



TOSHKENT IRRIGATSIYA VA QISHLOQ
XO'JALIGINI MEXANIZATSIYALASH
MUHANDISLARI INSTITUTI



FAN

**Elektrotexnika va Elektronika
asoslari**

MAVZU:

**O`zgarmas tok zanjirlarini
hisoblash**



Elektrotexnika va mexatronika
kafedrası o`qituvchisi



Cho`lliyev Ya`qubjon
Ergashovich

O`zgarmas tok zanjirlarini hisoblash

- Tokning issiqlik ta'siri - Joul-Lens qonunini ingliz fizigi **D. Joul** 1841 yili va rus akademigi **E. Lens** 1842 yilda ta'riflab berishgan. 1844 yil E. Lens elektromagnit inersiya qonunini bayon qilgan. Nemis olimi **G. Kirxgof** 1845 yilda elektr zanjirlarga oid ikkita muhim qonunga ta'rif bergan.

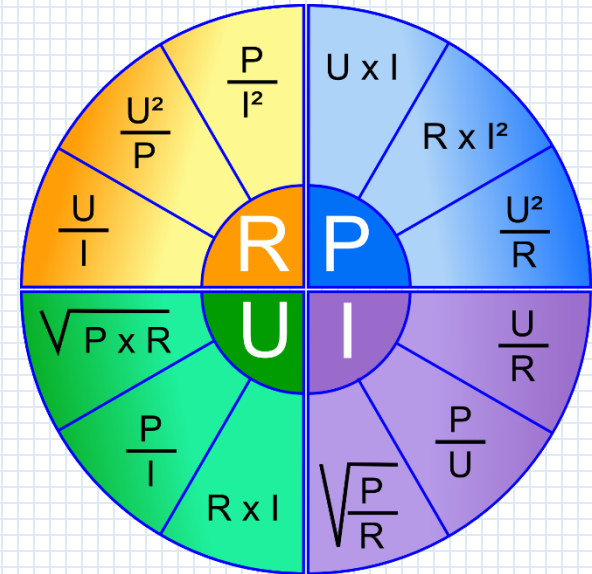
- **1-qoidasi:** Kirxgofning birinchi qoidasiga ko‘ra, o‘tkazgichlarning uchlari tutashgan nuqta (tugun) da uchrashuvchi tok kuchlarining algebraik yig‘indisi nolga teng:
- *Tugunga kelayotgan toklar musbat, undan chiqayotganlari manfiy deb hisoblanadi. Bu qoida elektr zaryadining saqlanish qonunini aks ettiradi.*

- **2- qoidasi:** Kirxgofning ikkinchi qoidasiga ko‘ra, o‘tkazgichlarning tarmoqlangan elektr zanjiridagi ixtiyoriy tanlangan har qanday berk konturda zanjirning tegishli qismlaridagi tok kuchlarining shu qismlar qarshiliklari R ga ko‘paytmalari yig‘indisi mazkur konturdagi EYUKlari yig‘indisiga teng.
- *Tarmoqlangan zanjirda kamida uchta o‘tkazgich tutashadigan har qanday nuqta tugun deb ataladi.*

O'zgarmas tok zanjirlari hisoblashga doir misol.

• 1-rasmda berilgan zanjirda:

- $E_1 = 12 \text{ V}$
- $E_2 = 24 \text{ V}$
- $R_1 = R_2 = 0,2 \text{ Om}$
- $R_3 = 20 \text{ Om}$.

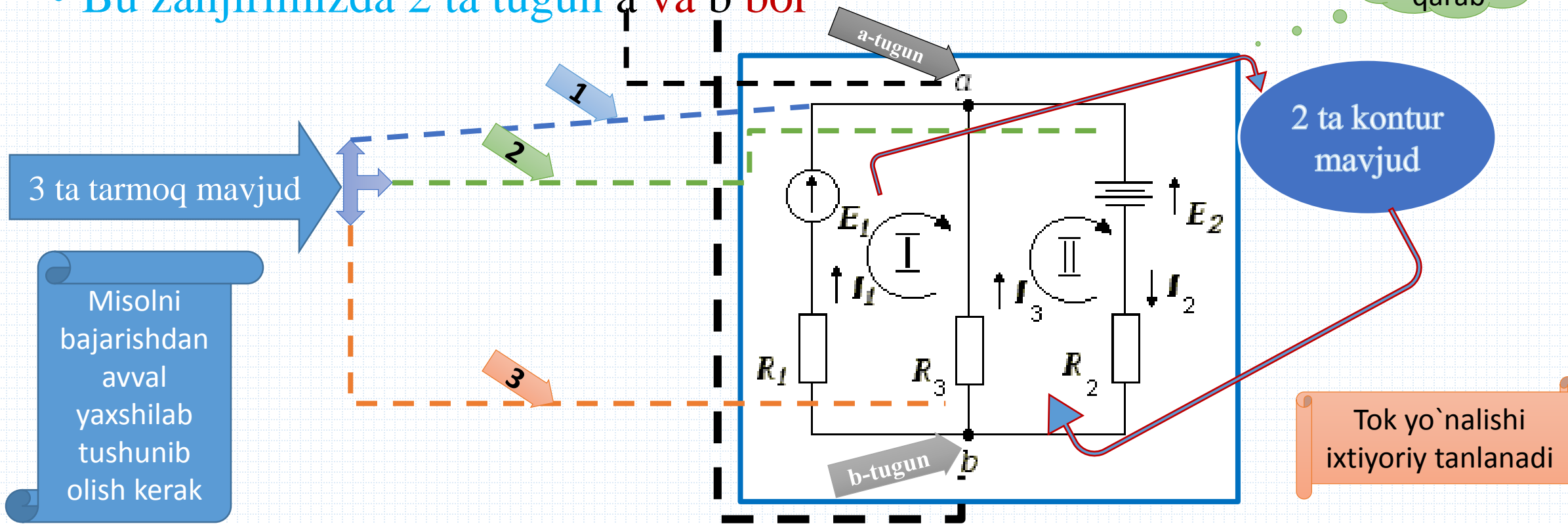


- Zanjirdagi I_1 , I_2 va I_3 toklar aniqlansin.
- Kirxgof tenglamalarini tuzish va ustma-ustlash usullari yordamida.

Eslab qoling

- Tokning yoʻnalishi bilan konturning yoʻnalishi soat mili yoʻnalishi
- boʻyicha boʻlsa va EYUK kontur yoʻnalishida tok hosil qilsa, tok va EYUK musbat, aks holda esa ular manfiy qiymatga ega boʻladi.
- Bu zanjirimizda 2 ta tugun a va b bor

Rangiga qarab



- **Masalaning yechilishi:**

- **1. Kirxgof tenglamalarini tuzish usuli.**

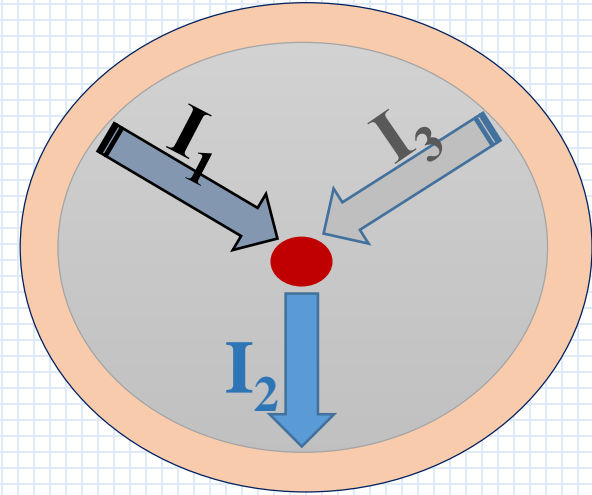
- a) zanjir tarmoqlaridagi toklarga ixtiyoriy yoʻnalish beriladi.

- b) berk konturlarda konturni aylanib chiqish yoʻnalishini ixtiyoriy tanlaymiz soat mili harakati yoʻnalishida;

- v) zanjirdagi tarmoqlar soni $m=3$, tugunlar soni $n=2$;

- g) zanjirning ixtiyoriy tuguni, masalan a tuguni uchun, Kirxgofning 1-qonuni asosida $n-1=2-1=1$ ta tenglama tuzamiz:

$$\bullet I_1 + I_3 - I_2 = 0$$



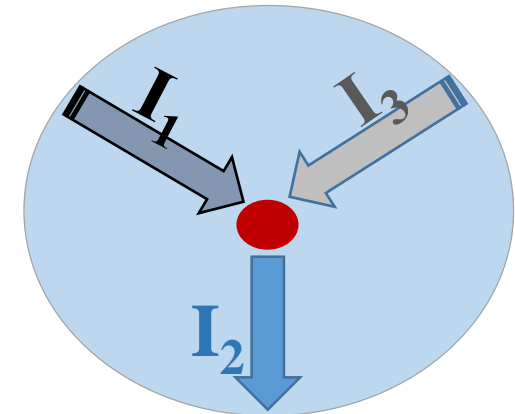
- d) zanjirning berk konturlari uchun Kirxgofning 2- qonuni asosida $m-(n-1)=3-(2-1)=2$ ta tenglama tuzamiz:

$$R_1 \cdot I_1 - R_3 \cdot I_3 = E_1$$

$$R_3 \cdot I_3 + R_2 \cdot I_2 = -E_2$$

- Tuzilgan $m=3$ ta tenglamalarni noma'lum toklarga nisbatan yechamiz. Bunda **Kramer** usulidan foydalanish mumkin.

$$\begin{cases} I_1 - I_2 + I_3 = 0 \\ R_1 I_1 + 0 \cdot I_2 - R_3 \cdot I_3 = E_1 \\ 0 \cdot I_1 + R_2 \cdot I_2 + R_3 \cdot I_3 = -E_2 \end{cases}$$



Kramer usuli

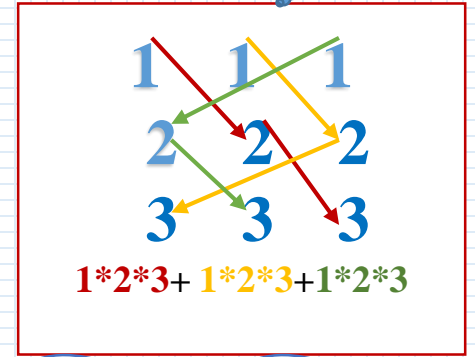
$$\Delta = \begin{vmatrix} 1 & -1 & 1 \\ 0,2 & 0 & -20 \\ 0 & 0,2 & 20 \end{vmatrix} = 4 + 4 + 0,04 = 8,04$$

$$\Delta_1 = \begin{vmatrix} 0 & -1 & 1 \\ 12 & 0 & -20 \\ -24 & 0,2 & 20 \end{vmatrix} = 240 - 480 + 2,4 = -237,6$$

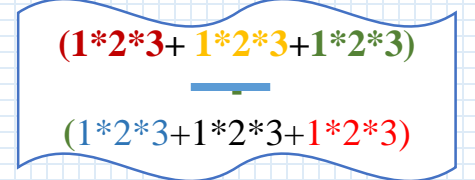
$$\Delta_2 = \begin{vmatrix} 1 & 0 & 1 \\ 0,2 & 12 & -20 \\ 0 & -24 & 20 \end{vmatrix} = 240 - 4,8 - 480 = -244,8$$

$$\Delta_3 = \begin{vmatrix} 1 & -1 & 0 \\ 0,2 & 0 & 12 \\ 0 & 0,2 & -24 \end{vmatrix} = -2,4 - 4,8 = -7,2$$

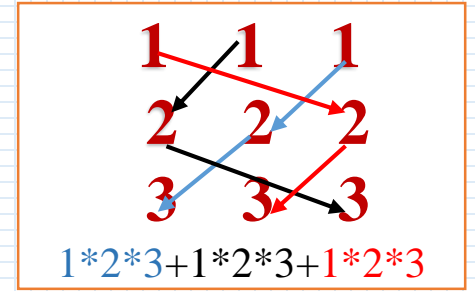
Yig'indisini



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Yig'indisini



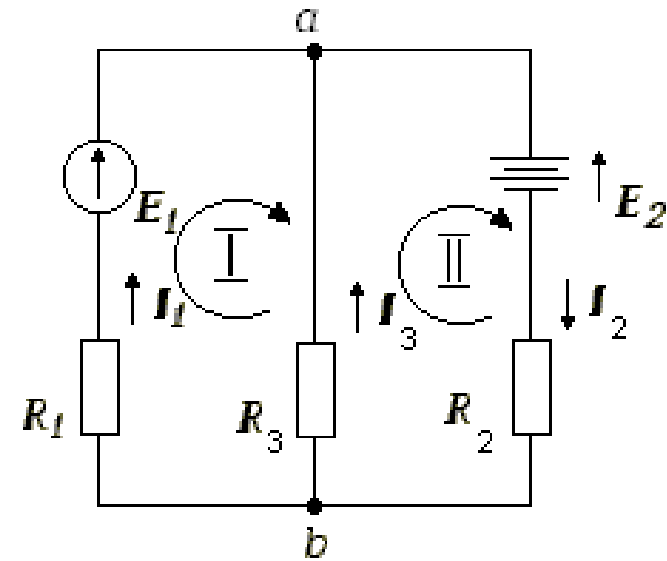
Natijani yozish kerak

Tarmoqlardagi toklar quyidagicha aniqlanadi:

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{-237,6}{8,04} = -29,55 \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-244,8}{8,04} = -30,45 \text{ A}$$

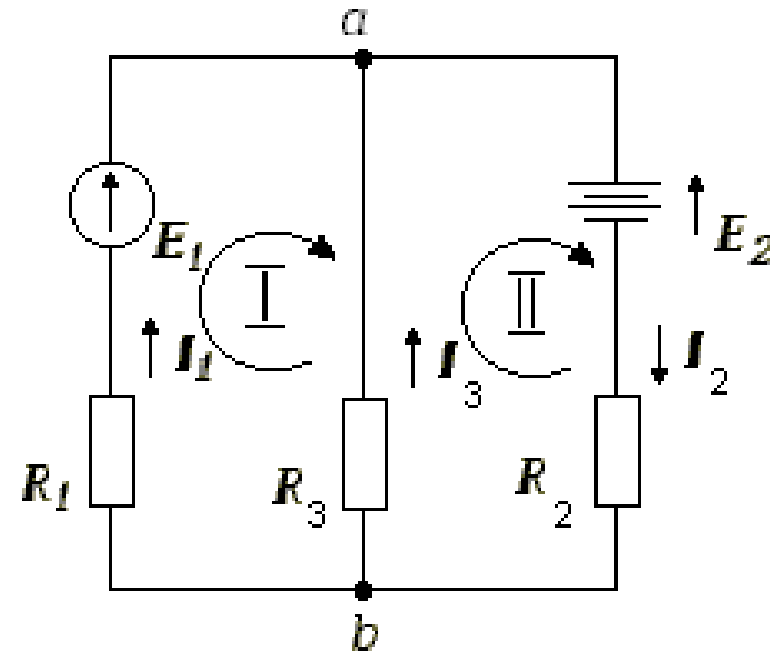
$$I_3 = \frac{\Delta_3}{\Delta} = \frac{-7,2}{8,04} = -0,895 \text{ A}$$



Toklarning aniqlangan qiymatlarini to'g'riligini tekshirishda a tugun uchun tuzilgan Kirxgofning 1- qonunidan foydalanish mumkin, ya'ni

$$I_1 - I_2 + I_3 = 0,$$

$$-29,55 + 30,45 - 0,895 = 0.$$



Ustma-ustlash usuli

1) faqat E_1 EYUK manбайдan tarmoqlarda hosil bo'ladigan qismaniy toklarni aniqlaymiz

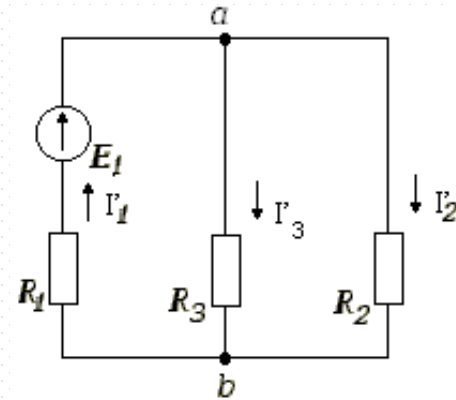
$$I'_1 = \frac{E_1}{R_1 + R_{23}} = \frac{12}{0,2 + 0,193} = \frac{12}{0,398} = 30,15A$$

Bunda:

$$R_{23} = \frac{R_2 \cdot R_3}{R_2 + R_3} = \frac{0,2 \cdot 20}{0,2 + 20} = \frac{4}{20,2} = 0,198 \text{ OM}$$

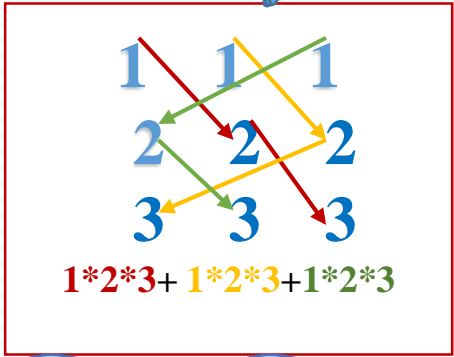
$$I'_2 = \frac{U'_{ab}}{R_2} = \frac{I'_1 \cdot R_{23}}{R_2} = \frac{R_{23}}{R_2} \cdot I'_1 = \frac{0,198}{0,2} \cdot 30,15 = 29,85A$$

$$I'_3 = \frac{U'_{ab}}{R_3} = \frac{I'_1 \cdot R_{23}}{R_3} = \frac{R_{23}}{R_3} \cdot I'_1 = \frac{0,198}{20} \cdot 30,15 = 0,290A$$



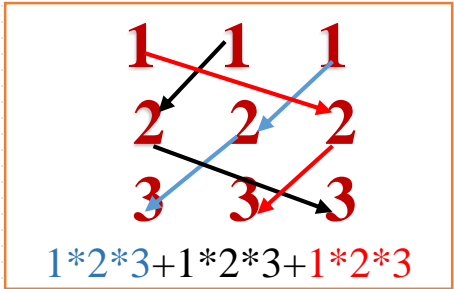
$E_2=0$ ga teng bo'lganda

Yig'indisini



$$\frac{(1*2*3 + 1*2*3 + 1*2*3)}{(1*2*3 + 1*2*3 + 1*2*3)}$$

Yig'indisini

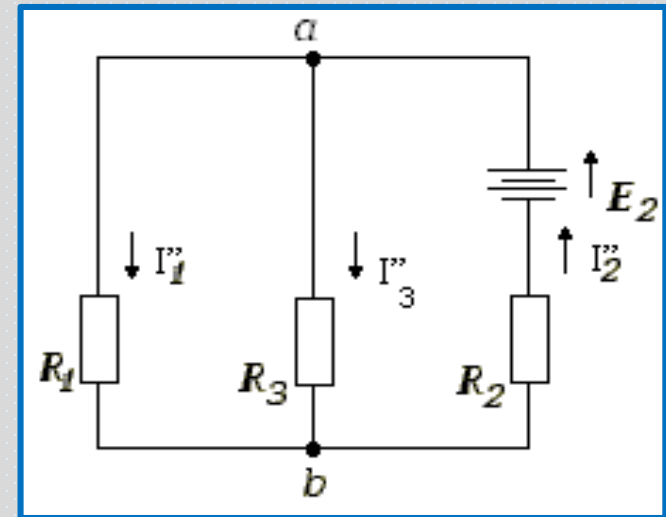
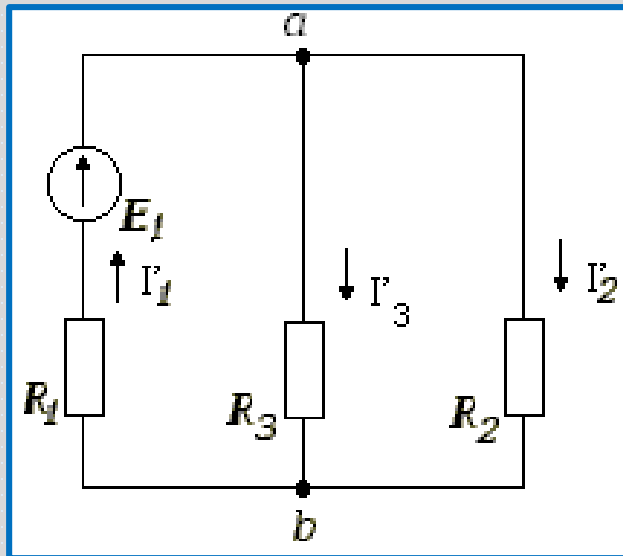
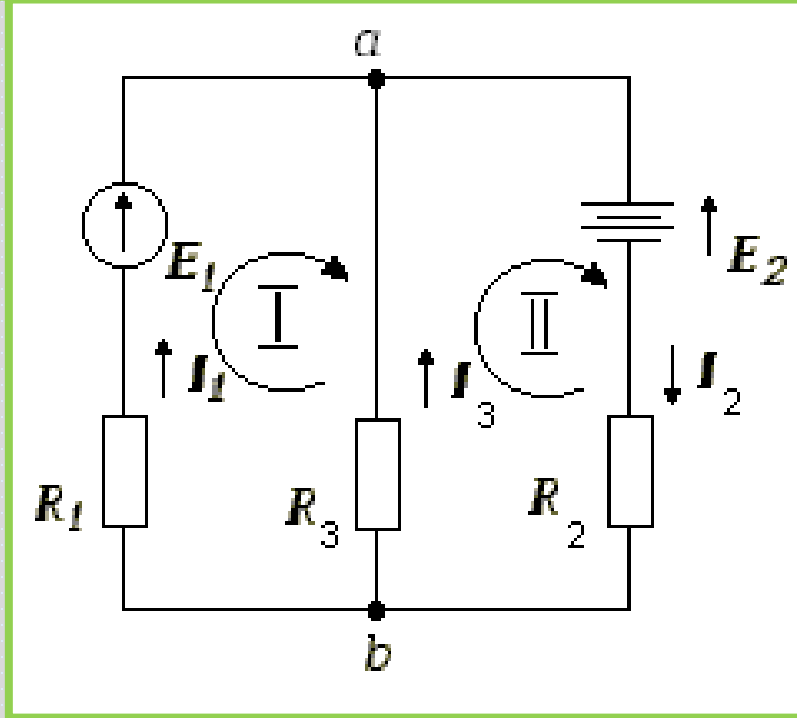


Natijani yozish kerak

EYUK manbaidan ta'minlanayotgan tarmoq

Berilgan zanjrn ustma-ustlash usulda bajarish uchun $E_2=0$ ga teng deb chizib olamiz

Berilgan zanjrn ustma-ustlash usulda bajarish uchun $E_1=0$ ga teng deb chizib olamiz



Toklar yo`nalishlari ixtiyoriy belgilanadi

YA gona EYUK manbaidan ta'minlanayotgan tarmoqlar

Rangiga qarab

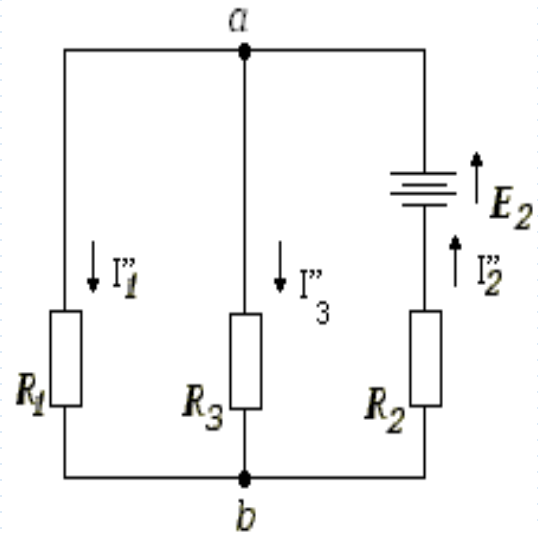
2) faqat E_2 EYUK manбайдan hosil bo'lgan qismaniy toklarni aniqlaymiz

$$I_2'' = \frac{E_2}{R_{13} + R_2} = \frac{24}{0,198 + 20} = \frac{14}{0,398} = 60,3 \text{ A}$$

$$R_{13} = \frac{R_1 \cdot R_3}{R_1 + R_3} = \frac{0,2 \cdot 20}{0,2 + 20} = \frac{4}{20,2} = 0,198 \text{ Ohm}$$

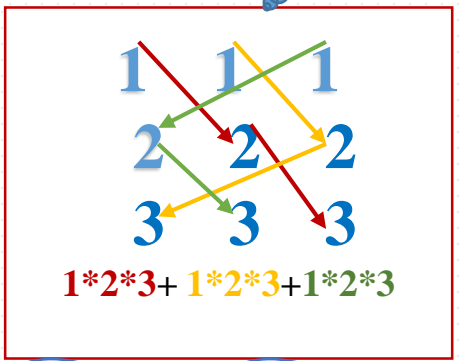
$$I_1'' = \frac{U_{ab}''}{R_1} = \frac{R_{13}}{R_1} \cdot I_2'' = \frac{0,198}{0,2} \cdot 60,3 = 59,7 \text{ A}$$

$$I_3'' = \frac{U_{ab}''}{R_3} = \frac{R_{13}}{R_3} \cdot I_2'' = \frac{0,198}{20} \cdot 60,3 = 0,597 \text{ A}$$



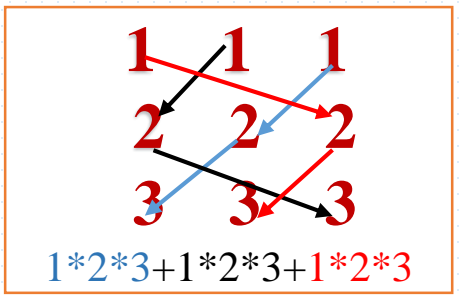
$E_1 = 0$ ga teng bo'lganda

Yig'indisini



$$\frac{(1*2*3 + 1*2*3 + 1*2*3)}{(1*2*3 + 1*2*3 + 1*2*3)}$$

Yig'indisini



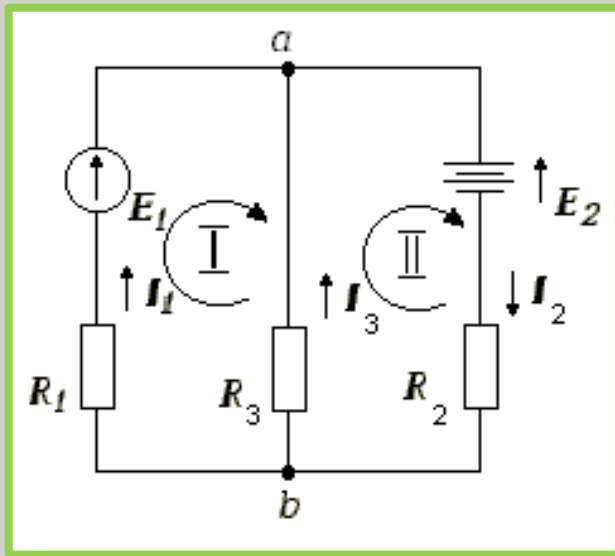
Natijani yozish kerak

3) har bir tarmoqdagi haqiqiy tokni shu tarmoq uchun topilgan qismaniy toklarni algebraik, qo‘shib aniqlaymiz, ya’ni:

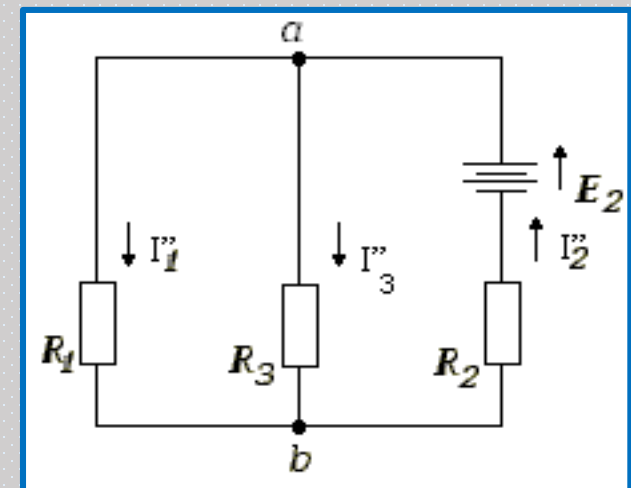
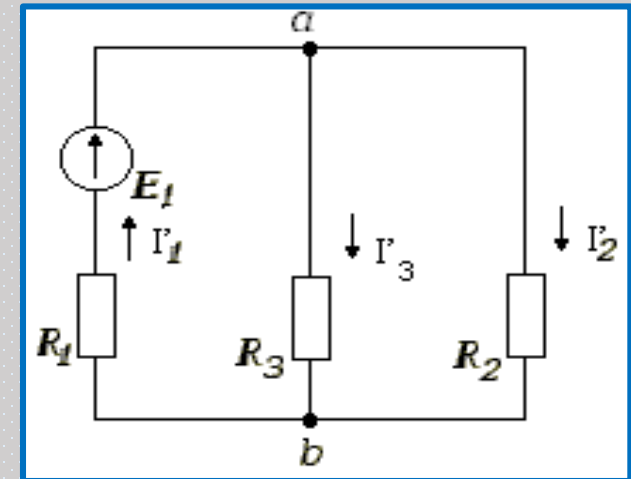
$$I_1 = I'_1 - I''_1 = 30,15 - 59,7 = -29,55 \text{ A},$$

$$I_2 = I'_2 - I''_2 = 29,85 - 60,3 = -30,45 \text{ A},$$

$$I_3 = -I'_3 - I''_3 = -0,296 - 0,597 = -0,893 \text{ A}.$$



Asosiy zanjirdagi tok yo`nalishi bilan bir xil bo`lgan toklar yo`nalishi musbat bo`ladi. Qarama-qarshi bo`lganlari manfiy bo`ladi



Savollar