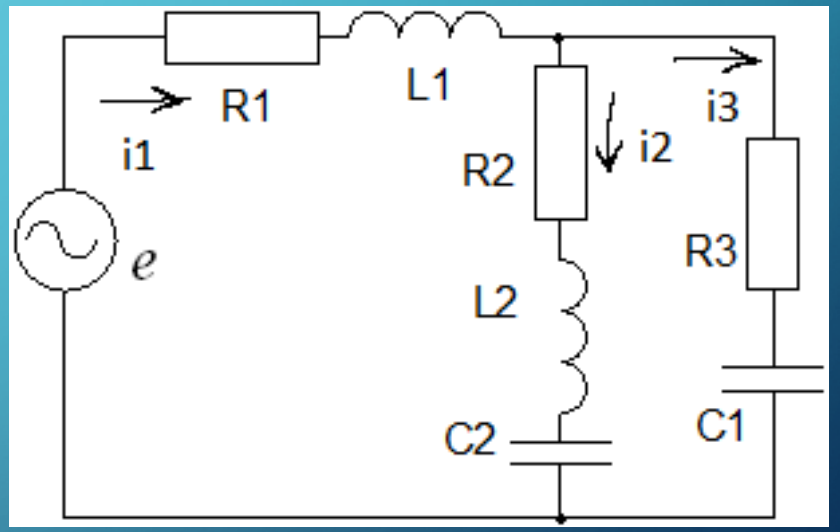
Calculation of the full equivalent resistance of the circuit

$$Z13k := R1 + j \cdot XL13 = 4 + 11.304i$$

$$Z23k := R2 + j \cdot XL23 - j \cdot XC23 = 12 - 65.856i$$

$$Z33k := R3 - j \cdot XC13 = 10 - 17.693i$$

$$Z3ek := Z13k + \frac{Z23k \cdot Z33k}{Z23k + Z33k} = 10.667 - 2.961i$$



Calculation of complex currents in branches

$$I13k := \frac{E3k}{Z3ek} = 7.311 + 8.873i$$

$$Uab3k := I11k \cdot \frac{Z23k \cdot Z33k}{Z23k + Z33k} = 68.134 + 11.428i$$

$$I23k := \frac{Uab3k}{Z23k} = 0.015 + 1.032i$$

$$I33k := \frac{Uab3k}{Z33k} = 1.16 + 3.195i$$

Result

$$i13(t) := |I13k| \cdot \sqrt{2} \cdot \sin(3 \cdot w \cdot t + \arg(I13k))$$

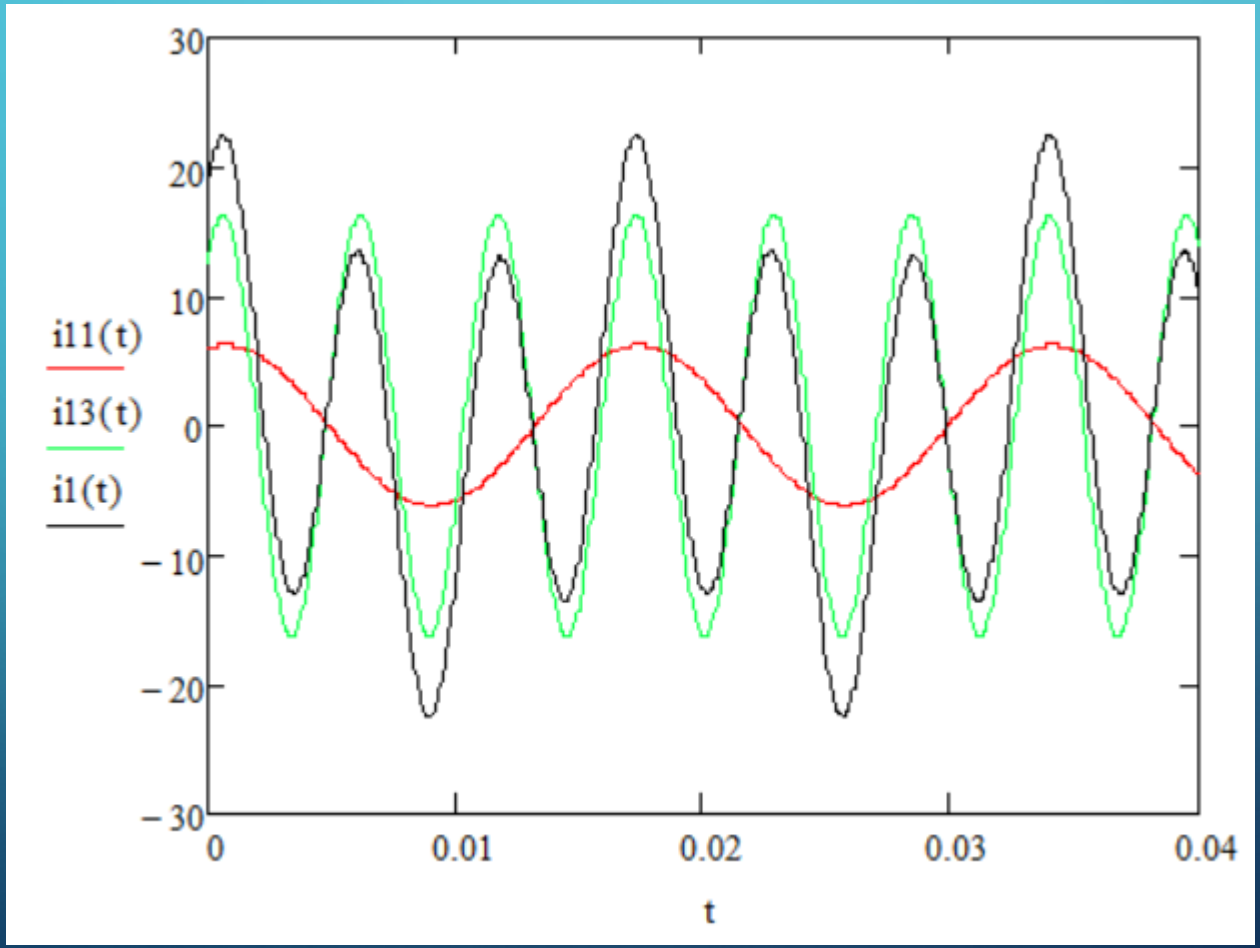
$$i23(t) := |I23k| \cdot \sqrt{2} \cdot \sin(3 \cdot w \cdot t + \arg(I23k))$$

$$i33(t) := |I33k| \cdot \sqrt{2} \cdot \sin(3 \cdot w \cdot t + \arg(I33k))$$

Final calculation of the currents in branches

first branch current

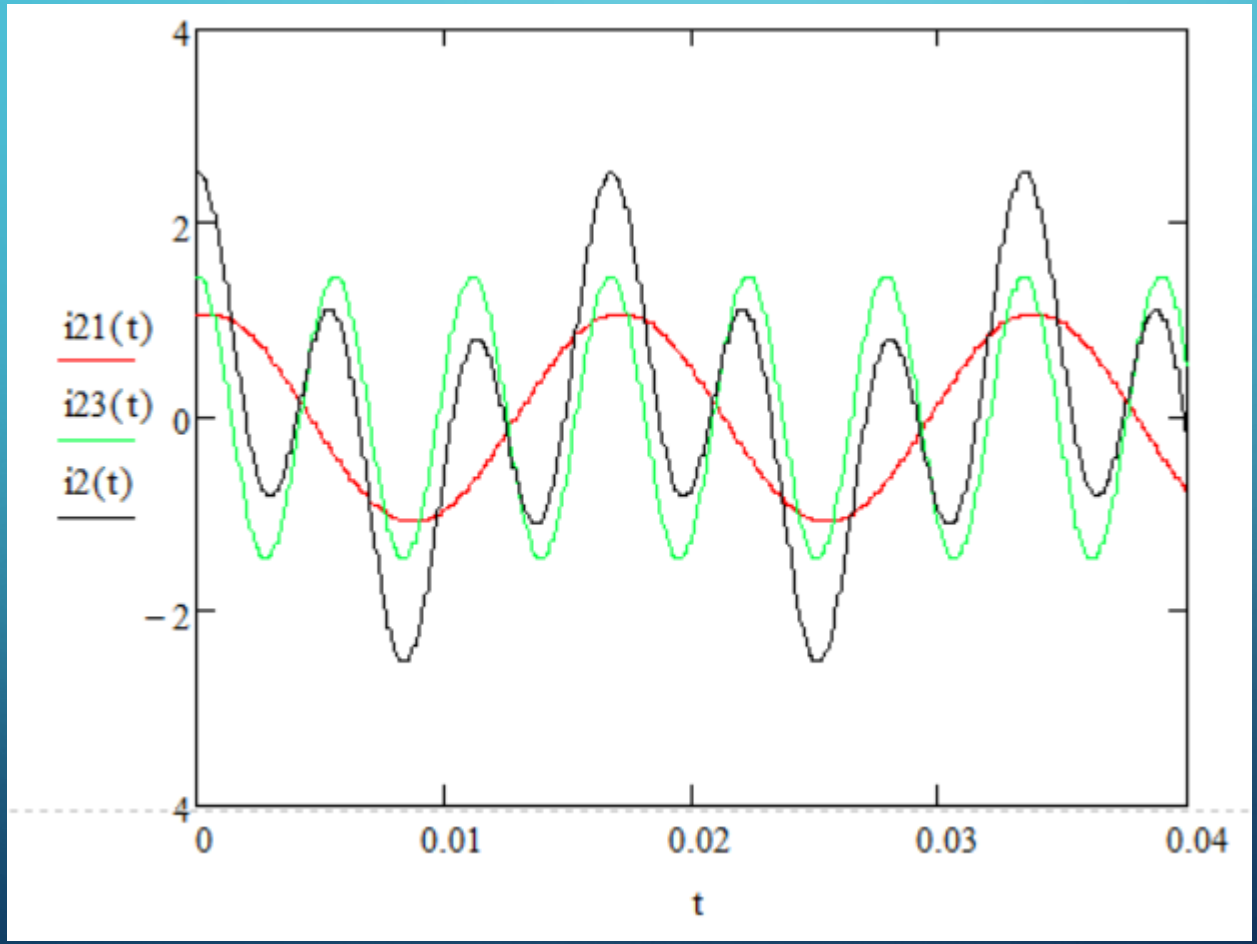
$$i1(t) := I10 + i11(t) + i13(t)$$



Final calculation of the currents in branches

second branch current

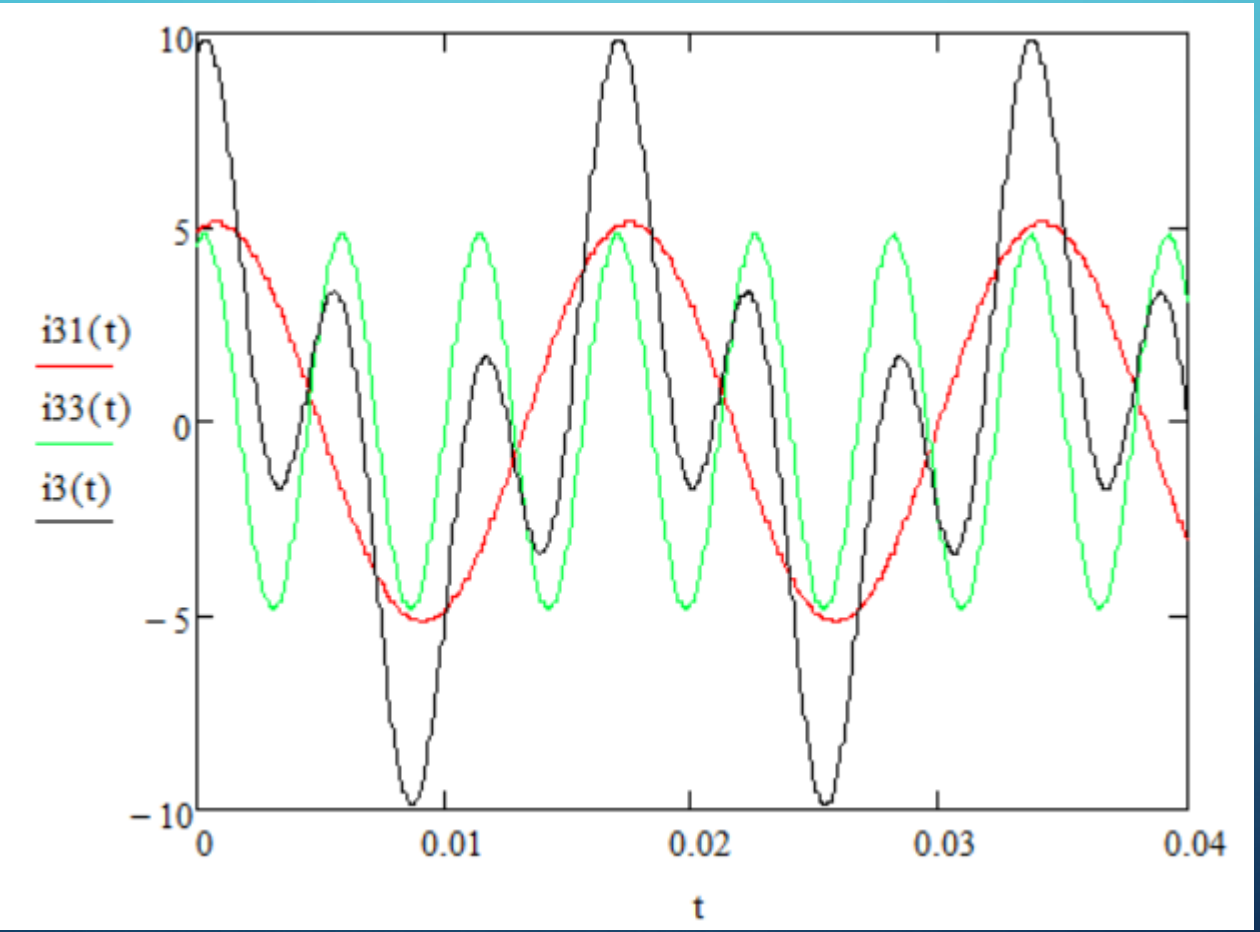
$$i2(t) := I20 + i21(t) + i23(t)$$



Final calculation of the currents in branches

third branch current

$$i3(t) := I30 + i31(t) + i33(t)$$



EXAMPLE OF CALCULATION (individual work)

Calculate the current in the circuit

$u(t) = 180 + 310\sin(\omega t - 30^0) + 165\sin(\omega t + 70^0)$ V

$R1 = 20\ Ohm$

$R2 = 15\ Ohm$

$R3 = 5\ Ohm$

$L = 80\ mH$