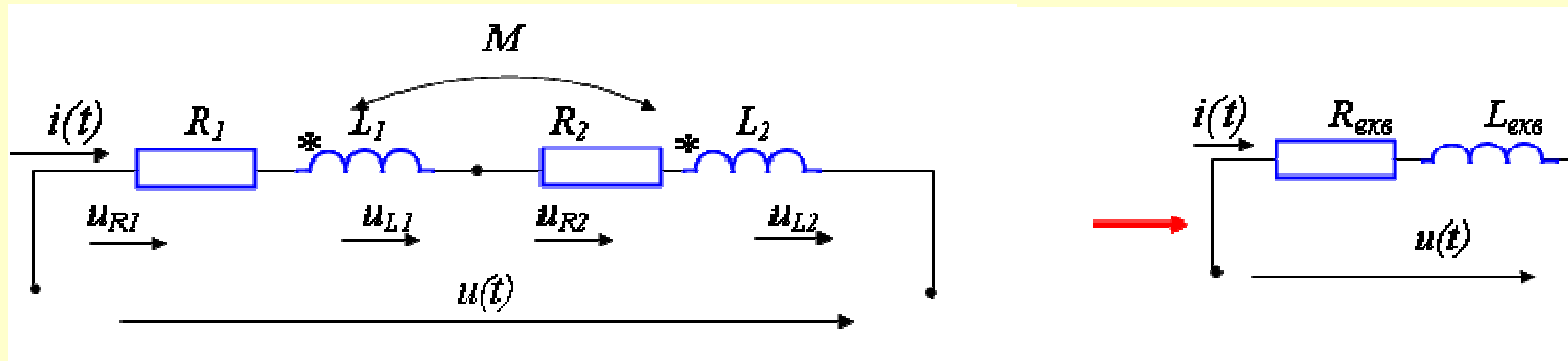


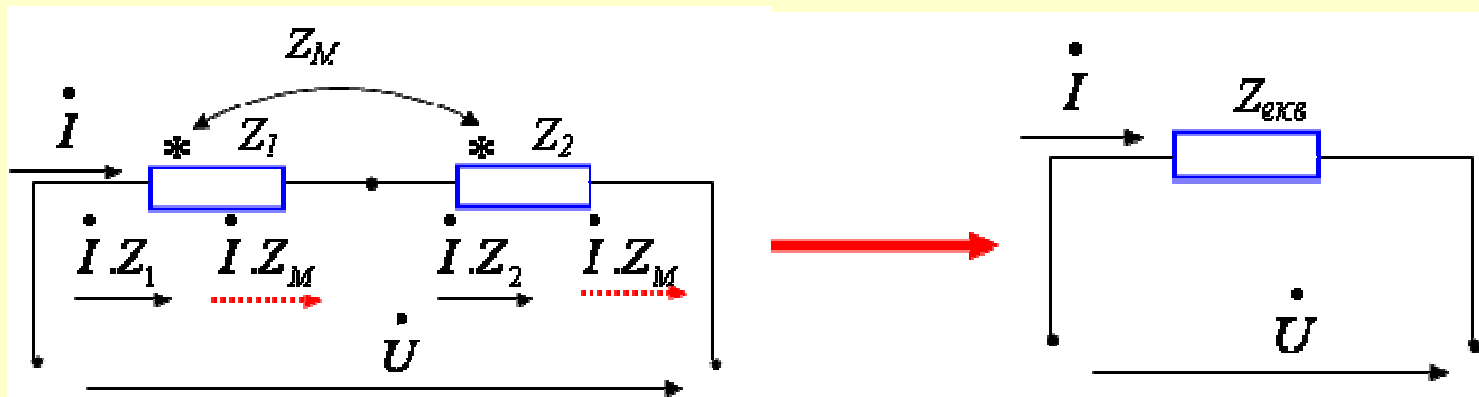
Последователно съединение на два индуктивно свързани елемента.

1. Съгласувано свързване



$$R_{екв} = R_1 + R_2$$
$$L_{екв} = L_1 + L_2 + 2M$$

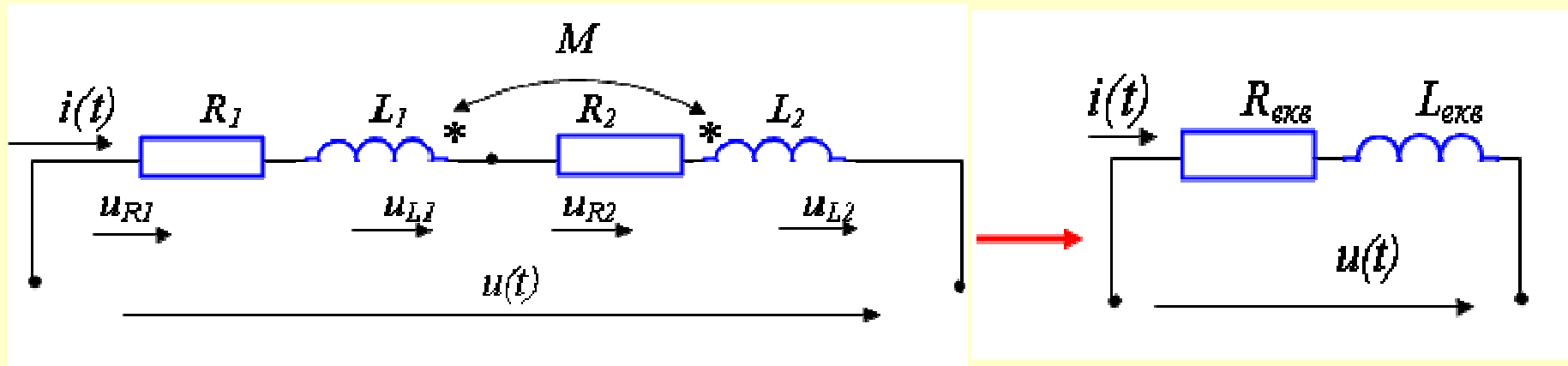
Съгласувано свързване – синусодален ток



$$Z_1 = R_1 + j\omega L_1; \quad Z_2 = R_2 + j\omega L_2; \quad Z_M = j\omega M$$

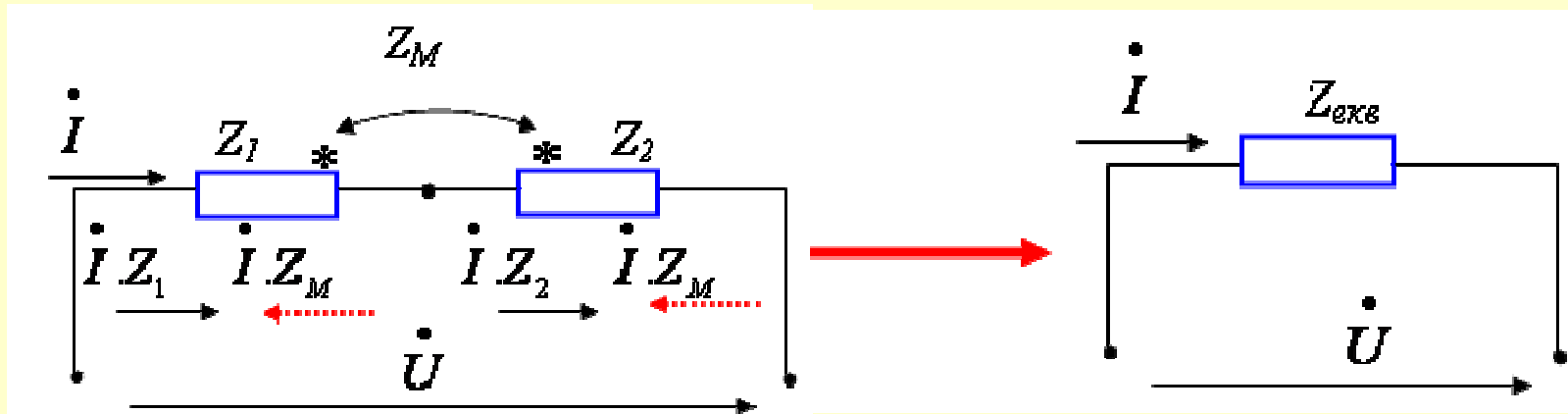
$$Z_{екв} = Z_1 + Z_2 + 2Z_M$$

2. Несъгласувано свързване.



$$R_{екв} = R_1 + R_2$$
$$L_{екв} = L_1 + L_2 - 2M$$

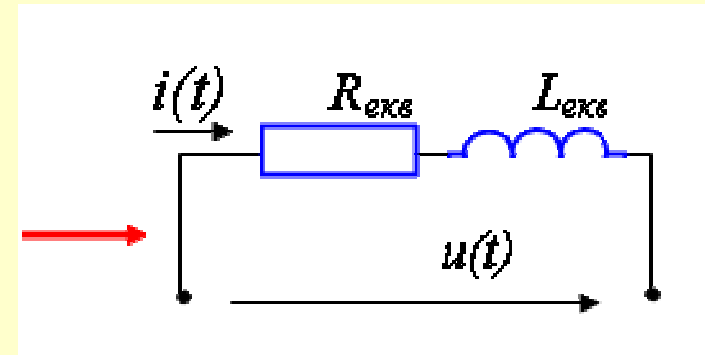
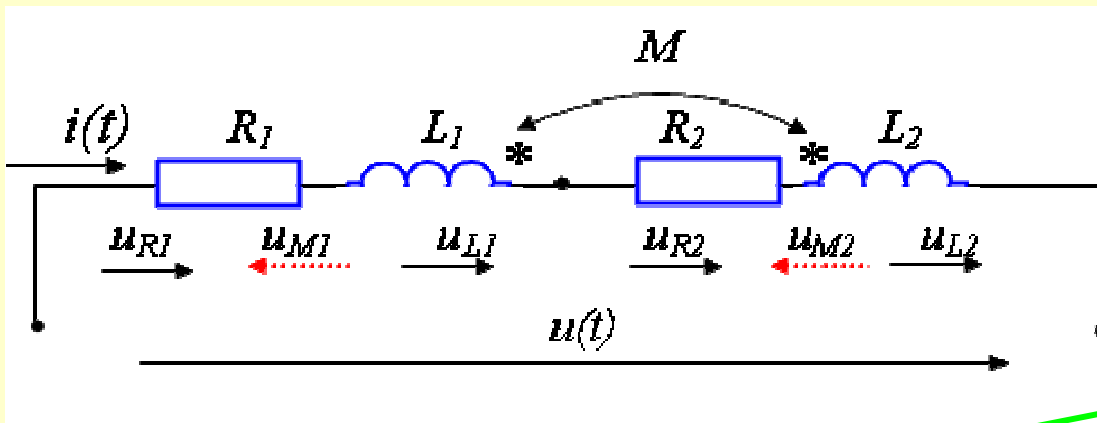
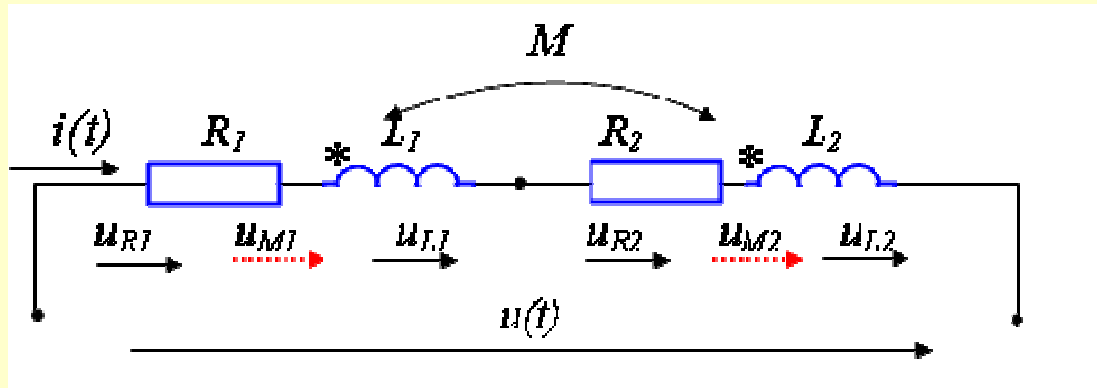
2. Несъгласувано свързване – синусоиден ток



$$Z_1 = R_1 + j\omega L_1; \quad Z_2 = R_2 + j\omega L_2; \quad Z_M = j\omega M$$

$$Z_{екв} = Z_1 + Z_2 - 2Z_M$$

ИЗВОД



$$R_{екв} = R_1 + R_2$$
$$L_{екв} = L_1 + L_2 \pm 2M$$

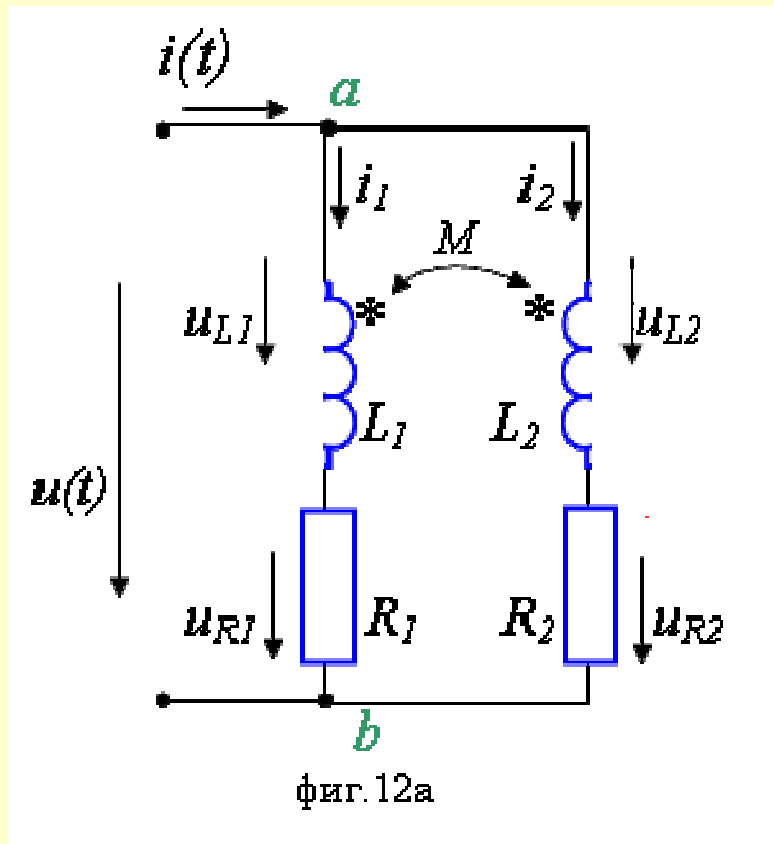
Знакът пред $2M$ се определя от начина на свързване:

"+" при съгласувано свързване

"-" при несъгласувано свързване.

Паралелно съединение на два индуктивно свързани елемента.

Едноименни изводи в
общата точка



$$i(t) = i_1(t) + i_2(t)$$

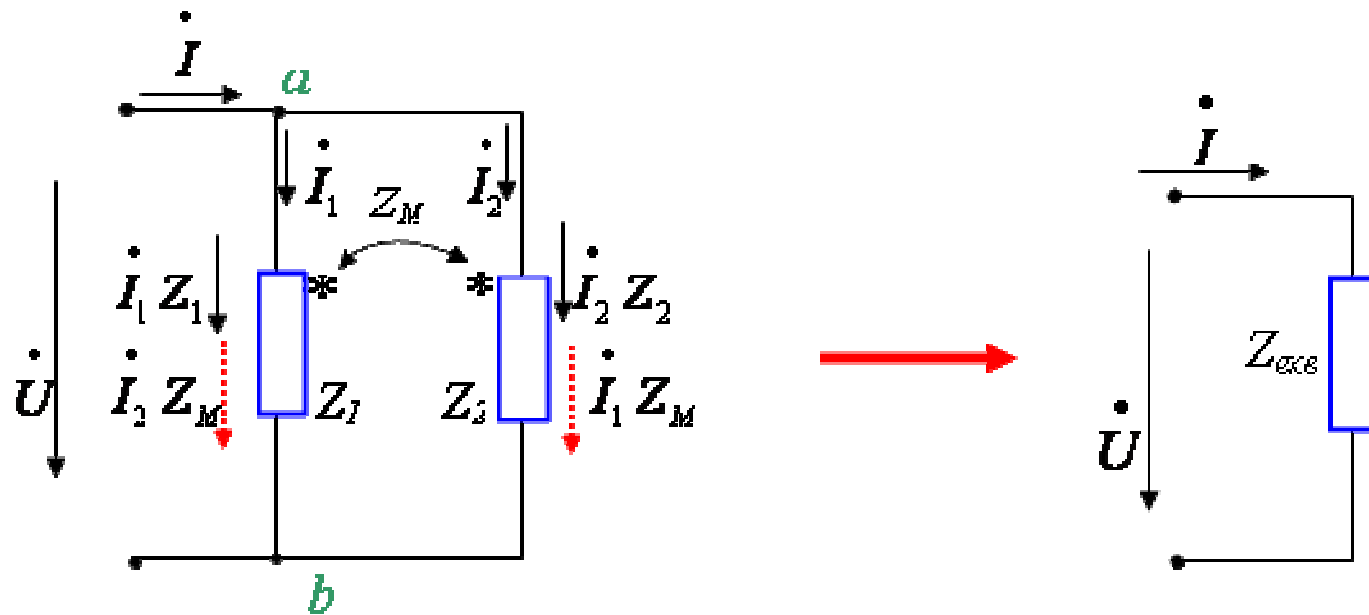
$$u(t) = u_{R_1}(t) + u_{L_1}(t) + u_{M_1}(t)$$

$$u(t) = u_{R_2}(t) + u_{L_2}(t) + u_{M_2}(t)$$

$$i(t) = i_1(t) + i_2(t)$$

$$u(t) = R_1 i_1(t) + L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$u(t) = R_2 i_2(t) + L_2 \frac{di_2}{dt} + M \frac{di_1}{dt}$$



$$Z_1 = R_1 + j\omega L_1; \quad Z_2 = R_2 + j\omega L_2; \quad Z_M = j\omega M$$

$$\dot{I} = \dot{I}_1 + \dot{I}_2$$

$$\dot{U} = \dot{I}_1(R_1 + j\omega L_1) + \dot{I}_2 \cdot j\omega M$$

$$\dot{U} = \dot{I}_2(R_2 + j\omega L_2) + \dot{I}_1 \cdot j\omega M$$

$$\dot{I} - \dot{I}_1 - \dot{I}_2 = 0$$

$$\dot{I}_1 Z_1 + \dot{I}_2 \cdot Z_M = \dot{U}$$

$$\dot{I}_1 Z_M + \dot{I}_2 \cdot Z_2 = \dot{U}$$

$$\dot{I} - \dot{I}_1 - \dot{I}_2 = 0$$

$$\dot{I}_1 Z_1 + \dot{I}_2 Z_M = \dot{U}$$

$$\dot{I}_1 Z_M + \dot{I}_2 Z_2 = \dot{U}$$



$$\dot{I}_1 = \frac{\begin{vmatrix} \dot{U} & Z_M \\ \dot{U} & Z_2 \end{vmatrix}}{\begin{vmatrix} Z_1 & Z_M \\ Z_M & Z_2 \end{vmatrix}} = \frac{\dot{U}(Z_2 - Z_M)}{Z_1 Z_2 - Z_M^2}$$

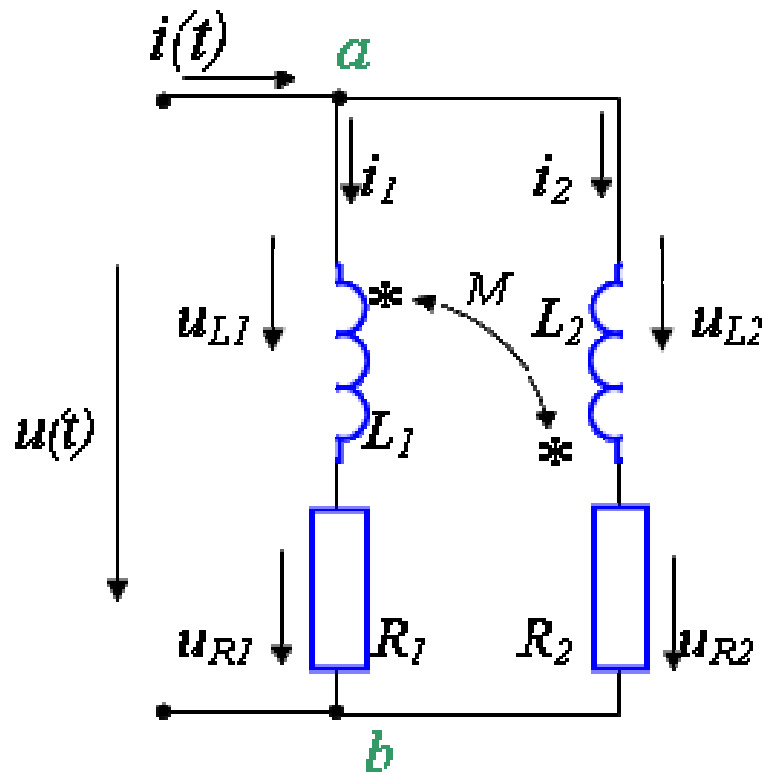
$$\dot{I}_2 = \frac{\begin{vmatrix} Z_1 & \dot{U} \\ Z_M & \dot{U} \end{vmatrix}}{\begin{vmatrix} Z_1 & Z_M \\ Z_M & Z_2 \end{vmatrix}} = \frac{\dot{U}(Z_1 - Z_M)}{Z_1 Z_2 - Z_M^2}$$

$$\dot{I} = \dot{I}_1 + \dot{I}_2$$

$$\dot{I} = \frac{\dot{U}(Z_1 + Z_2 - 2Z_M)}{Z_1 Z_2 - Z_M^2}$$

$$Z_{\text{экв}} = \frac{\dot{U}}{\dot{I}} = \frac{Z_1 Z_2 - Z_M^2}{Z_1 + Z_2 - 2Z_M}$$

Разноименни изводи в общата точка



фиг. 13а

$$i(t) = i_1(t) + i_2(t)$$

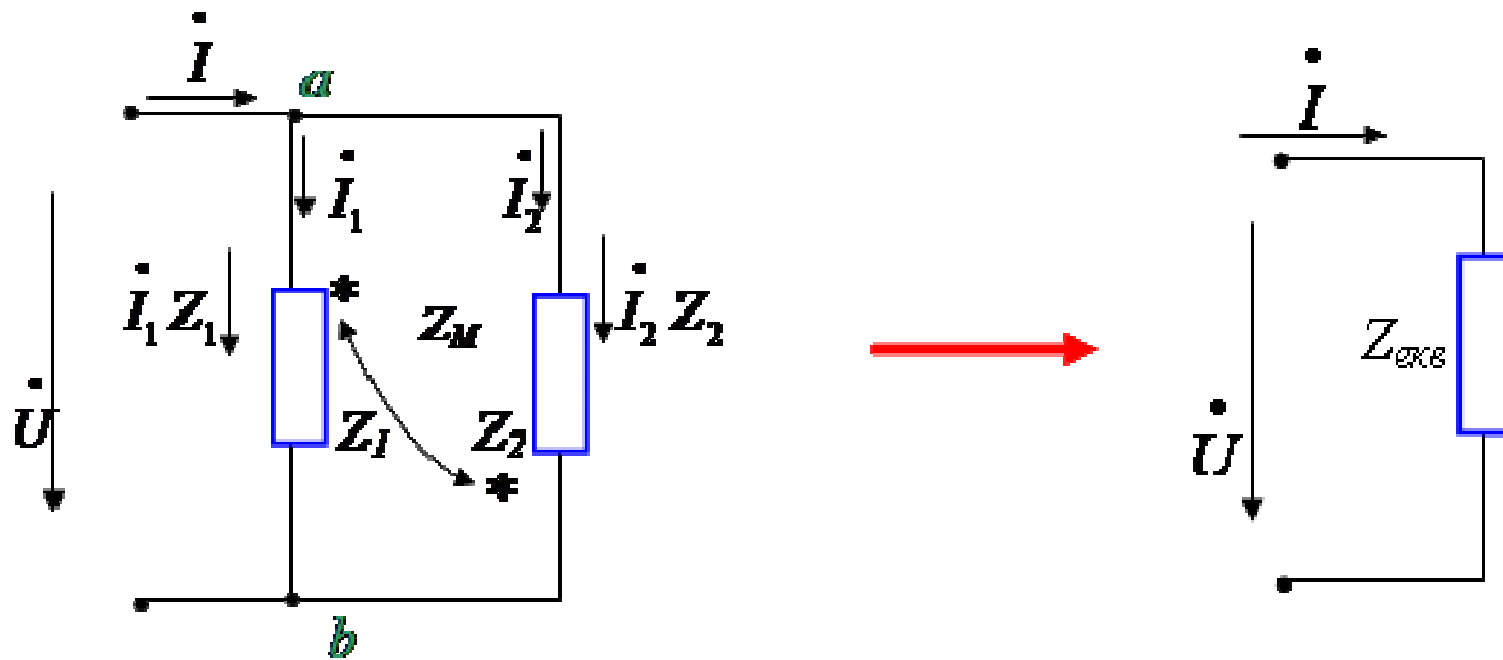
$$u(t) = u_{R1}(t) + u_{L1}(t) - u_{M1}(t)$$

$$u(t) = u_{R2}(t) + u_{L2}(t) - u_{M2}(t)$$

$$i(t) = i_1(t) + i_2(t)$$

$$u(t) = R_1 i_1(t) + L_1 \frac{di_1}{dt} - M \frac{di_2}{dt}$$

$$u(t) = R_2 i_2(t) + L_2 \frac{di_2}{dt} - M \frac{di_1}{dt}$$



$$\dot{I} = \dot{I}_1 + \dot{I}_2$$

$$\dot{U} = \dot{I}_1(R_1 + j\omega L_1) - \dot{I}_2 \cdot j\omega M$$

$$\dot{U} = \dot{I}_2(R_2 + j\omega L_2) - \dot{I}_1 \cdot j\omega M$$

$$\dot{I} - \dot{I}_1 - \dot{I}_2 = 0$$

$$\dot{I}_1 Z_1 - \dot{I}_2 \cdot Z_M = \dot{U}$$

$$-\dot{I}_1 Z_M + \dot{I}_2 \cdot Z_2 = \dot{U}$$

$$\dot{I} - \dot{I}_1 - \dot{I}_2 = 0$$

$$\dot{I}_1 Z_1 - \dot{I}_2 Z_M = \dot{U}$$

$$-\dot{I}_1 Z_M + \dot{I}_2 Z_2 = \dot{U}$$



$$\dot{I}_1 = \frac{\begin{vmatrix} \dot{U} & -Z_M \\ \dot{U} & Z_2 \end{vmatrix}}{\begin{vmatrix} Z_1 & -Z_M \\ -Z_M & Z_2 \end{vmatrix}} = \frac{\dot{U}(Z_2 + Z_M)}{Z_1 Z_2 - Z_M^2}$$

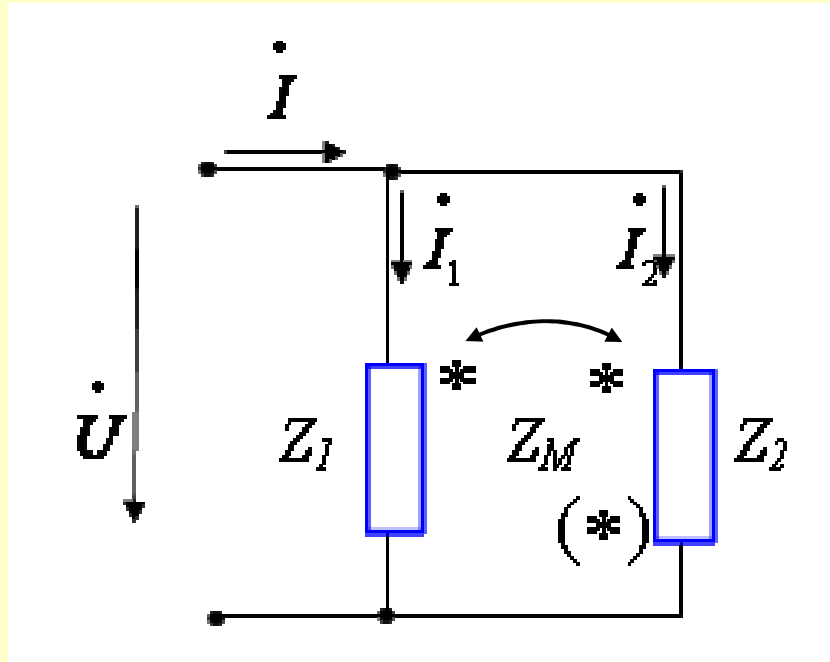
$$\dot{I}_2 = \frac{\begin{vmatrix} Z_1 & \dot{U} \\ -Z_M & \dot{U} \end{vmatrix}}{\begin{vmatrix} Z_1 & -Z_M \\ -Z_M & Z_2 \end{vmatrix}} = \frac{\dot{U}(Z_1 + Z_M)}{Z_1 Z_2 - Z_M^2}$$

$$\dot{I} = \dot{I}_1 + \dot{I}_2$$

$$\dot{I} = \frac{\dot{U}(Z_1 + Z_2 + 2Z_M)}{Z_1 Z_2 - Z_M^2}$$

$$Z_{екв} = \frac{\dot{U}}{\dot{I}} = \frac{Z_1 Z_2 - Z_M^2}{Z_1 + Z_2 + 2Z_M}$$

ИЗВОД



$$Z_{\text{екв}} = \frac{Z_1 Z_2 - Z_M^2}{Z_1 + Z_2 \pm 2Z_M}$$

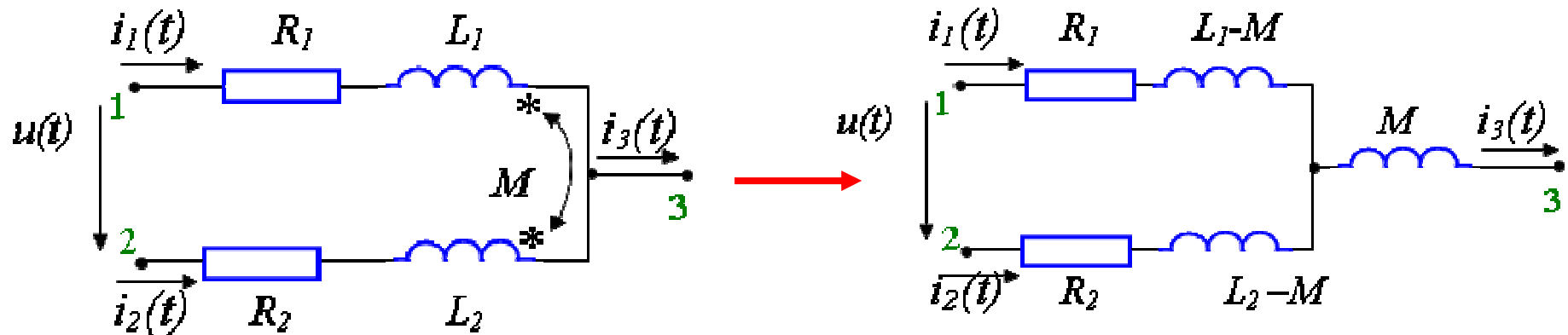
Знакът пред $2Z_M$ се определя от начина на свързване:

“ - ” при едноименни изводи в общата точка

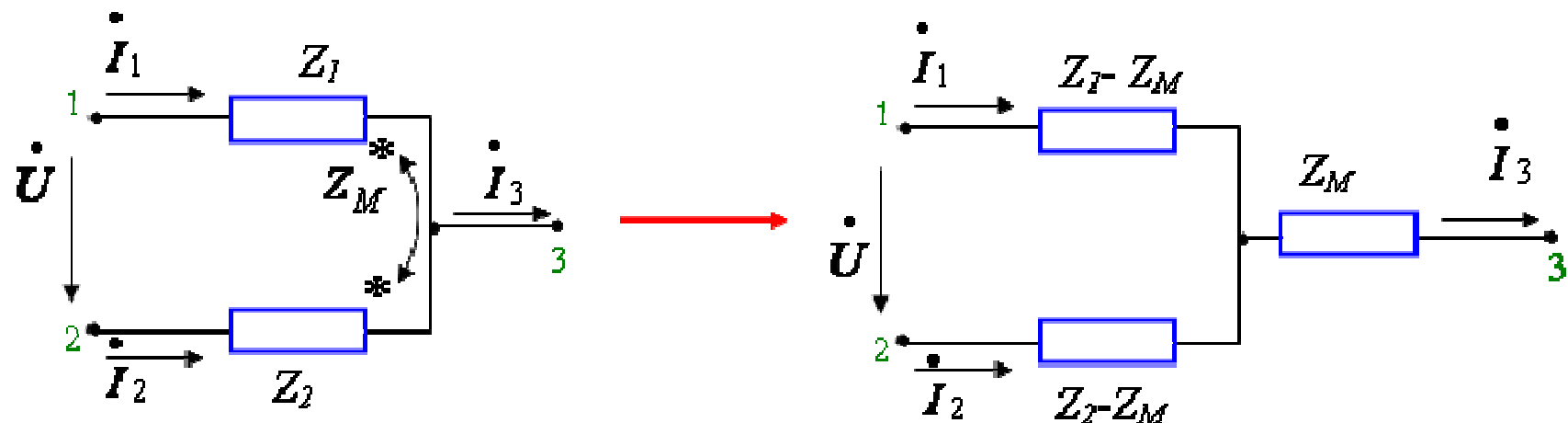
“ + ” при разноименни изводи в общата точка.

Преобразуване на триполюсно съединение с индуктивна връзка

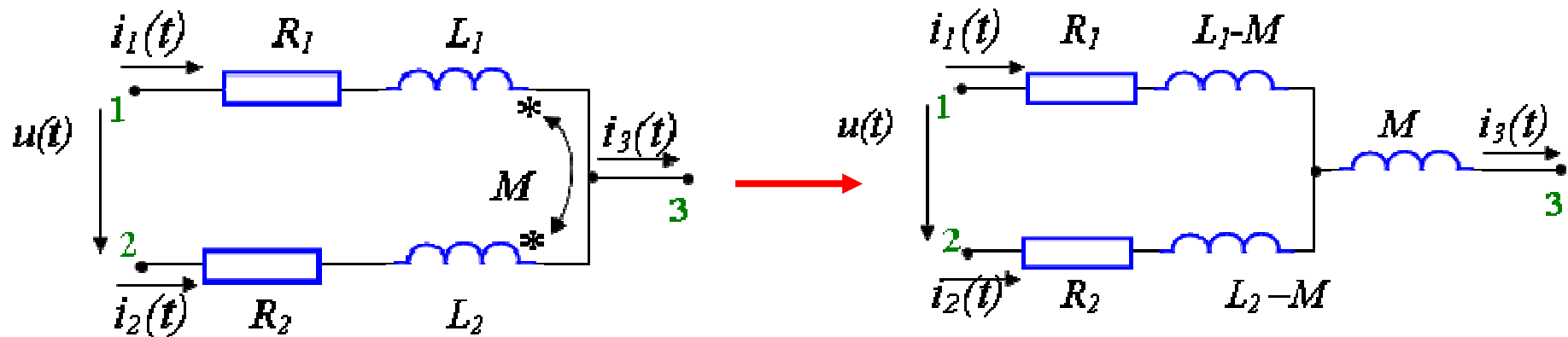
Едноименните изводи са в обща точка



фиг. 15



Доказательство



$$\dot{I}_3 = \dot{I}_1 + \dot{I}_2$$

$$\dot{U}_{13} = \dot{I}_1(R_1 + j\omega L_1) + \dot{I}_2 \cdot j\omega M$$

$$\dot{U}_{23} = \dot{I}_2(R_2 + j\omega L_2) + \dot{I}_1 \cdot j\omega M$$

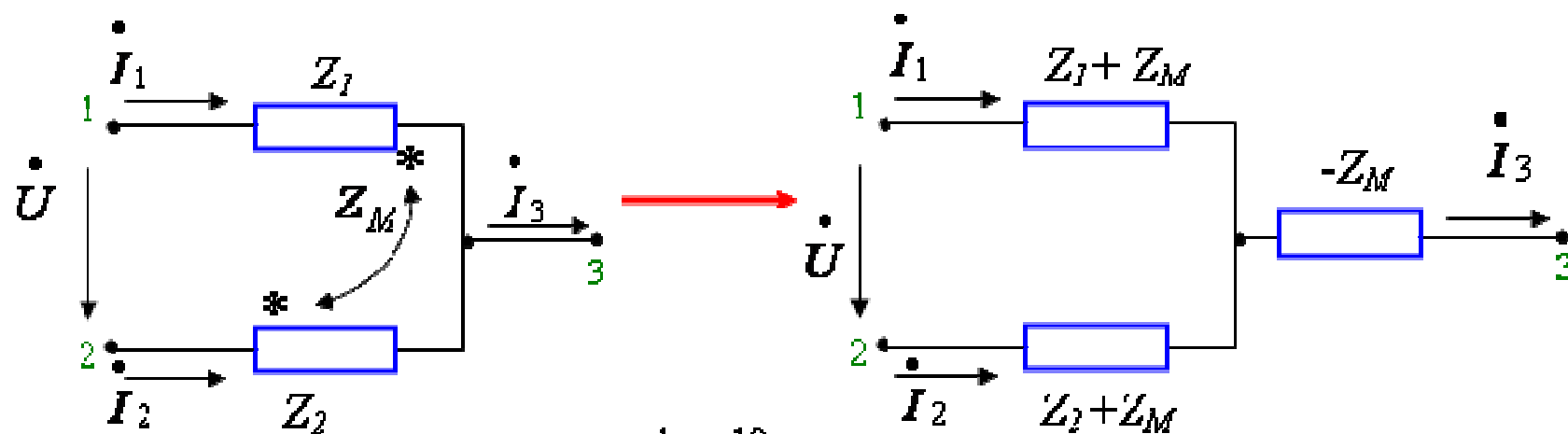
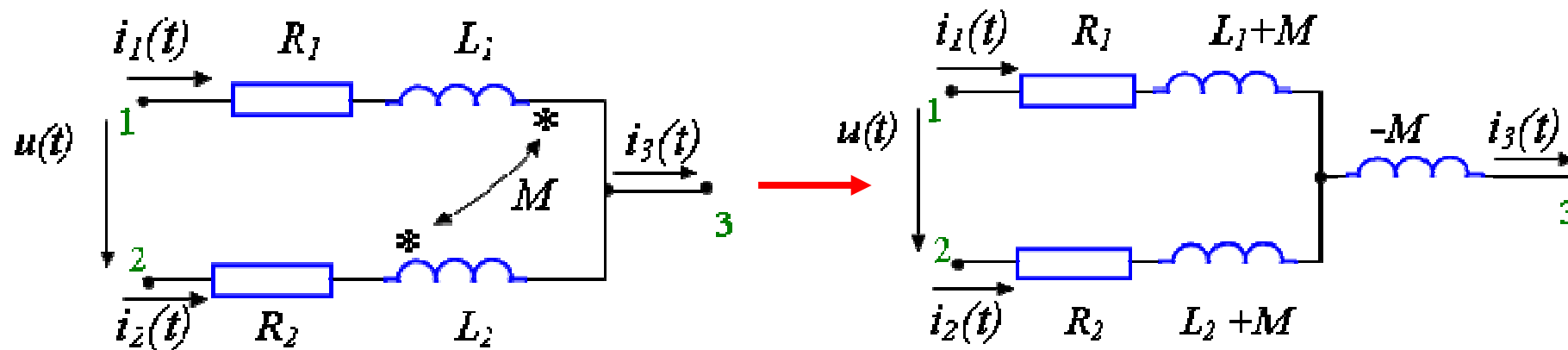
$$\dot{U}_{13} = \dot{I}_1(R_1 + j\omega L_1) + (\dot{I}_3 - \dot{I}_1) \cdot j\omega M$$

$$\dot{U}_{23} = \dot{I}_2(R_2 + j\omega L_2) + (\dot{I}_3 - \dot{I}_2) \cdot j\omega M$$

$$\dot{U}_{13} = \dot{I}_1 R_1 + \dot{I}_1 j\omega(L_1 - M) + \dot{I}_3 \cdot j\omega M$$

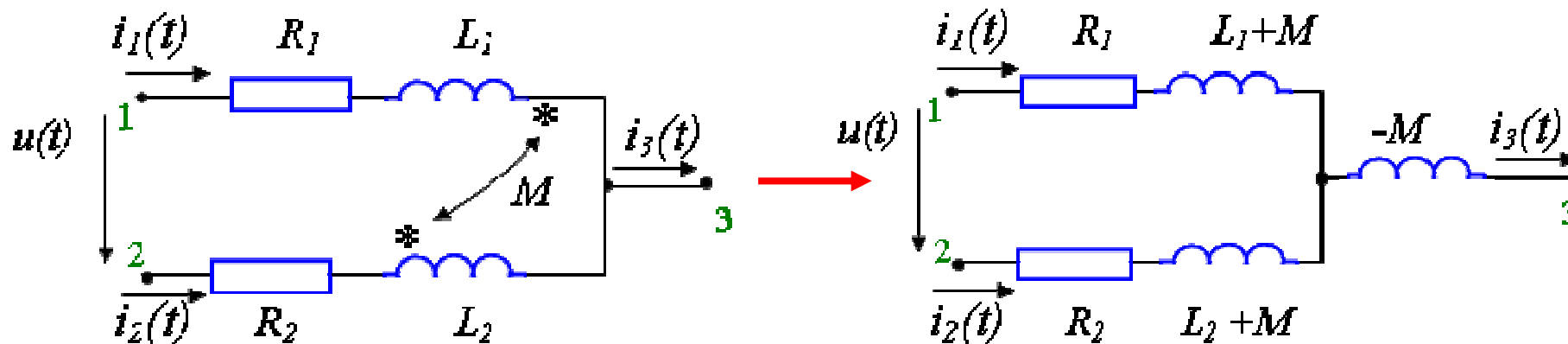
$$\dot{U}_{23} = \dot{I}_2 R_2 + \dot{I}_2 j\omega(L_2 - M) + \dot{I}_3 \cdot j\omega M$$

Разноименните изводи са в обща точка



фиг. 19

Доказательство



$$\dot{I}_3 = \dot{I}_1 + \dot{I}_2$$

$$\dot{U}_{13} = \dot{I}_1(R_1 + j\omega L_1) - \dot{I}_2 \cdot j\omega M$$

$$\dot{U}_{23} = \dot{I}_2(R_2 + j\omega L_2) - \dot{I}_1 \cdot j\omega M$$

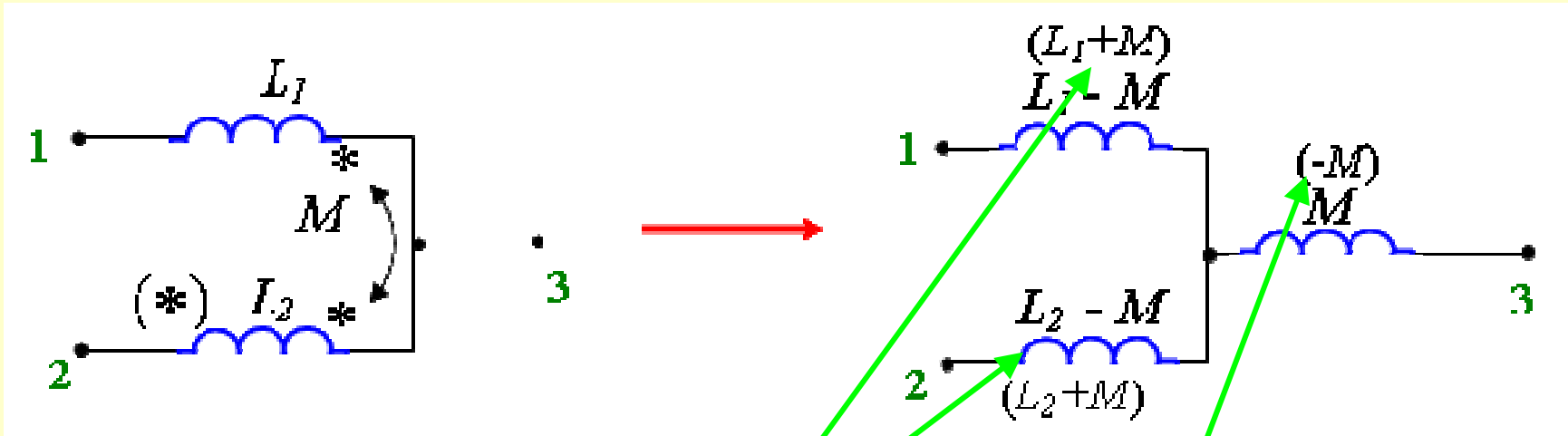
$$\dot{U}_{13} = \dot{I}_1(R_1 + j\omega L_1) - (\dot{I}_3 - \dot{I}_1) \cdot j\omega M$$

$$\dot{U}_{23} = \dot{I}_2(R_2 + j\omega L_2) - (\dot{I}_3 - \dot{I}_2) \cdot j\omega M$$

$$\dot{U}_{13} = \dot{I}_1 R_1 + \dot{I}_1 j\omega(L_1 + M) - \dot{I}_3 \cdot j\omega M$$

$$\dot{U}_{23} = \dot{I}_2 R_2 + \dot{I}_2 j\omega(L_2 + M) - \dot{I}_3 \cdot j\omega M$$

Извод:

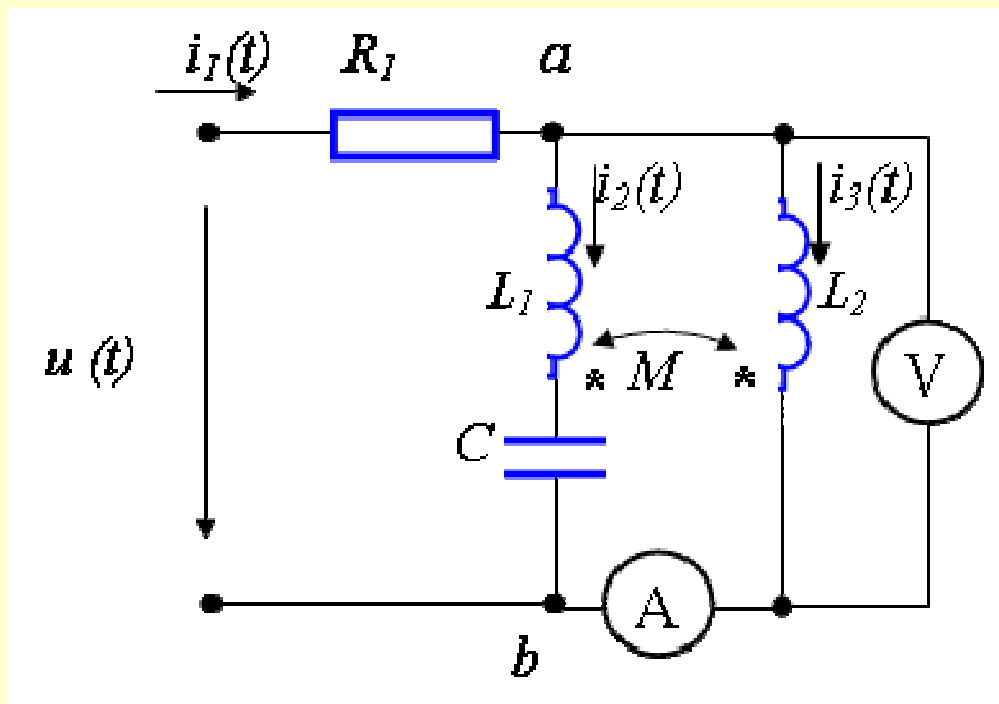


Знакът пред M се определя от начина на свързване:

- изразът без скоби е при едноименни изводи в общата точка
- а изразът в скобите е при разноименни изводи в общата точка.

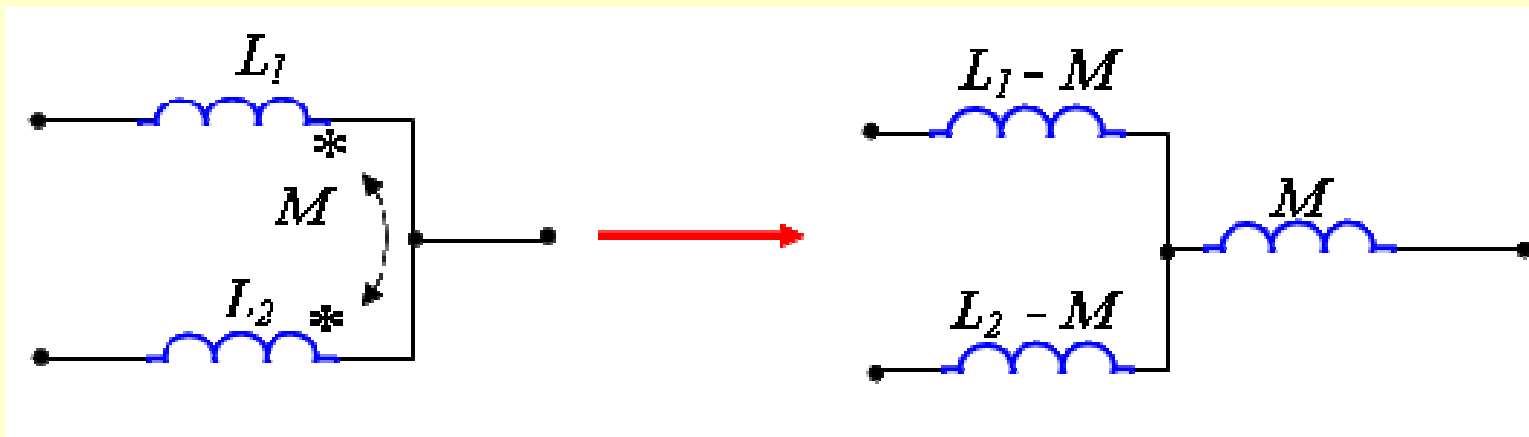
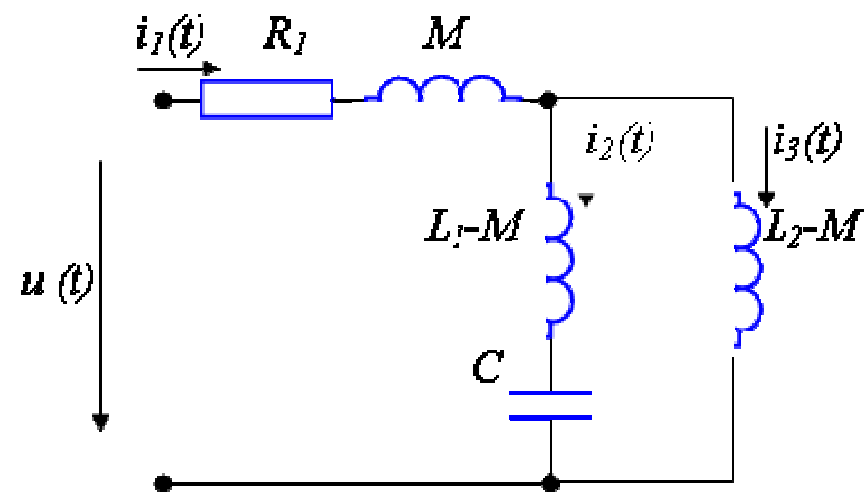
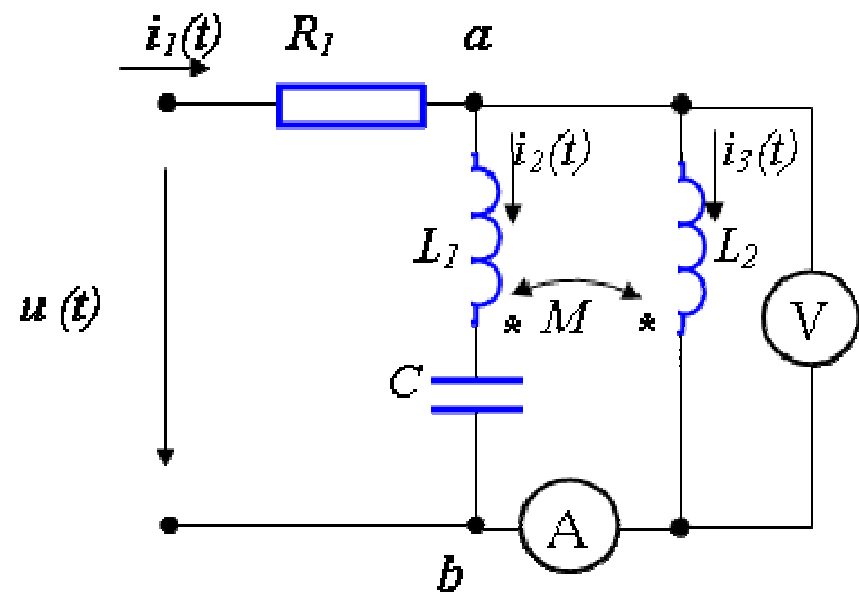
Посоките на токовете нямат значение за преобразуването.

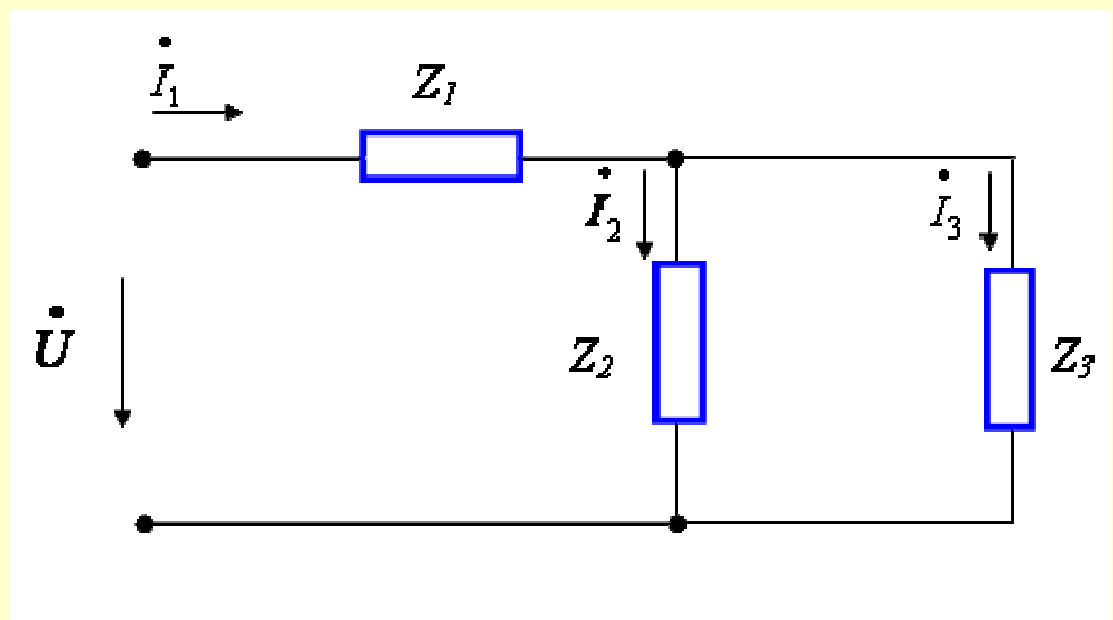
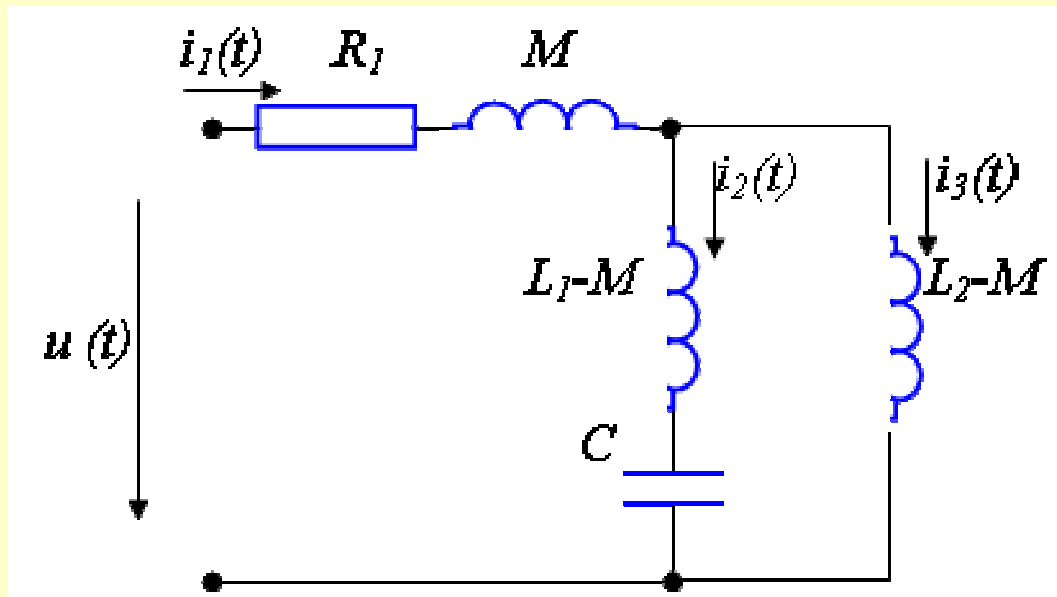
**Пример за анализ на верига с индуктивни връзки
посредством отстраняване на индуктивната връзка:**



$$u(t) = 141\sin(\omega t + 90)V$$

$$\begin{aligned} f &= 160\text{Hz}, \\ L_1 &= 40\text{mH}, \\ L_2 &= 30\text{mH}, \\ M &= 10\text{mH}, \\ C &= 100\mu\text{F} \\ R_1 &= 10\Omega, \end{aligned}$$

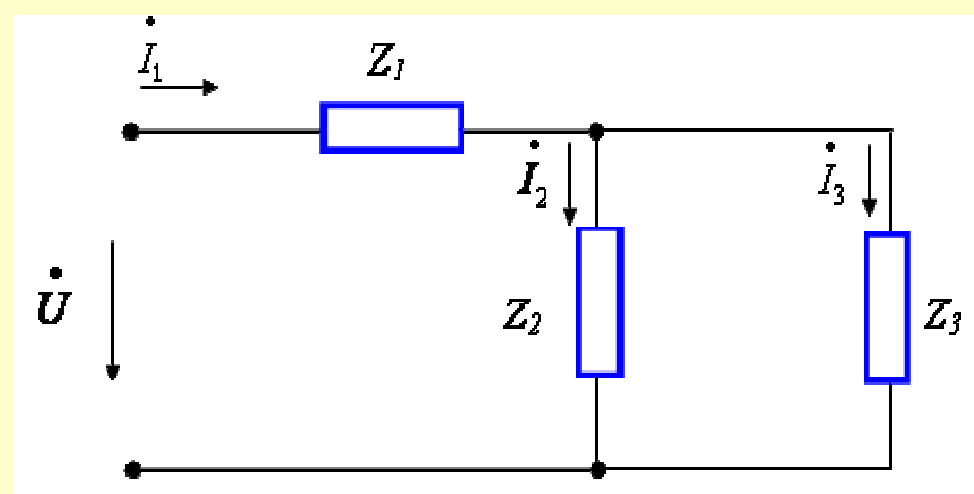
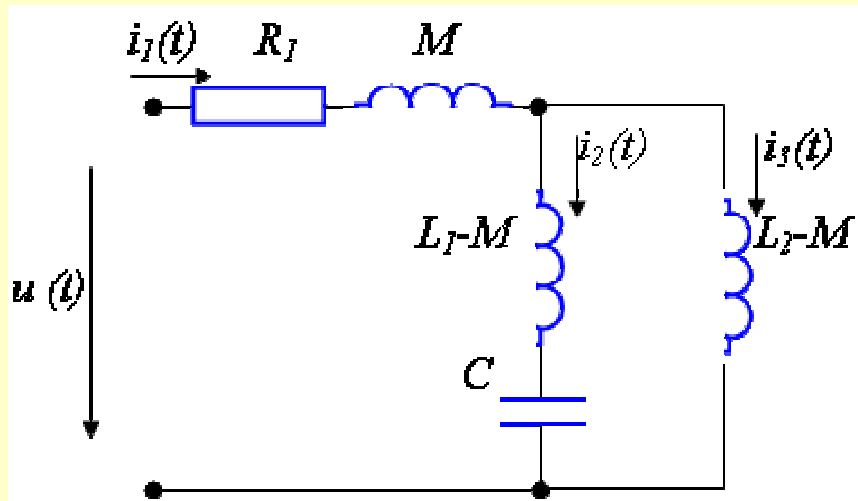




$$Z_1 = R_1 + j\omega M$$

$$Z_2 = j\omega(L_1 - M)$$

$$Z_3 = j\omega(L_2 - M)$$



$$\dot{U} = U e^{j\psi_u} = \frac{u_m}{\sqrt{2}} e^{j\psi_u} = \frac{141}{\sqrt{2}} e^{j90} = 100 \cdot [\cos(90) + j \sin(90)] = 100 \cdot (0 + j) = j100V$$

$$u(t) = 141 \sin(\omega t + 90) V$$

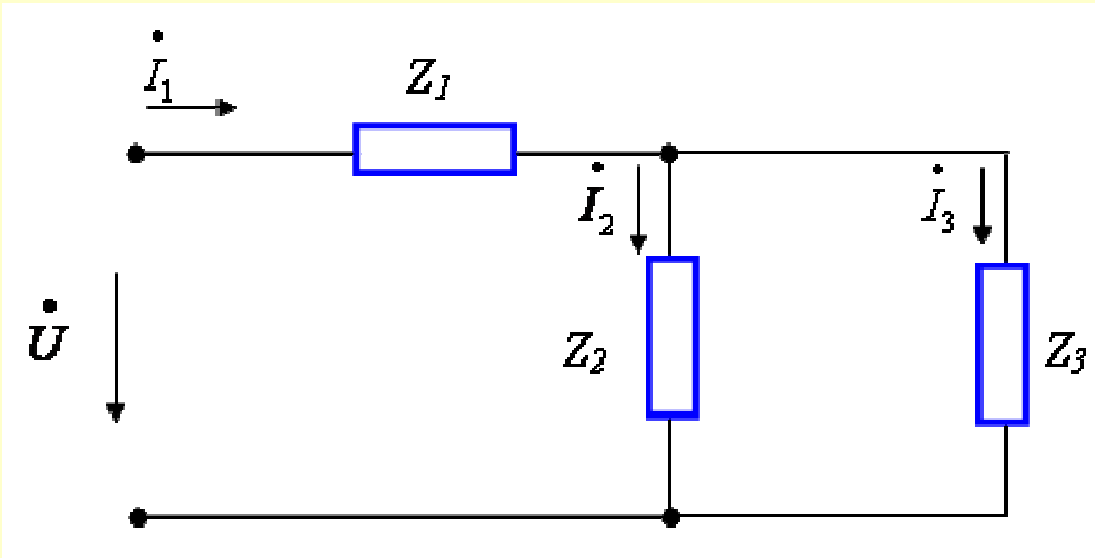
- $f = 160 \text{ Hz},$
- $L_1 = 40 \text{ mH},$
- $L_2 = 30 \text{ mH},$
- $M = 10 \text{ mH},$
- $C = 100 \text{ } \mu\text{F}$
- $R_1 = 10 \Omega,$

$$\omega = 2\pi f = 2\pi \cdot 160 \approx 1000 = 10^3 \text{ rad/s}$$

$$Z_1 = R_1 + j\omega M = (10 + j \cdot 10^3 \cdot 10 \cdot 10^{-3}) = (10 + j10) \Omega$$

$$Z_2 = j\omega(L_1 - M) - j \frac{1}{\omega C} = j \cdot 10^3 \cdot (40 - 10) \cdot 10^{-3} - j \frac{1}{10^3 \cdot 100 \cdot 10^{-6}} = j30 - j10 = j20 \Omega$$

$$Z_3 = j\omega(L_2 - M) = j \cdot 10^3 \cdot (30 - 10) \cdot 10^{-3} = j20 \Omega$$



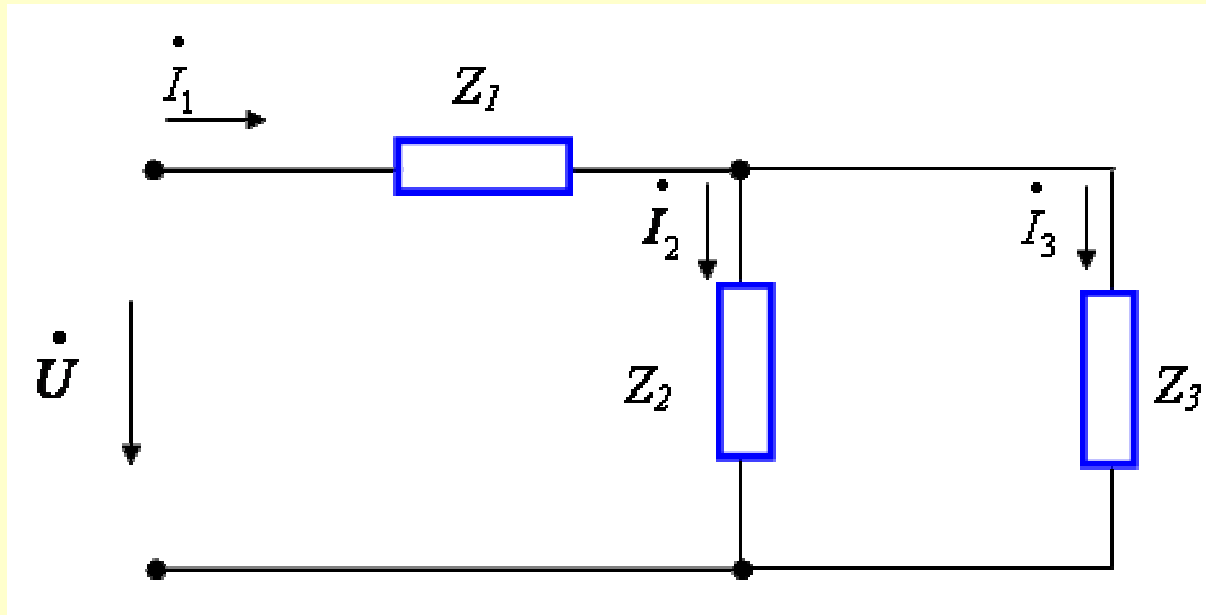
$$\dot{U} = j100V$$

$$Z_1 = (10 + j10) \Omega$$

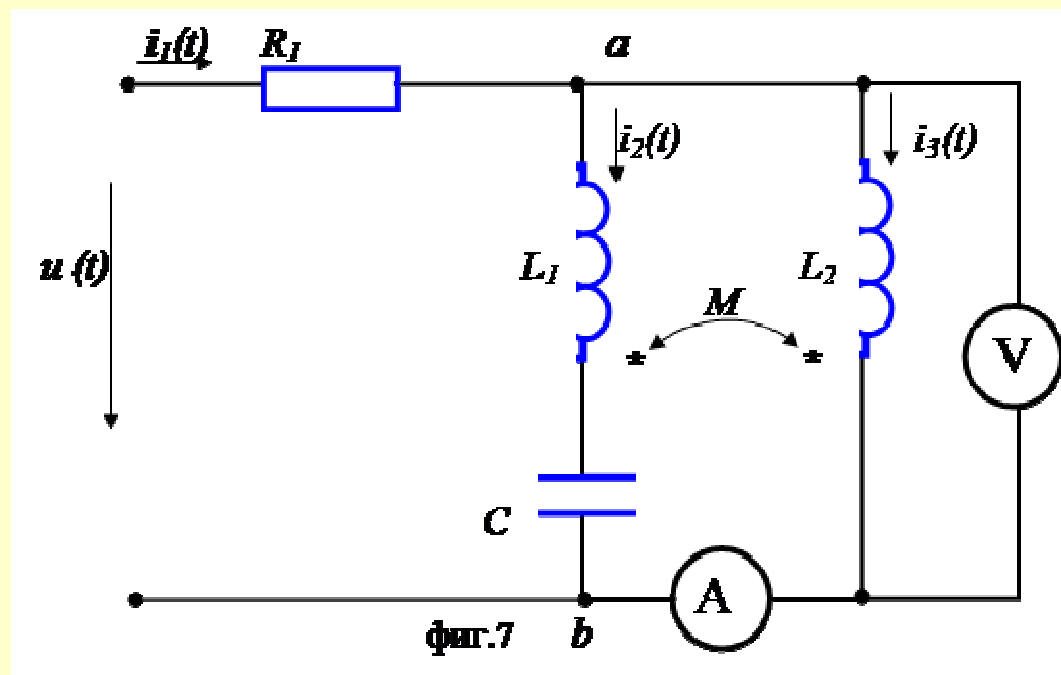
$$Z_2 = j20 \Omega$$

$$Z_3 = j20 \Omega$$

5. Определяме токовете \dot{I}_2 и \dot{I}_3 в двата паралелни клона

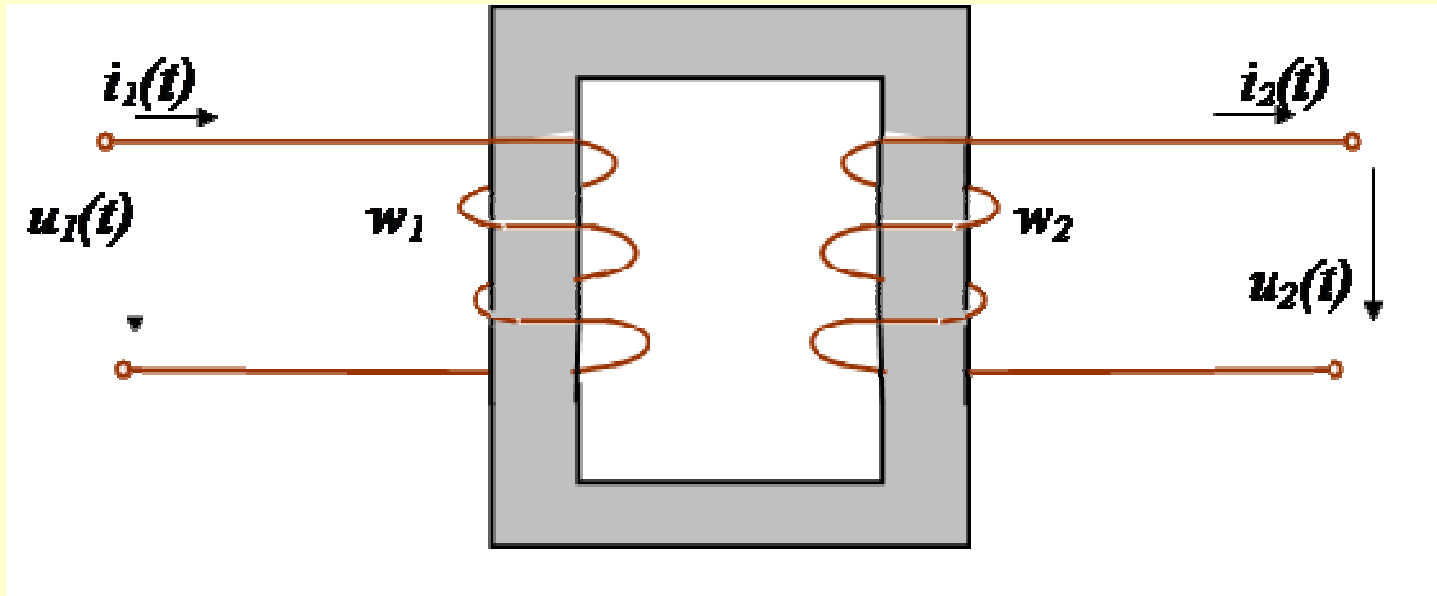


6. Определяме напрежението на волтметъра



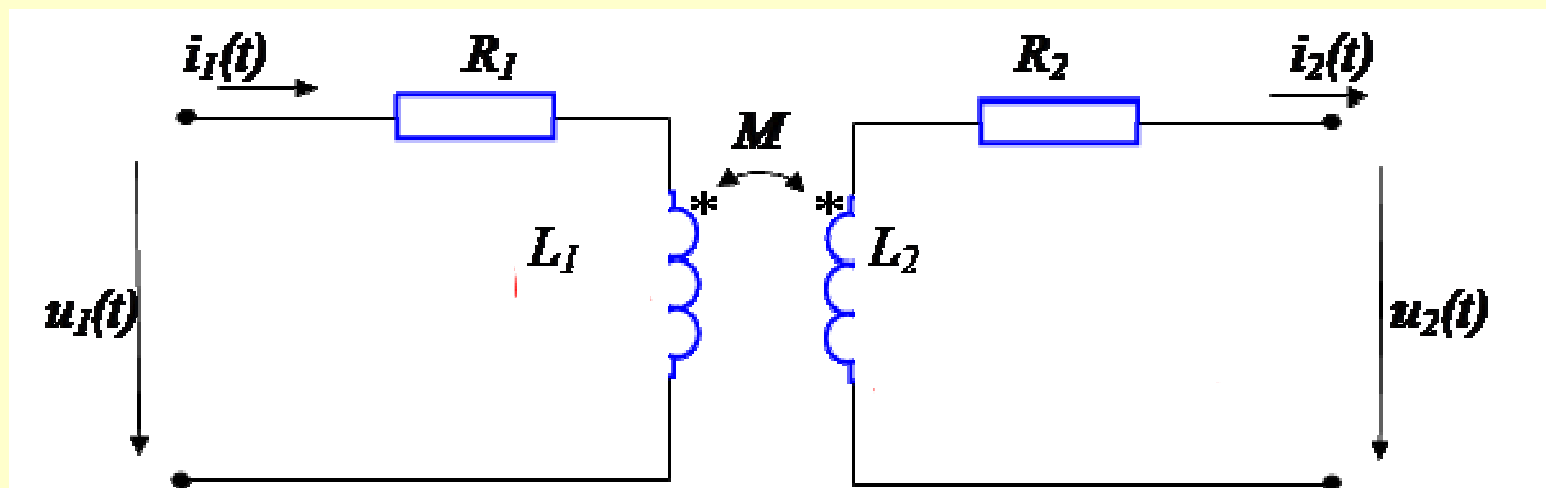
$$U_V = U_{ab}$$

Трансформаторно съединение.



- Трансформаторното съединение е съединение на две намотки с общо ядро
- Връзката между тях се осъществява посредством променливо магнитно поле.
- Енергията се предава от първичната към вторичната намотка на базата на взаимна индукция.

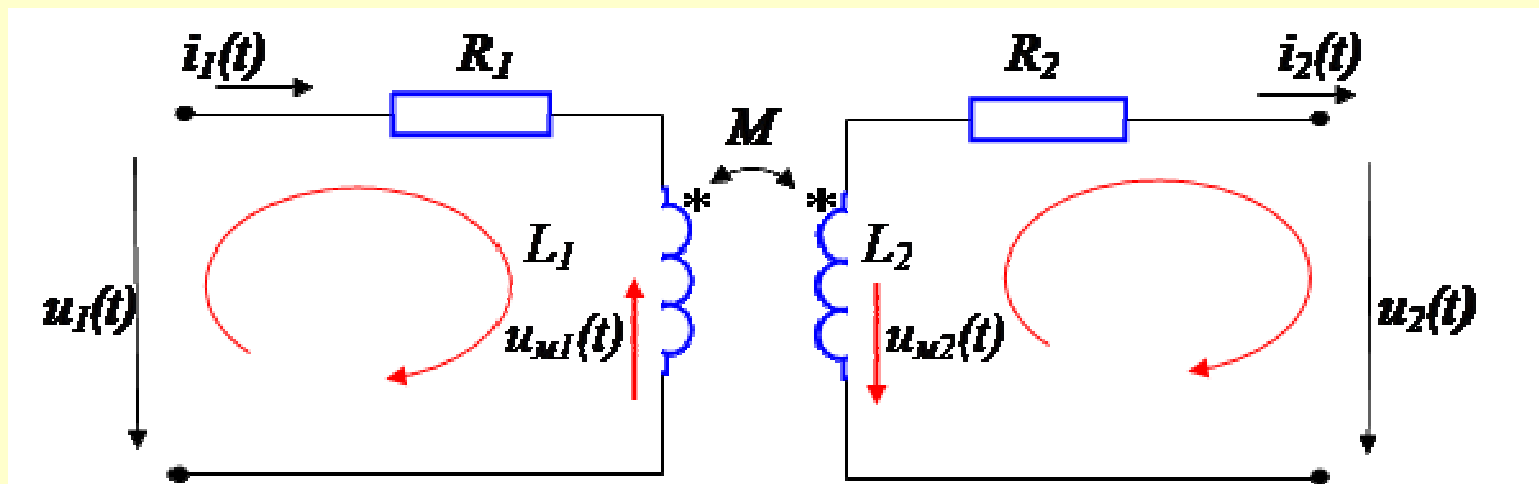
Уравнения на линейен трансформатор



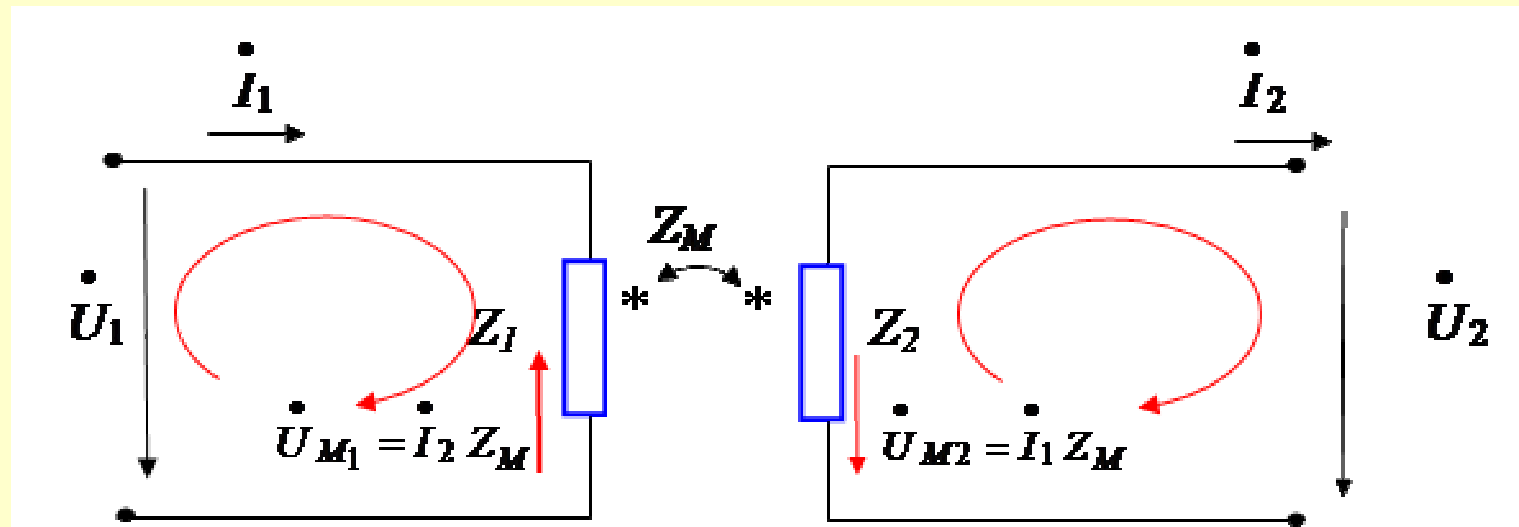
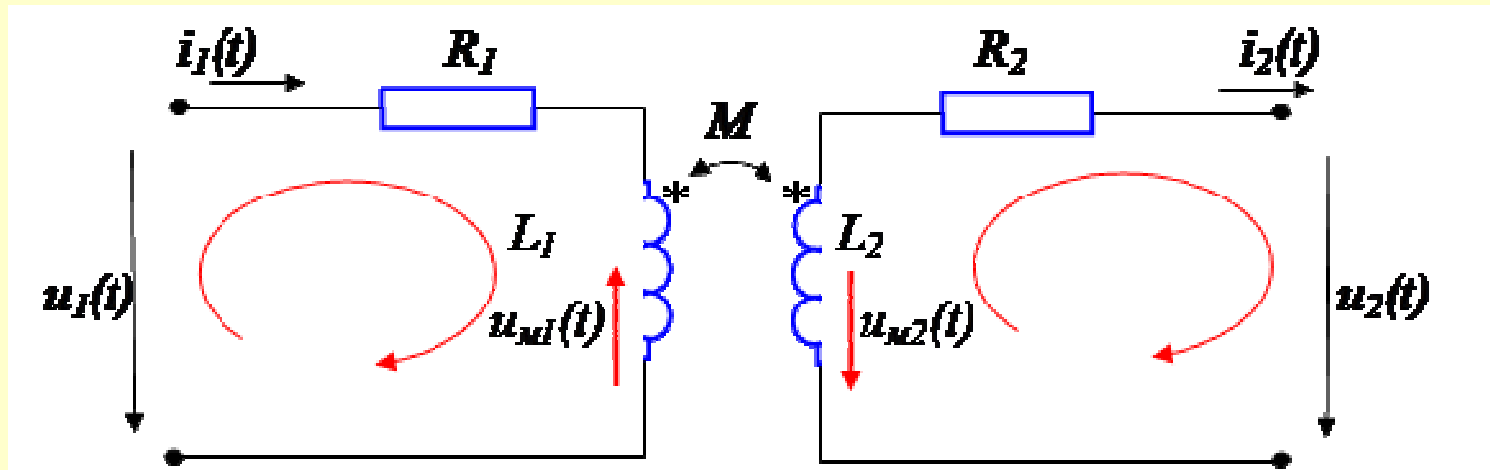
$$u_1(t) = u_{R_1}(t) + u_{L_1}(t) - u_{M_1}(t)$$

$$-u_2(t) = u_{R_2}(t) + u_{L_2}(t) - u_{M_2}(t)$$

Уравнения на линейен трансформатор



$$u_1(t) = R_1 i_1(t) + L_1 \frac{di_1}{dt} - M \frac{di_2}{dt}$$
$$-u_2(t) = R_2 i_2(t) + L_2 \frac{di_2}{dt} - M \frac{di_1}{dt}$$

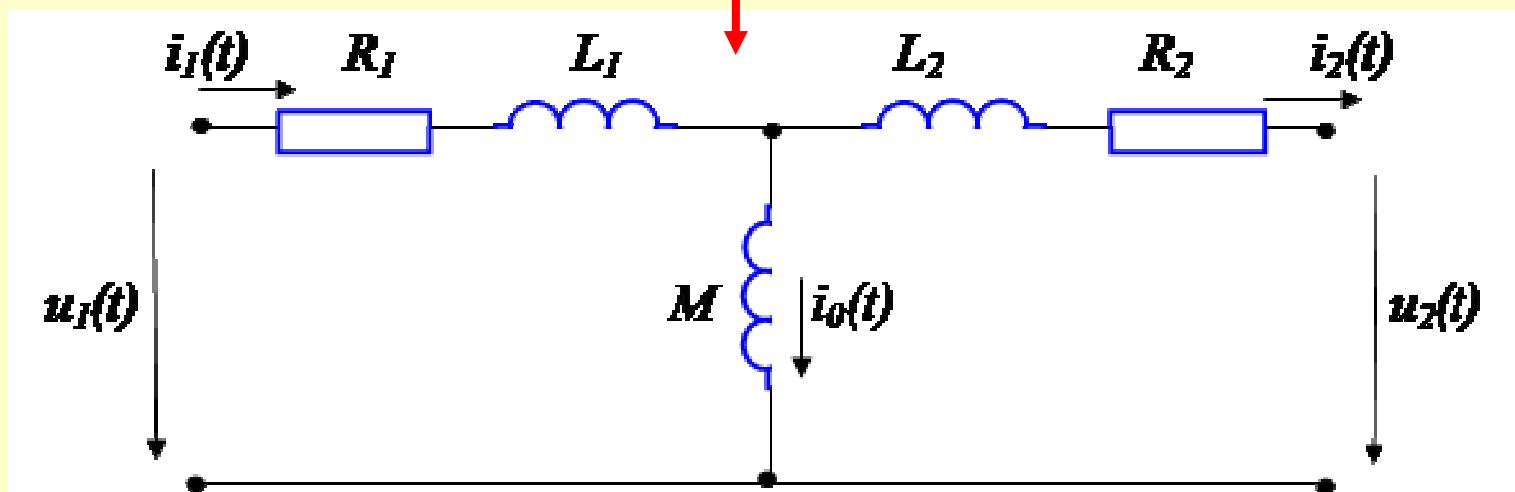
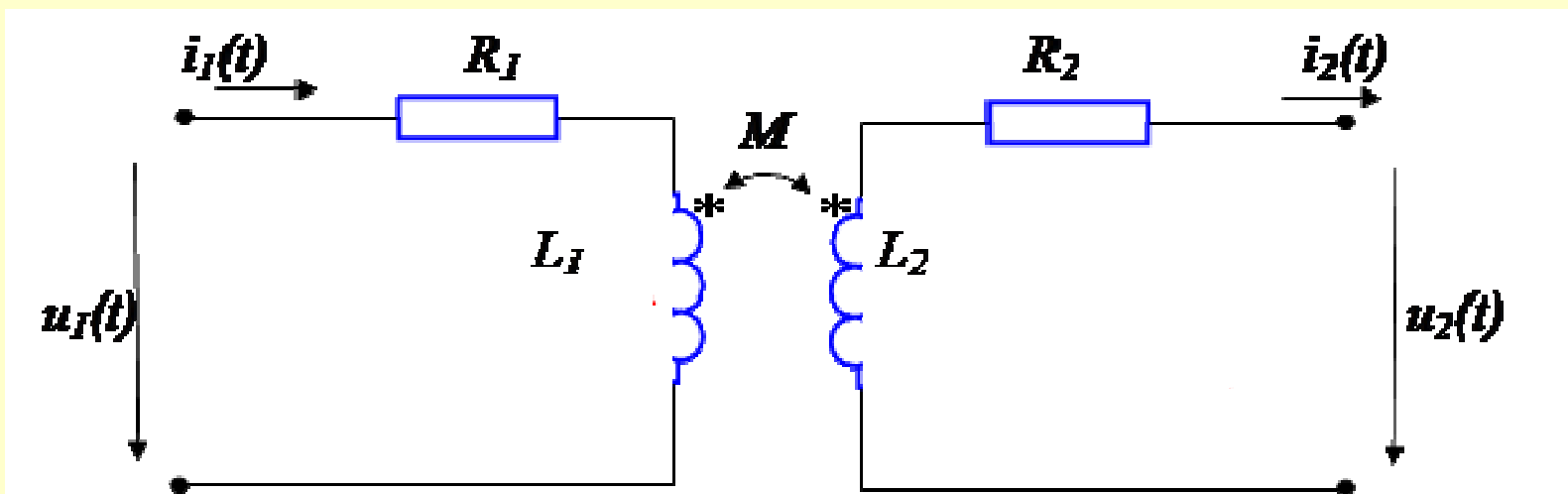


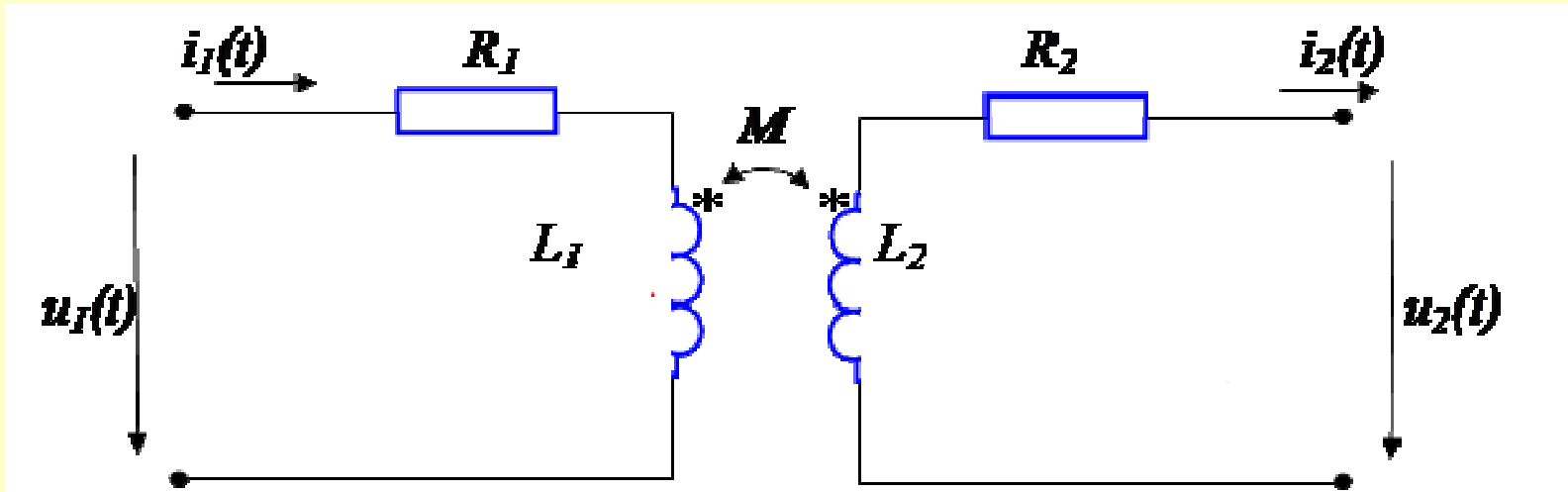
$$\begin{aligned} \dot{U}_1 &= \dot{I}_1 (R_1 + j\omega L_1) - \dot{I}_2 j\omega M \\ -\dot{U}_2 &= \dot{I}_2 (R_2 + j\omega L_2) - \dot{I}_1 j\omega M \end{aligned}$$



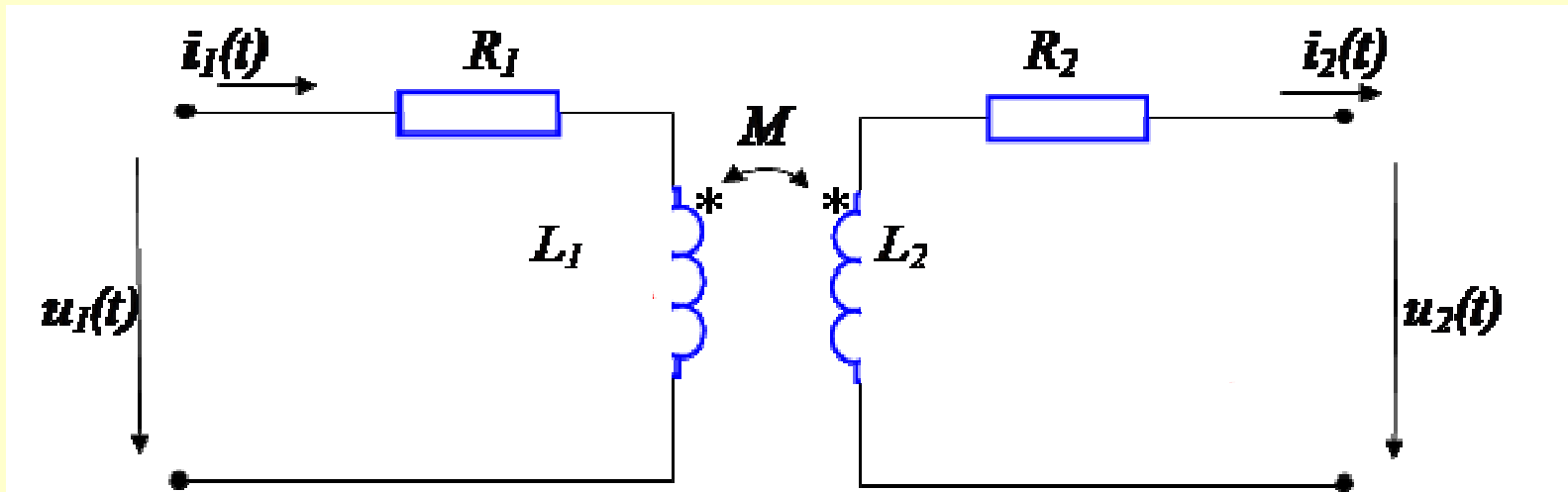
$$\begin{aligned} \dot{U}_1 &= \dot{I}_1 Z_1 - \dot{I}_2 Z_M \\ -\dot{U}_2 &= \dot{I}_2 Z_2 - \dot{I}_1 Z_M \end{aligned}$$

Еквивалентна схема на линеен трансформатор

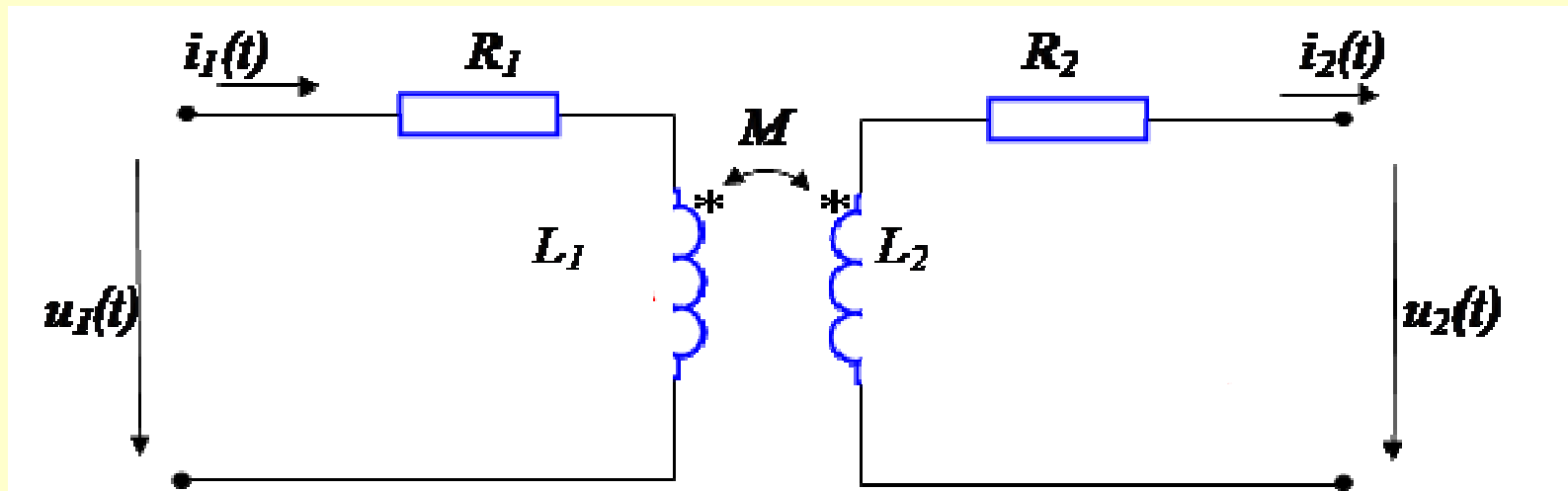




$$\begin{cases}
 u_1(t) = R_1 i_1(t) + L_1 \frac{di_1}{dt} - M \frac{di_2}{dt} & \leftarrow + \left(M \frac{di_1}{dt} - M \frac{di_1}{dt} \right) \\
 -u_2(t) = R_2 i_2(t) + L_2 \frac{di_2}{dt} - M \frac{di_1}{dt} & \leftarrow + \left(M \frac{di_2}{dt} - M \frac{di_2}{dt} \right)
 \end{cases}$$



$$\begin{cases}
 u_1(t) = R_1 i_1(t) + L_1 \frac{di_1}{dt} - M \frac{di_2}{dt} + (M \frac{di_1}{dt} - M \frac{di_1}{dt}) \\
 -u_2(t) = R_2 i_2(t) + L_2 \frac{di_2}{dt} - M \frac{di_1}{dt} + (M \frac{di_2}{dt} - M \frac{di_2}{dt})
 \end{cases}$$



$$u_1(t) = R_1 i_1(t) + (L_1 - M) \frac{di_1}{dt} + M \left(\frac{di_1}{dt} - \frac{di_2}{dt} \right)$$

$$-u_2(t) = R_2 i_2(t) + (L_2 - M) \frac{di_2}{dt} - M \left(\frac{di_1}{dt} - \frac{di_2}{dt} \right)$$

$$i_0 = i_1 - i_2$$

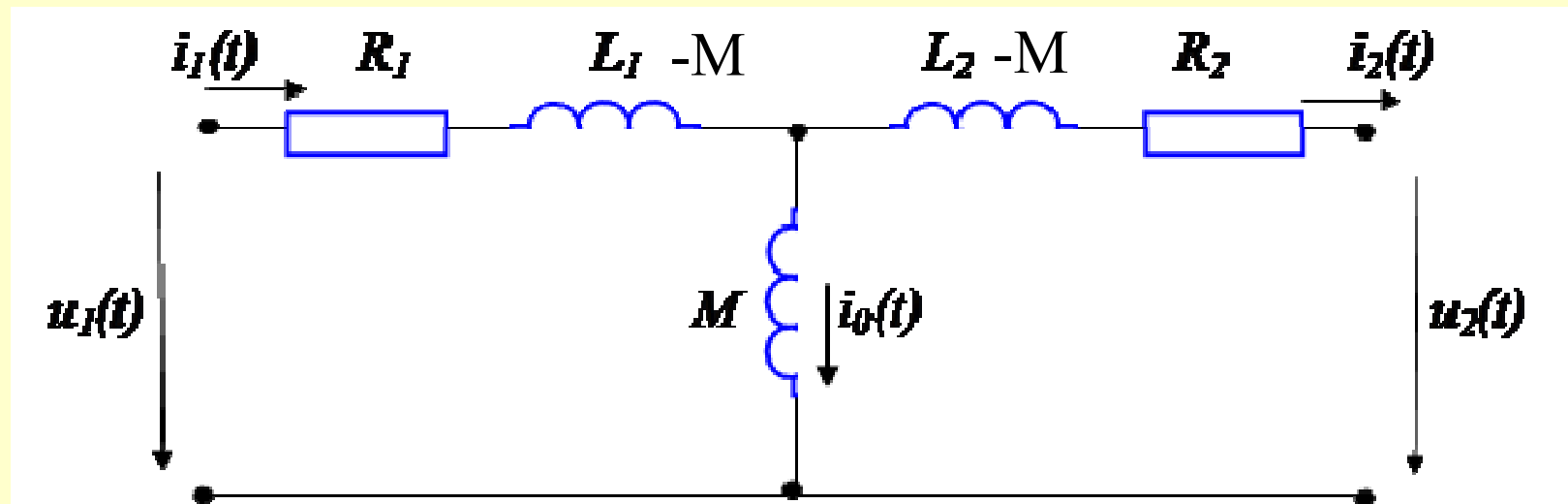
$$\frac{di_0}{dt} = \frac{di_1}{dt} - \frac{di_2}{dt}$$

$$u_1(t) = R_1 i_1(t) + (L_1 - M) \frac{di_1}{dt} + M \frac{di_0}{dt}$$

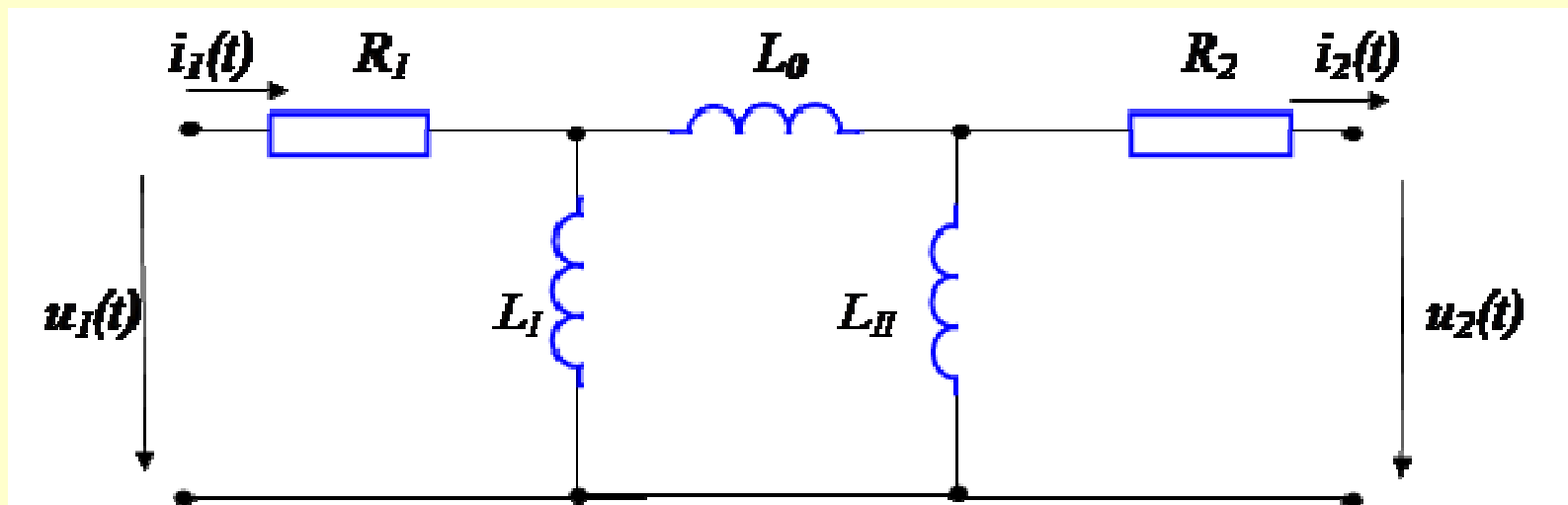
$$-u_2(t) = R_2 i_2(t) + (L_2 - M) \frac{di_2}{dt} - M \frac{di_0}{dt}$$

Т-образна еквивалентна схема на линеен трансформатор

$$u_1(t) = R_1 i_1(t) + (L_1 - M) \frac{di_1}{dt} + M \frac{di_0}{dt}$$
$$-u_2(t) = R_2 i_2(t) + (L_2 - M) \frac{di_2}{dt} - M \frac{di_0}{dt}$$

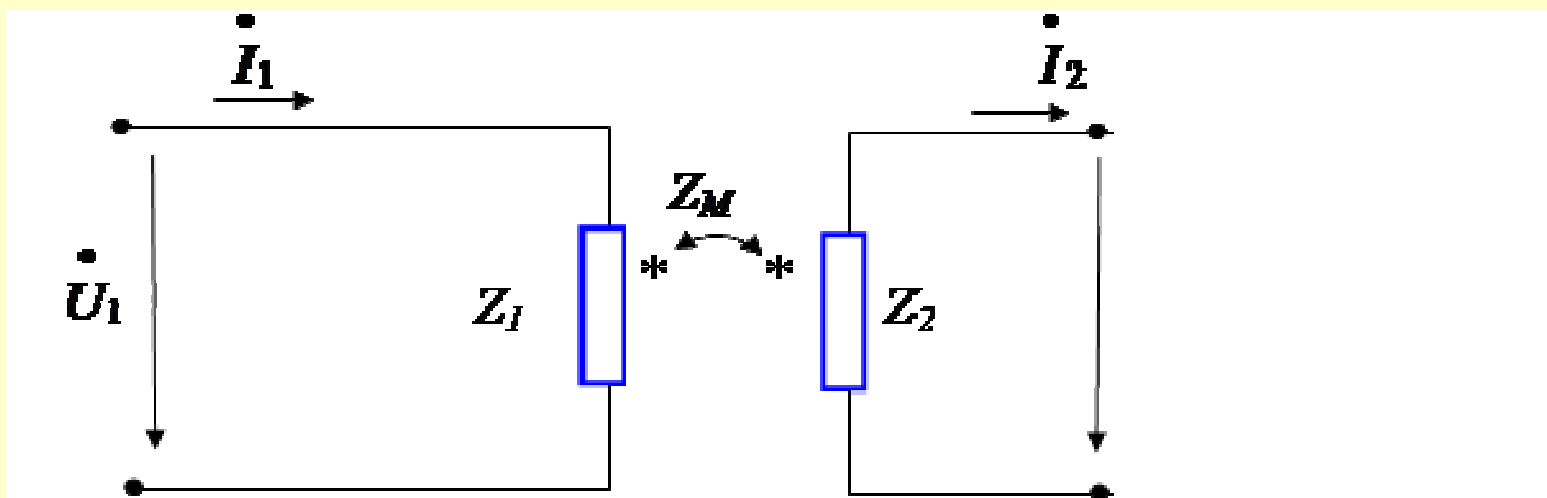


Π-образна еквивалентна схема на линеен трансформатор



$$L_0 = \frac{L_1 L_2 - M^2}{M}; \quad L_I = \frac{L_1 L_2 - M^2}{L_2 - M}; \quad L_{II} = \frac{L_1 L_2 - M^2}{L_1 - M}$$

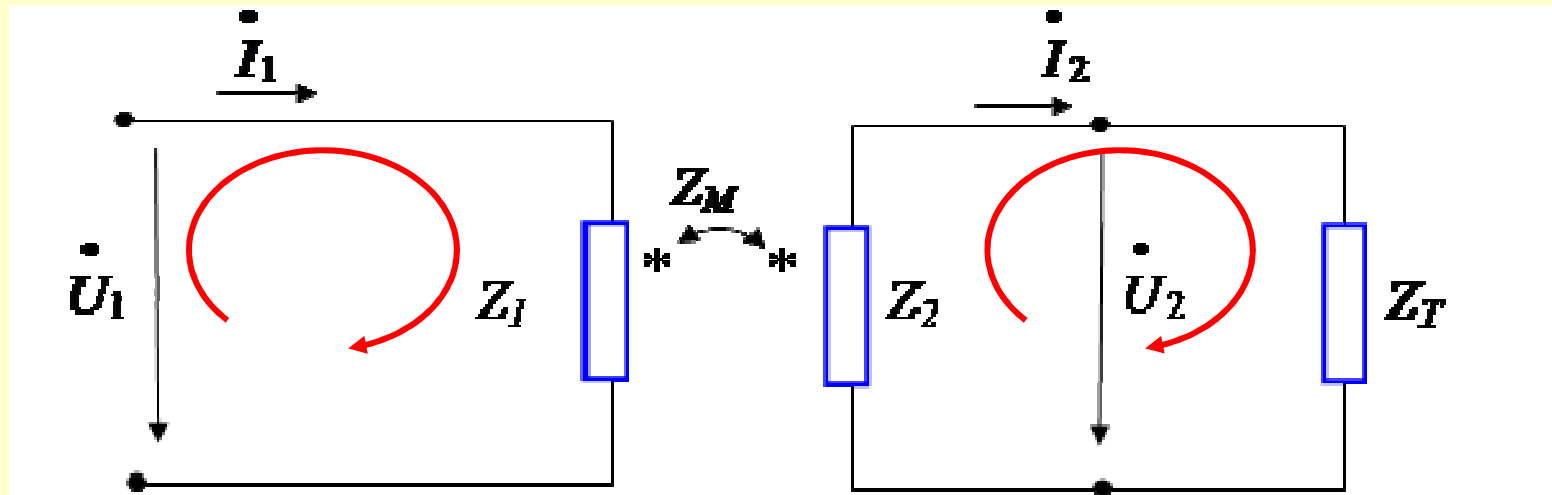
Векторна диаграма на натоварен трансформатор



$$\begin{aligned}Z_1 &= R_1 + j\omega L_1; \\Z_2 &= R_2 + j\omega L_2; \\Z_M &= j\omega M\end{aligned}$$

$$Z_T = R_T + j\omega L_T$$

Векторна диаграма на натоварен трансформатор



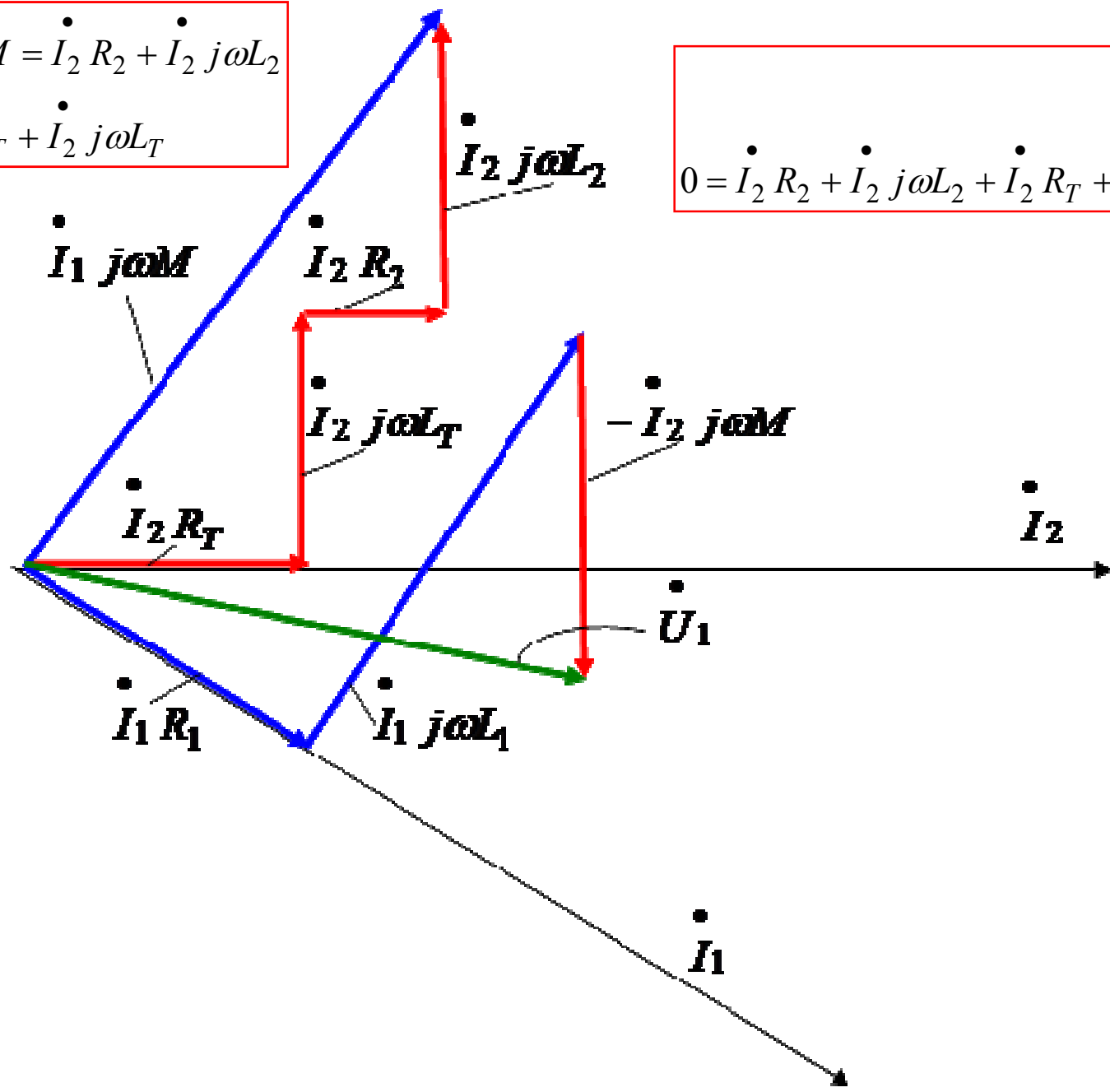
$$\dot{U}_1 = \dot{I}_1 Z_1 - \dot{I}_2 Z_M$$

$$0 = \dot{I}_2 Z_2 + \dot{I}_2 Z_T - \dot{I}_1 Z_M \quad \Rightarrow \quad \dot{I}_1 Z_M = \dot{I}_2 Z_2 + \dot{I}_2 Z_T$$

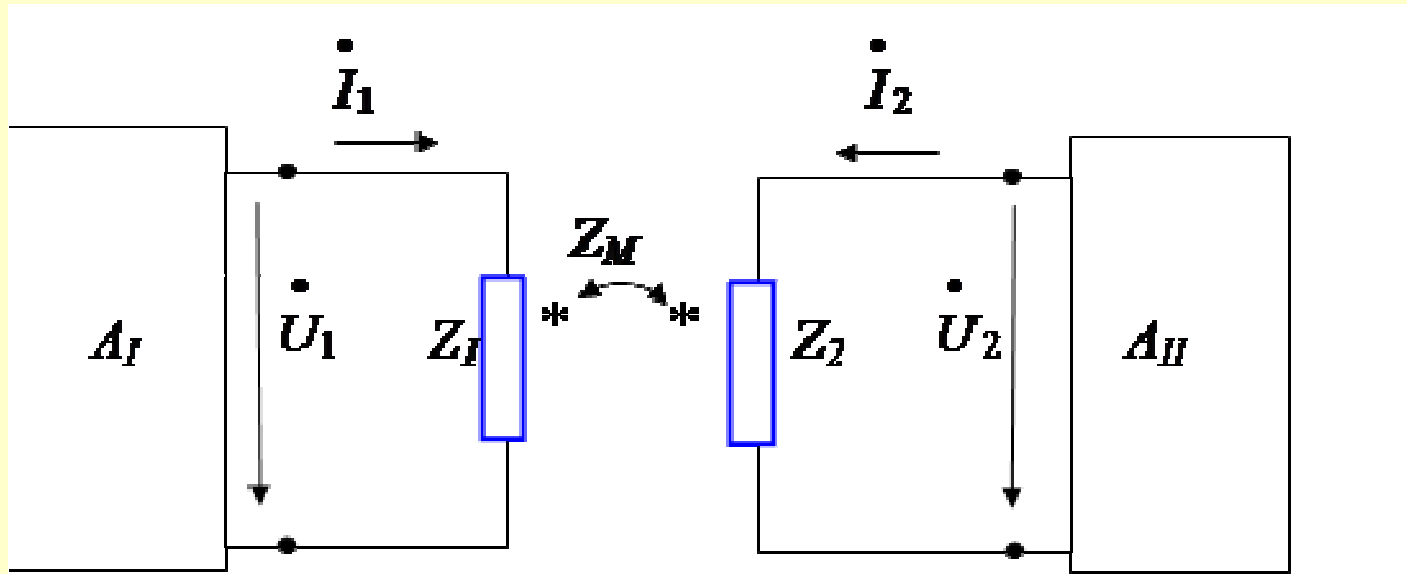
Векторна диаграма на натоварен трансформатор

$$\begin{aligned} \dot{I}_1 j\omega M &= \dot{I}_2 R_2 + \dot{I}_2 j\omega L_2 \\ &+ \dot{I}_2 R_T + \dot{I}_2 j\omega L_T \end{aligned}$$

$$0 = \dot{I}_2 R_2 + \dot{I}_2 j\omega L_2 + \dot{I}_2 R_T + \dot{I}_2 j\omega L_T - \dot{I}_1 j\omega M$$



Предаване на мощност по индуктивен път



$$\dot{I}_1 = I_1 e^{j\psi_1}$$

$$\dot{U}_{M1} = \dot{I}_2 Z_M = \dot{I}_2 j\omega M$$

$$\dot{S}_{M1} = \dot{U}_{M1} \dot{I}_1^*$$

$$\dot{I}_2 = I_2 e^{j\psi_2}$$

$$\dot{U}_{M2} = \dot{I}_1 Z_M = \dot{I}_1 j\omega M$$

$$\dot{S}_{M2} = \dot{U}_{M2} \dot{I}_2^*$$

Предаване на мощност по индуктивен път

За първия елемент

$$\begin{aligned} \bullet \quad \dot{S}_{M_1} &= \dot{U}_{M_1} I_1^* = Z_M I_2 I_1^* = j\omega M \cdot I_2 e^{j\psi_2} \cdot I_1 e^{-j\psi_1} = \\ &e^{j90} \omega M \cdot I_2 e^{j\psi_2} \cdot I_1 e^{-j\psi_1} = \omega M \cdot I_2 I_1 e^{(\psi_2 - j\psi_1 + 90)} \end{aligned}$$

$$\bullet \quad \Rightarrow \dot{S}_{M_1} = P_{M_1} + jQ_{M_1} = \omega M \cdot I_1 I_2 [\cos(\psi_2 - \psi_1 + 90) + j \sin(\psi_2 - \psi_1 + 90)]$$

За втория елемент

$$\begin{aligned} \bullet \quad \dot{S}_{M_2} &= \dot{U}_{M_2} I_2^* = Z_M I_1 I_2^* = j\omega M \cdot I_1 e^{j\psi_1} \cdot I_2 e^{-j\psi_2} = \\ &e^{j90} \omega M \cdot I_1 e^{j\psi_1} \cdot I_2 e^{-j\psi_2} = \omega M \cdot I_1 I_2 e^{(\psi_1 - j\psi_2 + 90)} \end{aligned}$$


$$\bullet \quad \Rightarrow \dot{S}_{M_2} = P_{M_2} + jQ_{M_2} = \omega M \cdot I_1 I_2 [\cos(\psi_1 - \psi_2 + 90) + j \sin(\psi_1 - \psi_2 + 90)]$$

Предаване на мощност по индуктивен път

- $\dot{S}_{M_1} = P_{M_1} + jQ_{M_1} = \omega M . I_1 I_2 [\cos(\psi_2 - \psi_1 + 90) + j \sin(\psi_2 - \psi_1 + 90)]$

- $\dot{S}_{M_2} = P_{M_2} + jQ_{M_2} = \omega M . I_1 I_2 [\cos(\psi_1 - \psi_2 + 90) + j \sin(\psi_1 - \psi_2 + 90)]$


$$\sin(\alpha + 90) = \cos \alpha \quad \cos(\alpha + 90) = -\sin \alpha$$



- $\dot{S}_{M_1} = -\omega M . I_1 I_2 \sin(\psi_2 - \psi_1) + j\omega M . I_1 I_2 \cos(\psi_2 - \psi_1)$

- $\dot{S}_{M_2} = -\omega M . I_1 I_2 \sin(\psi_1 - \psi_2) + j\omega M . I_1 I_2 \cos(\psi_1 - \psi_2)$

$$\cos(-\alpha) = \cos \alpha; \quad \sin(-\alpha + 90) = -\sin \alpha$$


$$P_{M_1} = -P_{M_2}$$

$$Q_{M_1} = Q_{M_2}$$

Правило:

при **еднакво** ориентирани спрямо едноименните изводи токове

Ако $P_{M1} = \text{Re}[\dot{S}_{M1}] > 0$ то клон 1 прехвърля енергия към клон 2,

Ако $P_{M1} = \text{Re}[\dot{S}_{M1}] < 0$ то клон 1 приема енергия от клон 2.

при **различно** ориентирани спрямо едноименните изводи токове

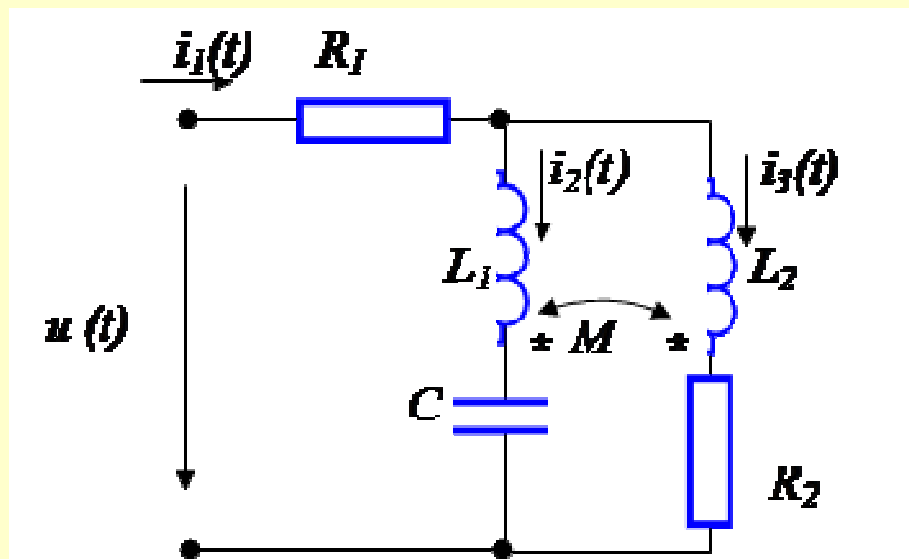
Ако $P_{M1} = \text{Re}[\dot{S}_{M1}] > 0$ то клон 1 приема енергия от клон 2,

Ако $P_{M1} = \text{Re}[\dot{S}_{M1}] < 0$ то клон 1 прехвърля енергия към клон 2.

Пример:

Определяне на мощност, предавана по индуктивен път

Да се определи мощността, предавана по индуктивен път за веригата:



$$u(t) = 200\sin(\omega t - 45^\circ) \text{ V}$$

$$f = 160 \text{ Hz},$$

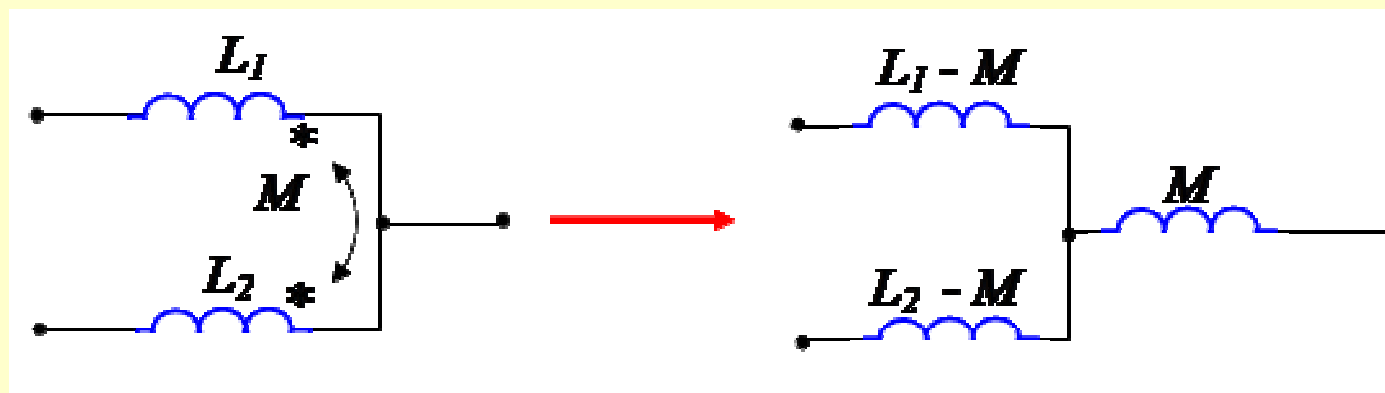
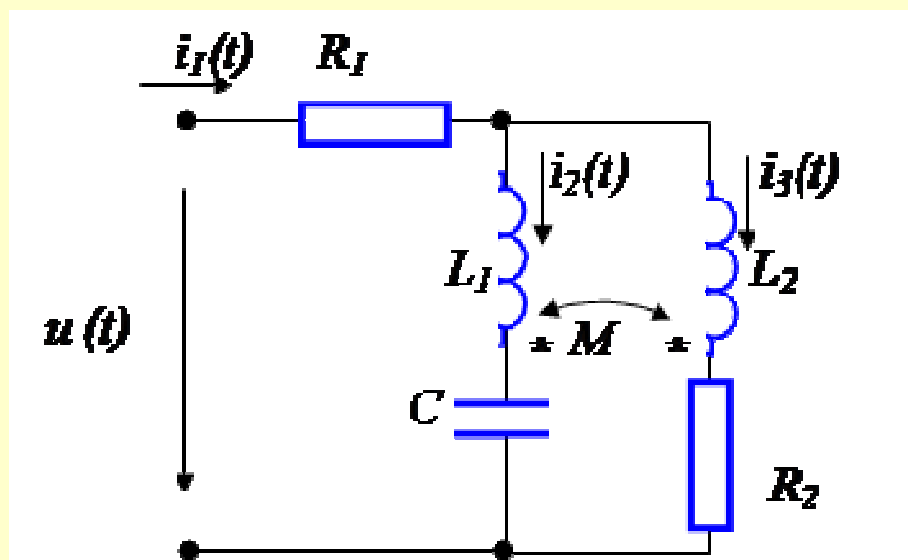
$$L_2 = 20 \text{ mH},$$

$$L_1 = M = 10 \text{ mH},$$

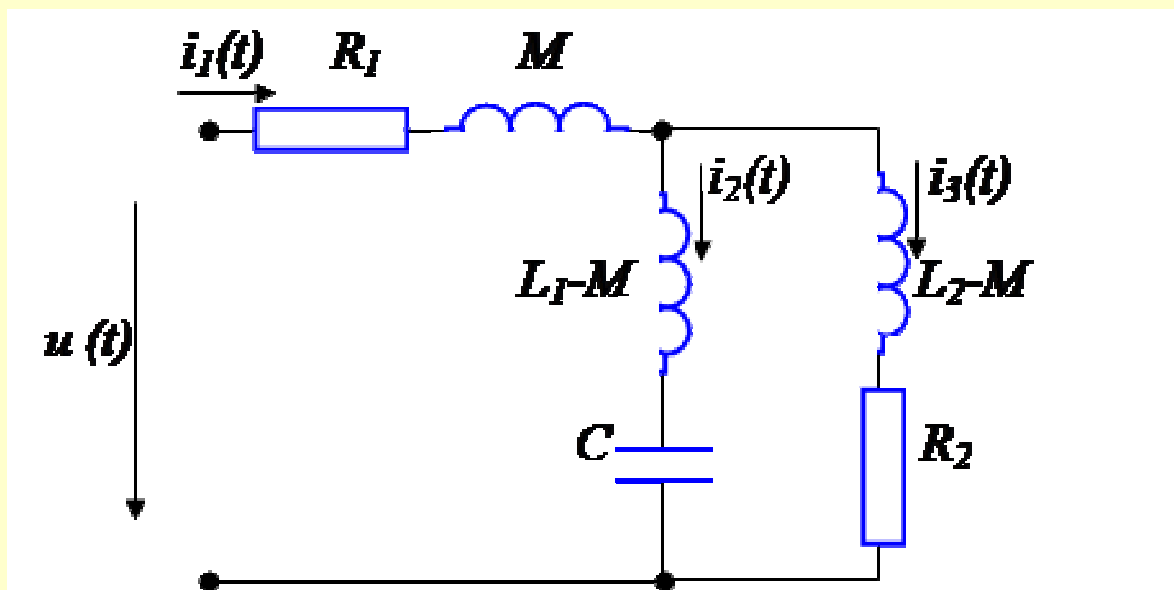
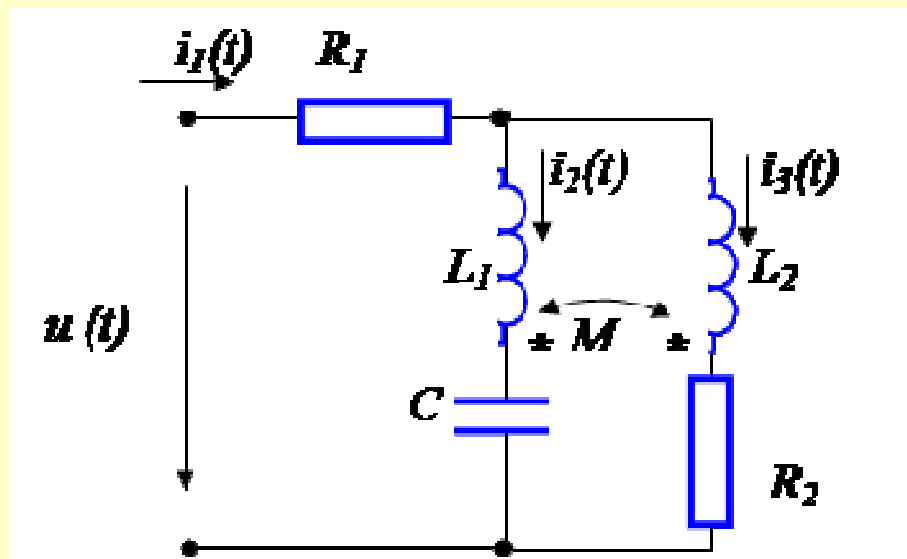
$$C = 50 \text{ } \mu\text{F}$$

$$R_1 = R_2 = 10 \text{ } \Omega$$

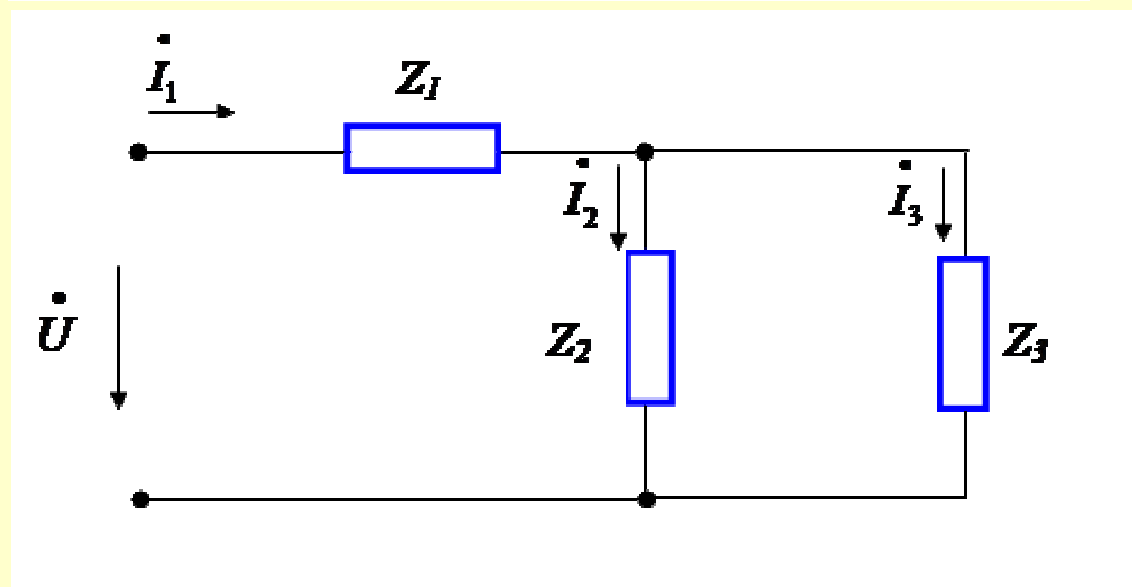
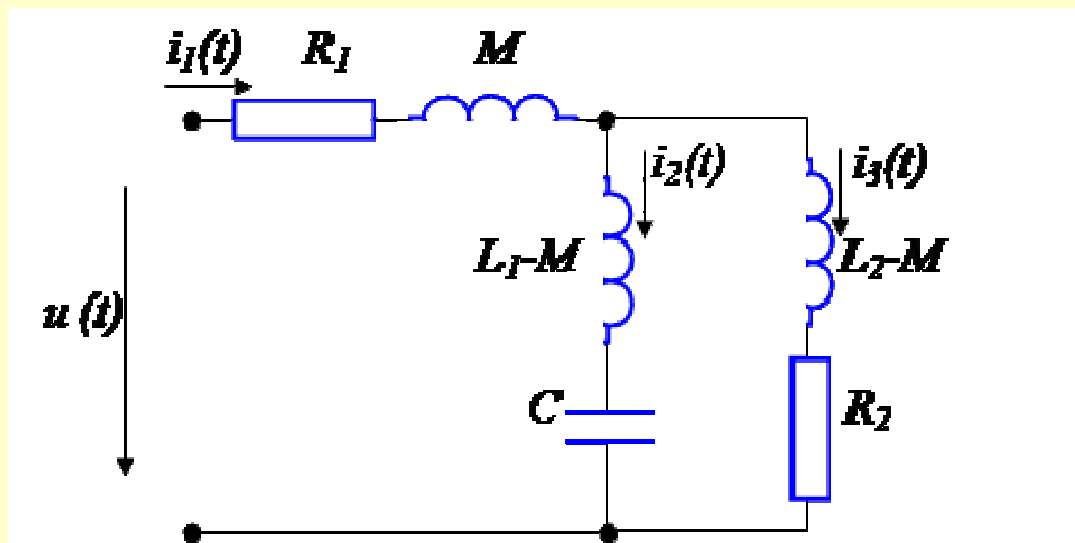
Определяне на мощност, предавана по индуктивен път



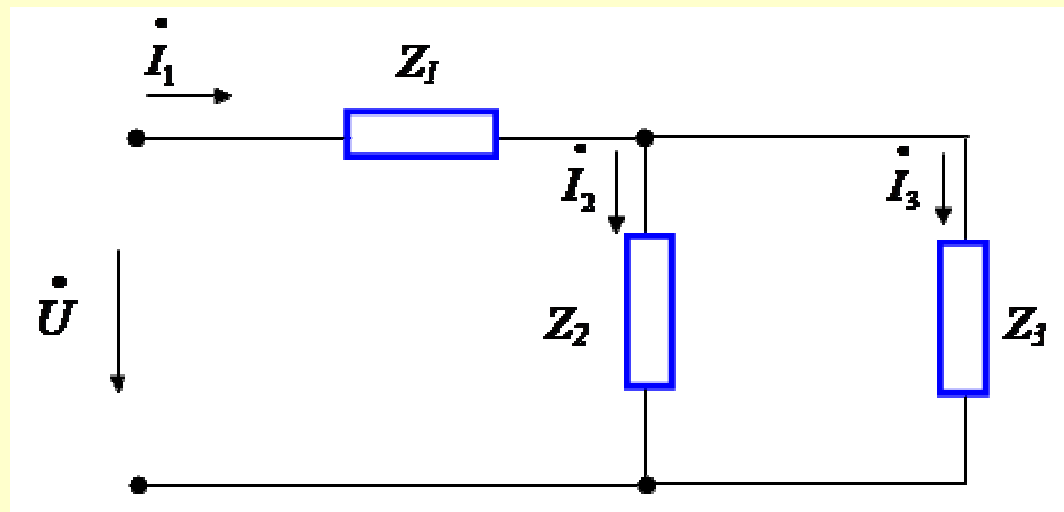
Определяне на мощност, предавана по индуктивен път



Определяне на мощност, предавана по индуктивен път

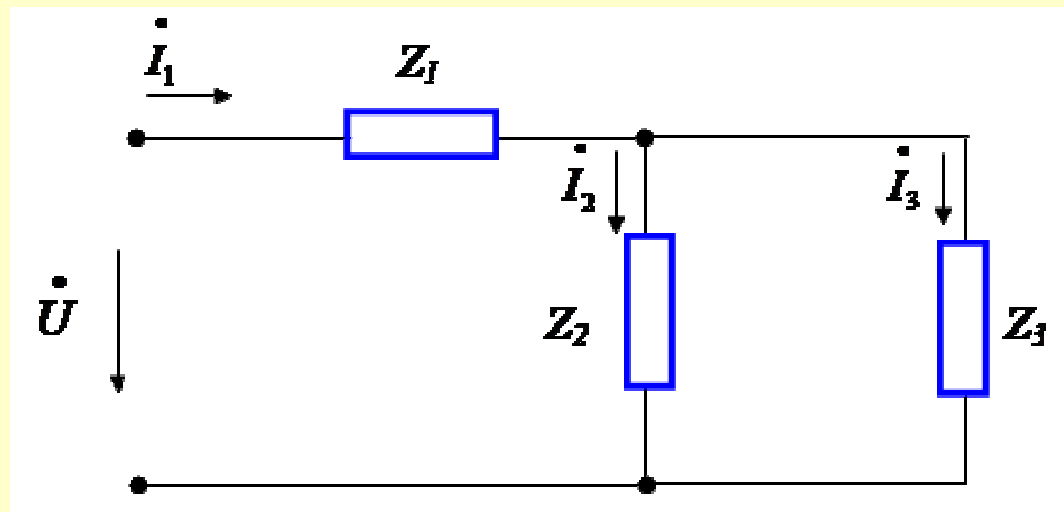


Определяне на мощност, предавана по индуктивен път



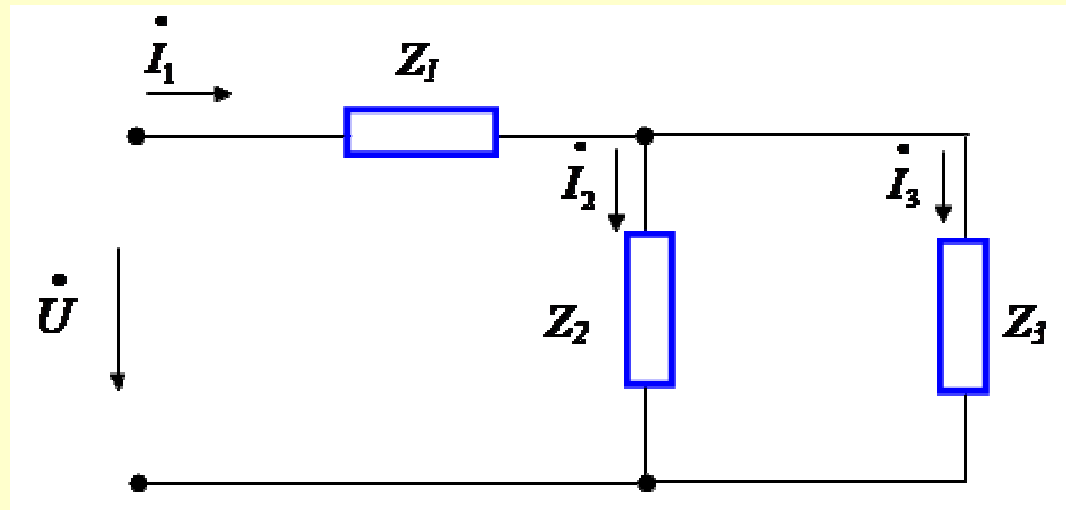
$$\begin{aligned} u(t) &= 200\sin(\omega t - 45^\circ) \text{ V} \\ f &= 160 \text{ Hz}, \\ L_2 &= 20 \text{ mH}, \\ L_1 = M &= 10 \text{ mH}, \\ C &= 50 \text{ } \mu\text{F} \\ R_1 = R_2 &= 10 \text{ } \Omega \end{aligned}$$

Определяне на мощност, предавана по индуктивен път



$$\begin{aligned} u(t) &= 200\sin(\omega t - 45^\circ) \text{ V} \\ f &= 160 \text{ Hz}, \\ L_2 &= 20 \text{ mH}, \\ L_1 = M &= 10 \text{ mH}, \\ C &= 50 \text{ } \mu\text{F} \\ R_1 = R_2 &= 10 \text{ } \Omega \end{aligned}$$

Определяне на мощност, предавана по индуктивен път

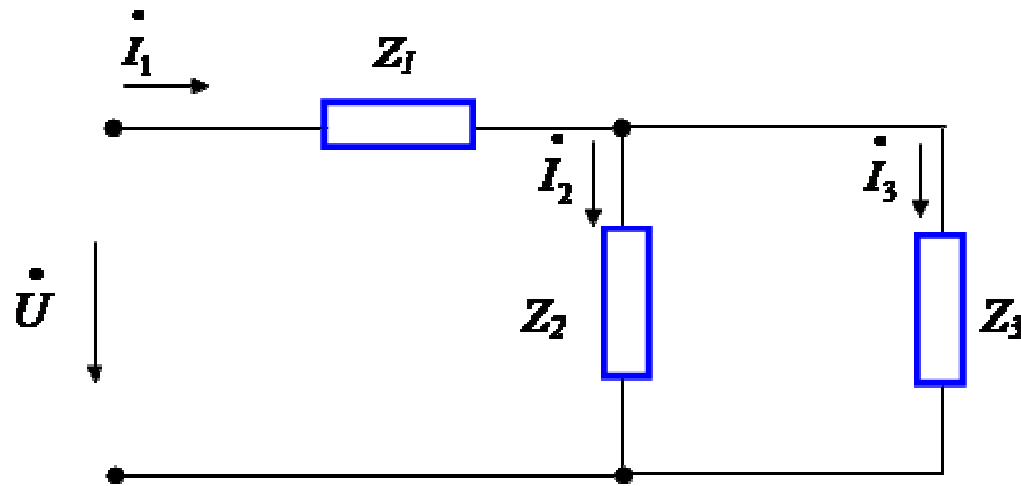


$$\dot{U} = (100 + j100)V$$

$$Z_1 = (10 + j10) \Omega$$

$$Z_2 = -j20 \Omega$$

$$Z_3 = 10 + j10 \Omega$$



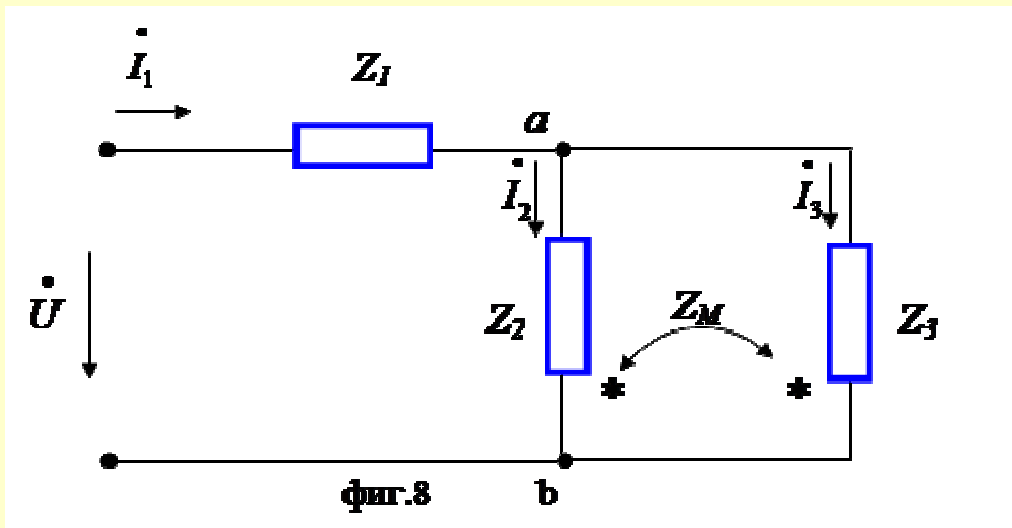
$$\dot{I}_1 = \frac{\dot{U}}{Z_{ek}} = \frac{100 + j100}{30 + j10} = \frac{10 + j10}{3 + j} = \frac{10(1 + j)(3 - j)}{(3 + j)(3 - j)} = \frac{10(3 + 3j - j + 1)}{10} = (4 + 2j)A$$

$$\dot{I}_3 = \dot{I}_1 \frac{Z_2}{Z_2 + Z_3} = (4 + 2j) \frac{-j20}{10 - j10} = \frac{-j2(4 + 2j)}{1 - j} =$$

$$\frac{2(2 - 4j)}{1 - j} = \frac{2(2 - 4j)(1 + j)}{(1 - j)(1 + j)} = \frac{2(2 - 4j)(1 + j)}{2} = (6 - 2j)A$$

$$\dot{I}_2 = \dot{I}_1 - \dot{I}_3 = 4 + 2j - 6 + 2j = (-2 + 4j)A$$

Определяне на мощност, предавана по индуктивен път



$$P_{M2} = 200W > 0$$

$$P_{M3} = -200W < 0$$

$$P_{M2} = \operatorname{Re}[U_{M2} I_2] = \operatorname{Re}[I_3 j\omega M \cdot I_2] = \operatorname{Re}[(6 - j2)j10 \cdot (-2 - j4)] =$$

$$= \operatorname{Re}[(20 + j60)(-2 - j4)] = 20 \cdot (-2) + 4 \cdot 60 = -40 + 240 = 200W$$

$$P_{M3} = \operatorname{Re}[U_{M3} I_3] = \operatorname{Re}[I_2 j\omega M \cdot I_3] = \operatorname{Re}[(-2 + j4)j10 \cdot (6 + j2)] =$$

$$= \operatorname{Re}[(-40 - j20)(6 + j2)] = -40 \cdot 6 + 2 \cdot 20 = -240 + 40 = -200W$$

Следователно енергията се предава от клон «2» към клон «3»