



**TOSHKENT IRRIGATSIYA VA QISHLOQ XO‘JALIGINI  
MEXANIZATSIYALASHTIRISH MUHANDISLARI INSTITUTI**



**ELEKTROTEXNIKA VA MEXATRONIKA KAFEDRASI**

**ELEKTROTEXNIKA VA ELEKTRONIKA  
ASOSLARI FANI**

**MAVZU: UCH FAZALI ZANJIRLAR**

**O‘qituvchi:**

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## MAVZU REJASI

- I. Uch fazali sinusoidal EYUK ni hosil qilish.**
- II. Uch fazali zanjirlarni ulash usullari.**
- III. Manba va iste'molchilarni yulduz hamda uchburchak usulida ulash.**
- IV. Uch fazali zanjirlarda simmetrik va nosimmetrik rejimlar.**

**Ma’ruzaning maqsadi** – uch fazali sinusoidal EYUK hosil qilish prinsiplari, ish rejimlari va uch fazali zanjirlarni hisoblashni o’rganish.

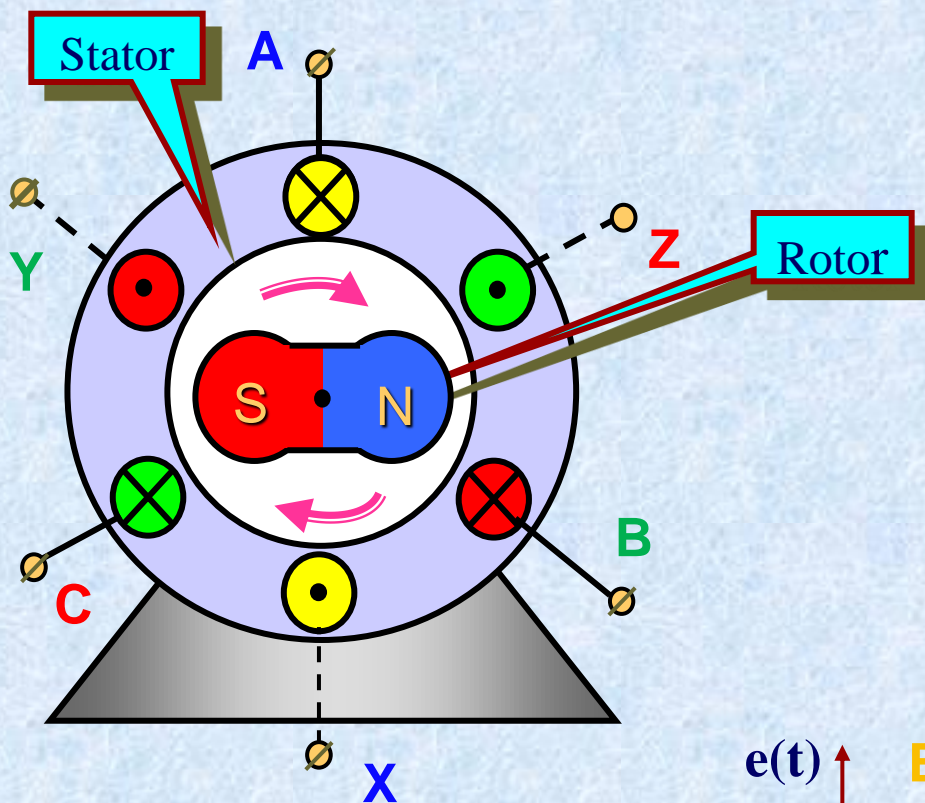
## **I. Uch fazali sinusoidal EYUK ni hosil qilish.**

Bir xil chastotali o'zaro  $120^0$  siljigan ( $120^0 + 120^0 + 120^0 = 360^0$  to'la bir davrga to'g'ri keladi) uchta EYUK li elektr zanjiri tizimidagi tok uch fazali tok deyiladi.

Rus olimi **M. O. Dolivo – Dobrovolskiy** tomonidan ixtiro qilingan (1889-1891) uch fazali tok generatori elektrotexnikaning fan va texnikada etakchi sohalaridan biriga aylanishiga sababchi bo'ldi.

Uch fazali tok bir fazali tokka nisbatan quyidagi afzalliklarga ega:

- 1) uch fazali mashinalar tuzilish jihatdan oddiy, yaxshi ish xarakteristikalariga ega, ishlashda ishonchli va arzon, hamda bir necha 10 Vatt dan 10 ming kVt va undan ham katta quvvatli uch fazali motorlar yaratish imkoni mavjud;
- 2) Uch fazali tok energiyasini uzatishda bir fazali tok energiyasini uzatishdagiga nisbatan taxminan 25% gacha rangli metall tejaladi;
- 3) Uch fazali to'rt simli tizimda bir-biridan  $\sqrt{3}$  ga farqlanuvchi ikkita kuchlanishdan foydalanish mumkin.



1.1 – rasm.

## Uch fazali EYUK lar:

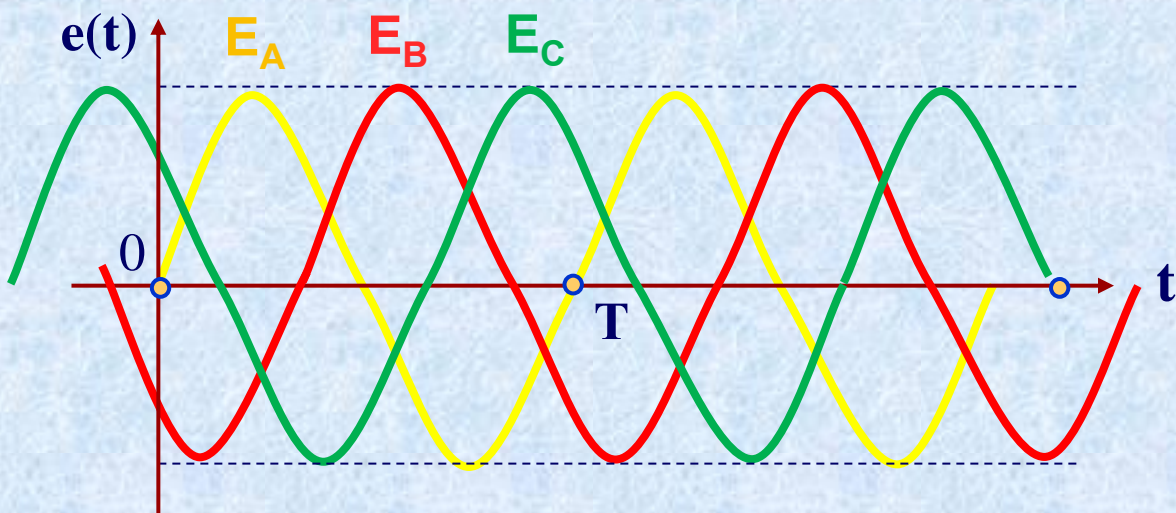
$$e_A = E_m \sin \omega t$$

$$e_B = E_m \sin(\omega t - 120^\circ)$$

$$e_C = E_m \sin(\omega t + 120^\circ)$$

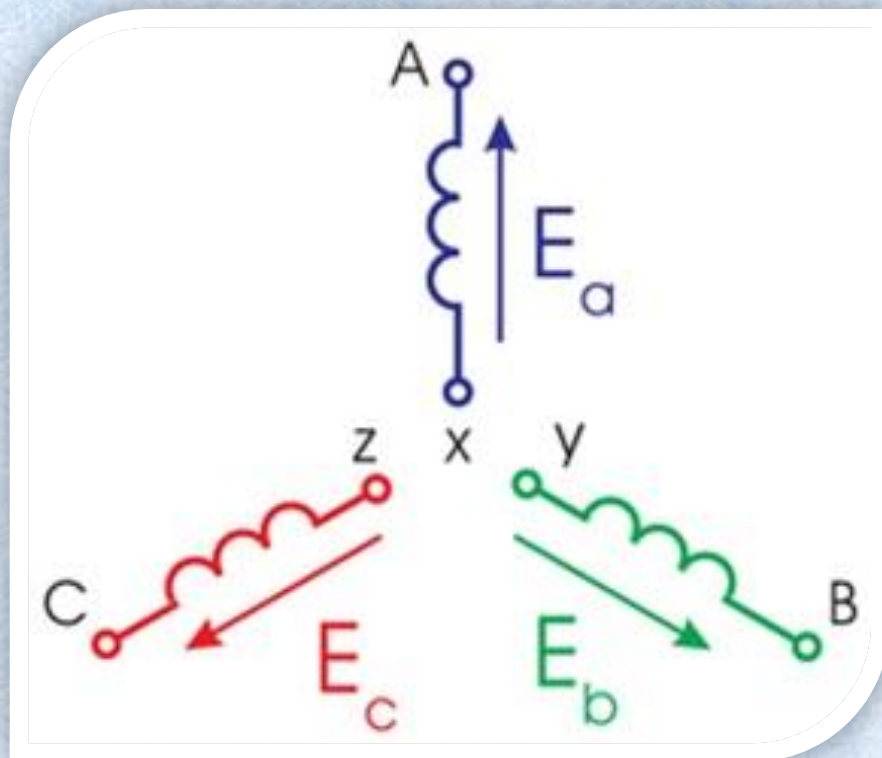
yoki

$$e_C = E_m \sin(\omega t - 240^\circ)$$

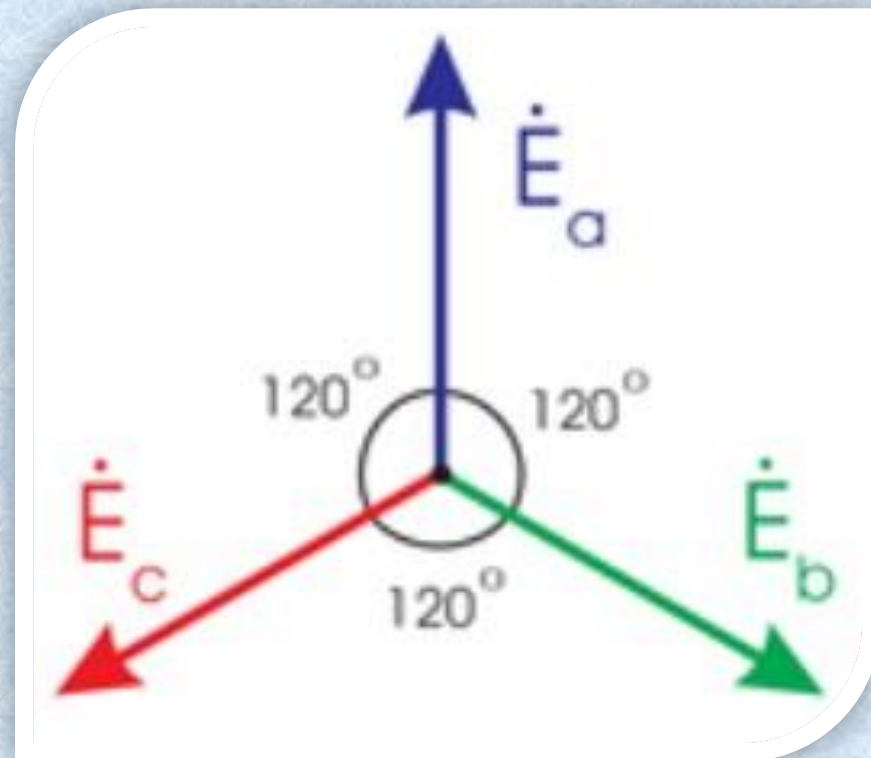




## Uch fazali elektr zanjiri fazalarining boshi va oxirlari



## Uch fazali elektr zanjirida EYUK lar vektor diagrammasi



1.3 – rasm.

## II. Uch fazali zanjirlarni ulash usullari.

Uch fazali zanjirlarda generatorlar, motorlar, transformatorlar chulg'amlari va iste'molchilar asosan yulduz va uchburchak sxemalari bo'yicha ulanadi.

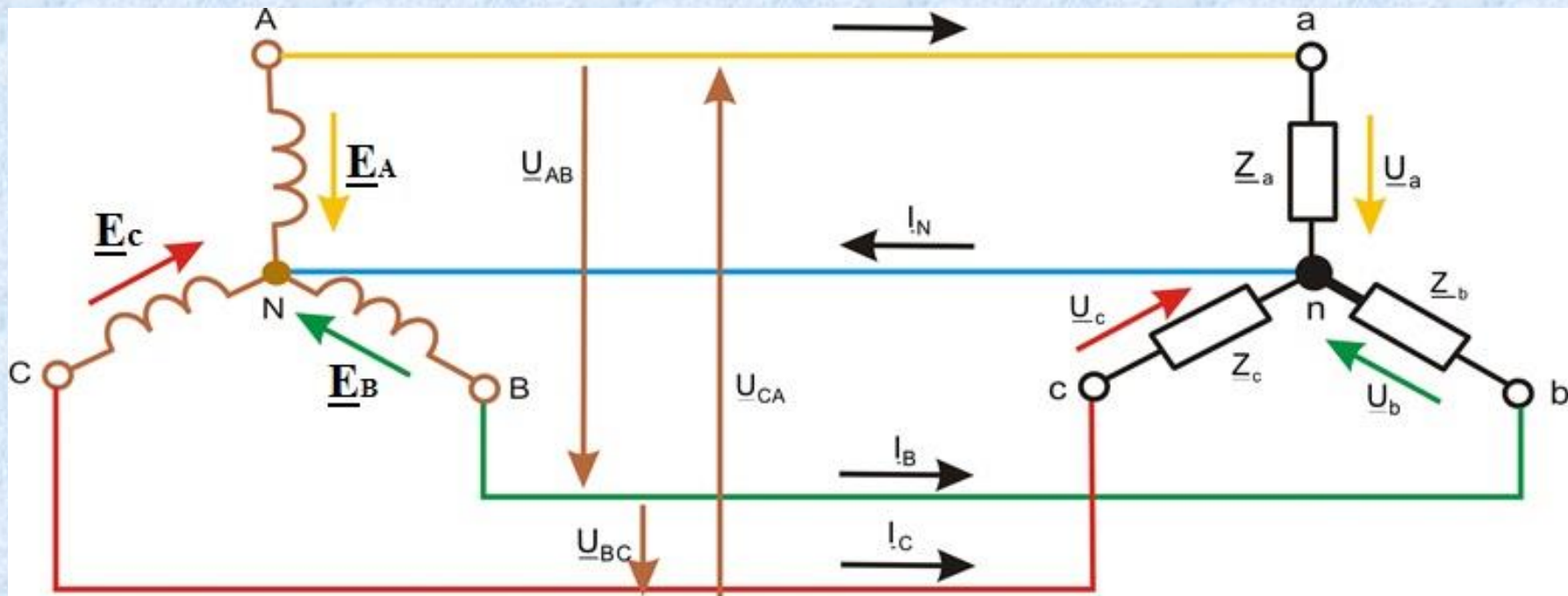
Agar generator chulg'amlarining uchlari o'zaro ulansa, u holda **yulduz** sxema hosil bo'ladi (1.4-rasm).

Faza chulg'amlarining uchlari o'zaro ulangan umumiy nuqta generator neytral nuqtasi deb ataladi va **N** harfi bilan belgilanadi.

Uch fazali zanjirda yuklama ham yulduz sxemasida ulanishi mumkin. Iste'molchilar fazalari o'zaro ulangan umumiy nuqta iste'molchilar neytral nuqtasi **n**, uni generator neytral nuqtasi bilan ulab turuvchi **Nn** sim neytral sim deb ataladi (1.4-rasm).



## Uch fazali yulduz usulida ulangan elektr zanjiri



1.4-rasm

**Liniya kuchlanishlari**      **Faza kuchlanishlari**      **Liniya toklari**      **Faza toklari**

$$\underline{U}_{AB}, \underline{U}_{BC}, \underline{U}_{CA}$$

$$\underline{U}_A, \underline{U}_B, \underline{U}_C$$

$$\underline{I}_A, \underline{I}_B, \underline{I}_C$$

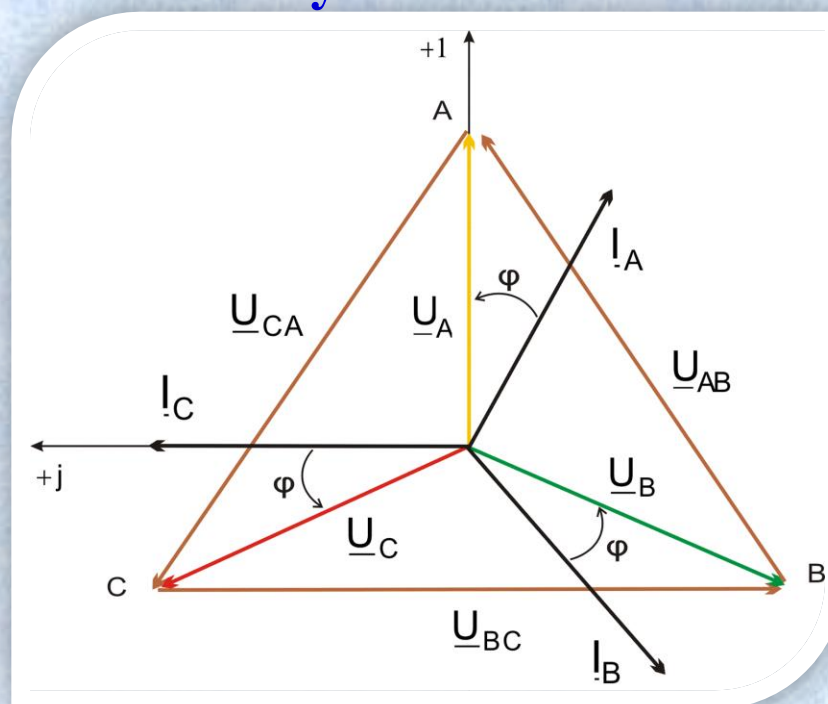
$$\underline{I}_A, \underline{I}_B, \underline{I}_C$$

$$\underline{U}_L = \sqrt{3} \underline{U}_f;$$

$$\underline{I}_{-L} = \underline{I}_{-f}$$

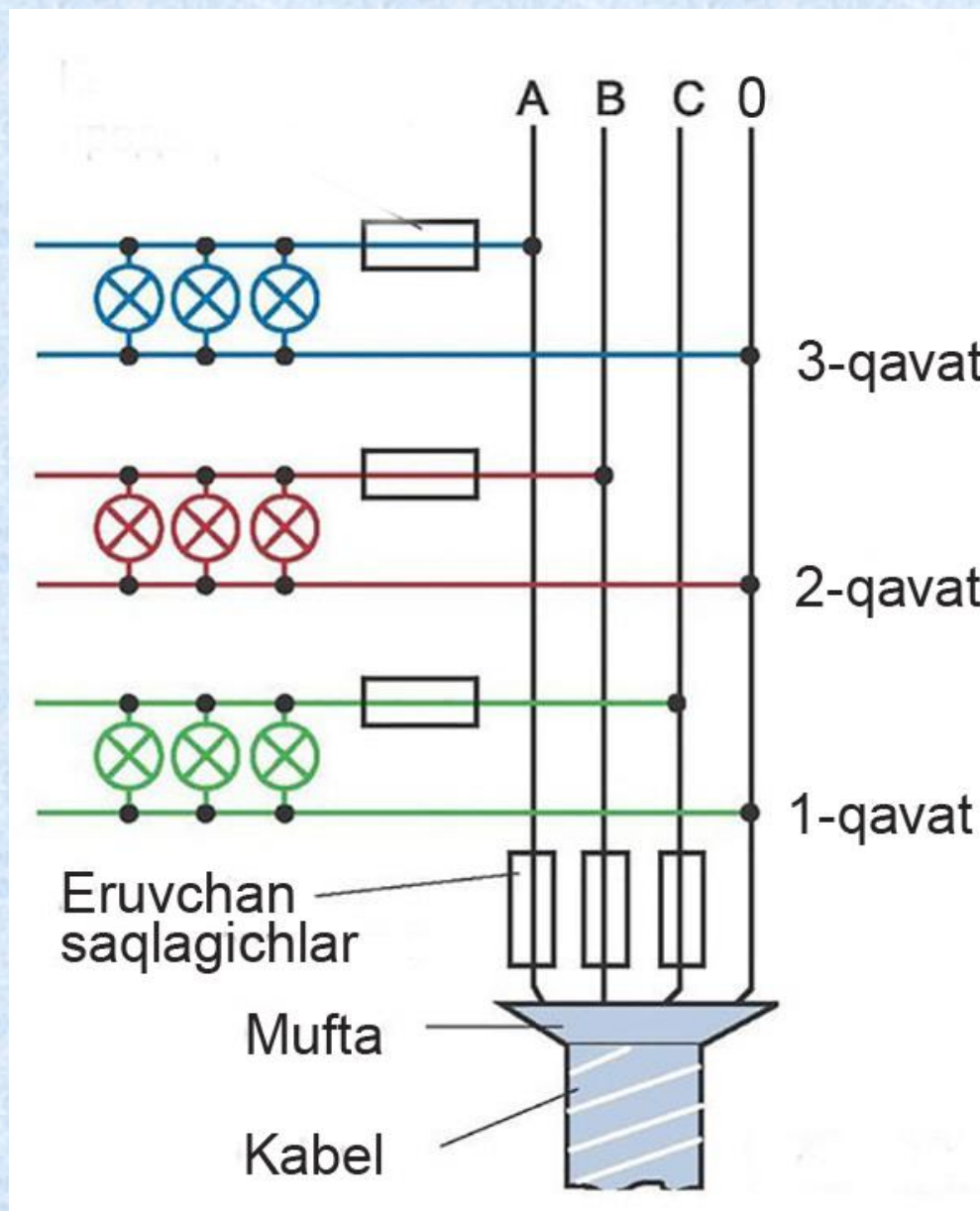
$$\underline{I}_N = \underline{I}_A + \underline{I}_B + \underline{I}_C$$

Generator va iste'molchi mos fazalarini ulovchi  $Ax$ ,  $By$ ,  $Cz$  simlar liniya simlari, ulardagi  $I_A$ ,  $I_B$ ,  $I_C$  toklar esa liniya toklari deb ataladi. Liniya simlari orasidagi  $U_{AB}$ ,  $U_{BC}$ ,  $U_{CA}$  kuchlanishlar liniya kuchlanishlari deb ataladi. Liniya simlaridagi toklarning musbat yo'nalishi generator (manba)dan yuklama (iste'molchi)ga tomon, neytral simdagi tokning musbat yo'nalishi esa yuklamadan generator tomon olinadi. Generator faza chulg'amlaridan yoki iste'molchilardan o'tayotgan toklar faza toklari deb ataladi. 1.4 va 1.5-rasmdan ko'rinib turganidek, yulduz sxemada liniya toklari faza toklariga teng bo'ladi.



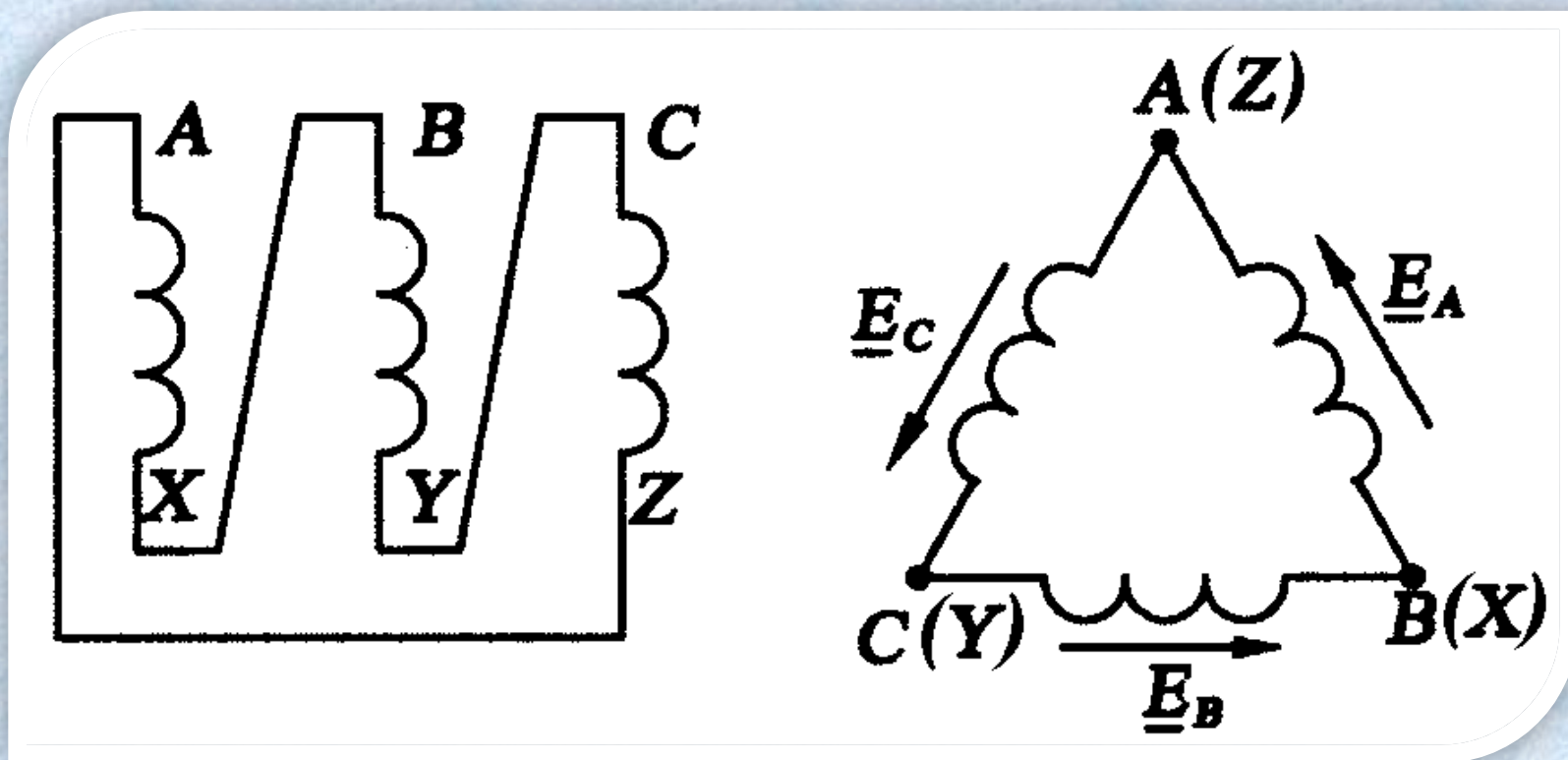
1.5-rasm

# Elektr zanjirlarida iste'molchilarning yulduz usulida ulanishi



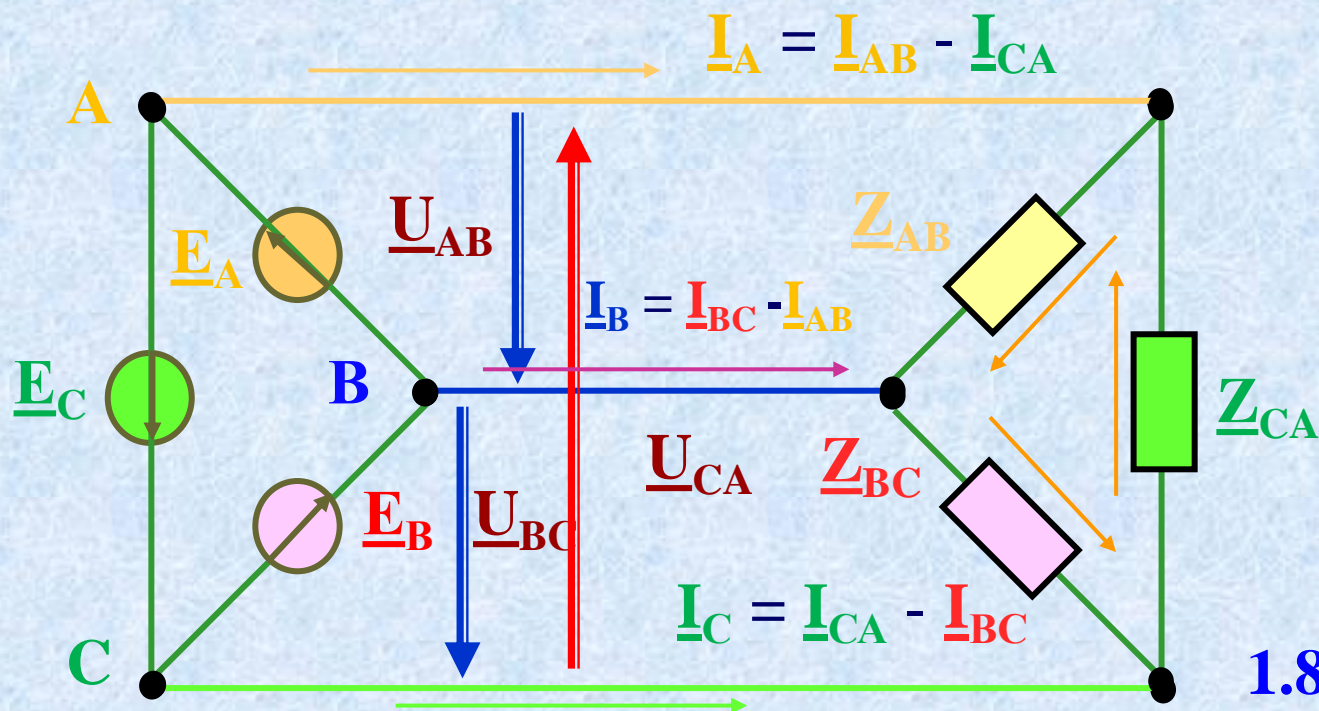
1.6-rasm

Uch fazali generator faza chulg'amlarini **uchburchak** sxemasi bo'yicha ulash uchun ular o'zaro ketma-ket ulanadi (1.7 a, b-rasm). Uchburchak ulanganda chulg'amlar berk kontur hosil qilsada, konturdagi tok nolga teng, chunki EYUK lar geometrik yig'indisi nolga teng bo'ladi.



1.7 a, b- rasm.

## Uch fazali uchburchak usulida ulangan elektr zanjiri



1.8 - rasm.

**Liniya**

**kuchlanishlari**

**Faza kuchlanishlari**

**Liniya toklari**

**Faza toklari**

$$\underline{U}_{AB}, \underline{U}_{BC}, \underline{U}_{CA}$$

$$\underline{U}_{AB}, \underline{U}_{BC}, \underline{U}_{CA}$$

$$\underline{I}_A, \underline{I}_B, \underline{I}_C$$

$$\underline{I}_{AB}, \underline{I}_{BC}, \underline{I}_{CA}$$

$$\underline{U}_L = \underline{U}_f;$$

$$\underline{I}_L = \sqrt{3} \underline{I}_f$$

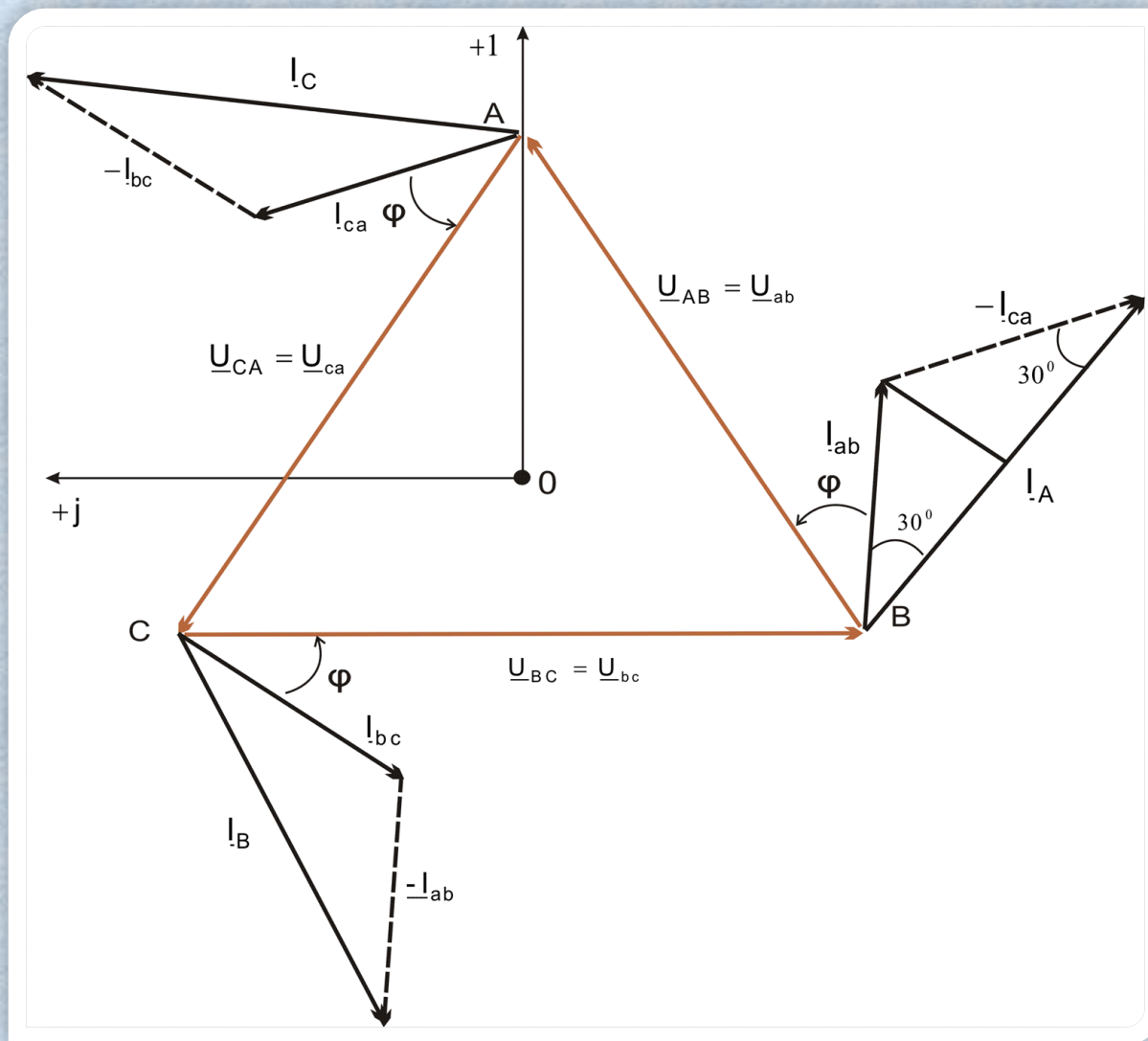
Generator chulg'amlari va iste'molchilar o'zaro uchburchak usulida ulanganda liniya kuchlanishlari faza kuchlanishlariga teng bo'ladi. Liniya toklari esa faza toklari orqali topiladi. Masalan, yuqorida keltirilgan (1.8-rasm) elektr zanjirining tok va kuchlanishlar vektor diagrammasini chizamiz. Berilgan zanjirni simmetrik (simmetrik uch fazali zanjirlar bo'yicha kenyingi slaydlarda tanishamiz) va uning faza qarshiliklari  $Z_{ab}=Z_{bc}=Z_{ca}=R$  deb hisoblaymiz. U holda vektor diagramma quyidagicha quriladi:

$$\text{a tugun uchun: } \underline{I}_A + \underline{I}_{ca} - \underline{I}_{ab} = 0; \quad \underline{I}_A = \underline{I}_{ab} - \underline{I}_{ca}$$

$$\text{b tugun uchun: } \underline{I}_B + \underline{I}_{ab} - \underline{I}_{bc} = 0; \quad \underline{I}_B = \underline{I}_{bc} - \underline{I}_{ab}$$

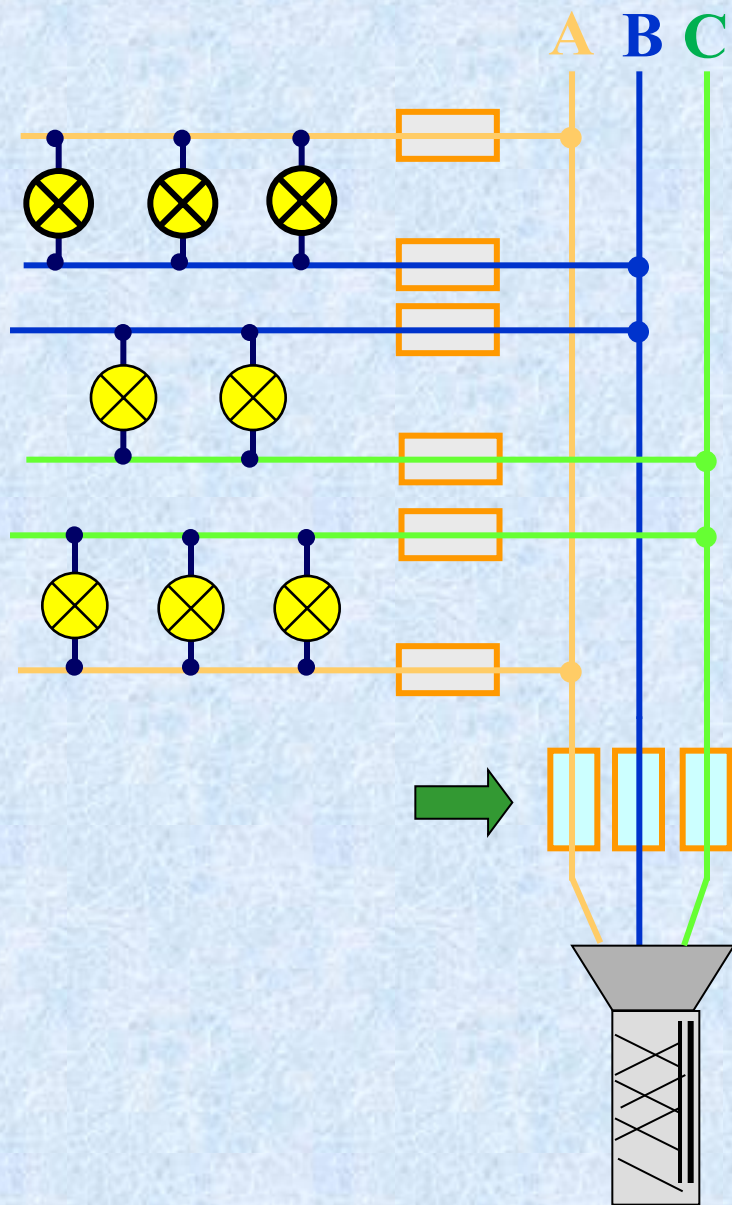
$$\text{c tugun uchun: } \underline{I}_C + \underline{I}_{bc} - \underline{I}_{ca} = 0; \quad \underline{I}_C = \underline{I}_{ca} - \underline{I}_{bc}$$

## Uch fazali uchburchak sxemada ulangan elektr zanjiri uchun tok va kuchlanishlar vektor diagrammasi



1.9 - rasm.

# Elektr zanjirlarida iste'molchilarning uchburchak usulida ulanishi



1.10-rasm



## IV. Uch fazali zanjirlarda simmetrik va nosimmetrik rejimlar.

Kompleks qarshiliklari o'zaro teng bo'lgan uch fazali yuklama simmetrik kuchlanish (EYUK)lar sistemasidan ta'minlanayotgan uch fazali zanjirning rejimi simmetrik rejim deb ataladi. Bunday zanjir tarmoqlaridan simmetrik toklar o'tadi.

### Uch fazali simmetrik elektr zanjirining asosiy xususiyatlari

$$\underline{E}_A + \underline{E}_B + \underline{E}_C = 0$$



$$e_A(t) + e_B(t) + e_C(t) = 0$$

$$\underline{E}_A = E_\Phi e^{-j0} = E_\Phi$$

$$\underline{E}_B = E_\Phi e^{-j\frac{2\pi}{3}} = E_\Phi e^{-j120^\circ} = E_\Phi \left(-\frac{1}{2} - j\frac{\sqrt{3}}{2}\right) = E_\Phi (-0,5 - j0,867)$$

$$\underline{E}_C = E_\Phi e^{j\frac{2\pi}{3}} = E_\Phi e^{j120^\circ} = E_\Phi \left(-\frac{1}{2} + j\frac{\sqrt{3}}{2}\right) = E_\Phi (-0,5 + j0,867)$$

Uch fazali zanjirlarda nosimmetrik rejimlar turli sabablarga ko'ra yuzaga kelishi mumkin: yuklama nosimmetrik bo'lganida, generator faza EYUK lari har xil bo'lganida, nosimmetrik (masalan, ikkita faza o'rtasida, faza bilan neytral sim o'rtasida) qisqa tutashishda, fazaning uzilib qolishi va h.k.

Nosimmetrik uch fazali zanjirlarni hisoblash bir fazali zanjirlarni hisoblashda foydalanilgan usullar yordamida amalga oshiriladi.

Iste'molchilar yulduz usulida ulanganda  $N$  va  $n$  tugunlar orasidagi kuchlanishni aniqlash formulasi:

$$\underline{U}_{Nn} = \frac{\underline{E}_A \underline{Y}_A + \underline{E}_B \underline{Y}_B + \underline{E}_C \underline{Y}_C}{\underline{Y}_A + \underline{Y}_B + \underline{Y}_C};$$

Bu erda  $\underline{Y}_A, \underline{Y}_B, \underline{Y}_C$  – o'tkazuvchanliklar:  $\underline{Y}_A = \frac{1}{\underline{Z}_A}; \underline{Y}_B = \frac{1}{\underline{Z}_B};$   
 $\underline{Y}_C = \frac{1}{\underline{Z}_C};$

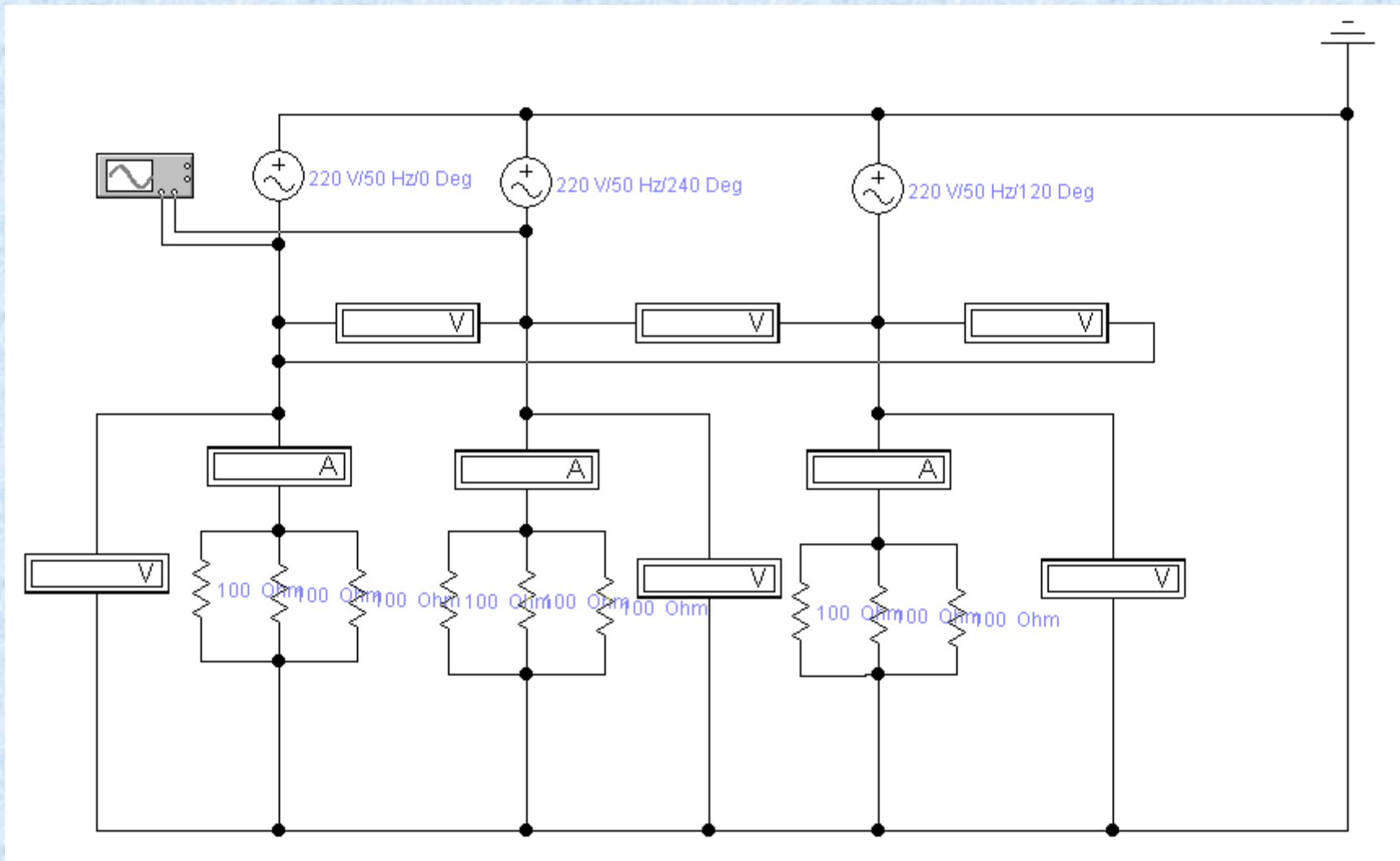
## SAVOL?

### BLITS – SO’ROV SAVOLLARI

№	Savol	Javob
1.	Qanday zanjirlar uch fazali deb ataladi?	
2.	Yulduz usulida liniya va faza kuchlanishlari qanday aniqlanadi?	
3.	Uch fazali sistema simmetrik yuklanganda faza va liniya kuchlanishlari nisbati qanday bo’ladi?	
4.	Qaysi hollarda uch fazali elektr zanjirlarning uch simli va to’rt simli sxemalari ishlatiladi?	
5.	Nol (nN) simning vazifasi nimadan iborat?	

## UYGA TOPSHIRIQ

Berilgan zanjirni EWB visual dasturida yig'ib iste'molchilarning simmetrik va nosimmetrik rejimlarida natijalar olib ko'ring.



1.11-rasm. Yulduz usulida ulangan uch fazali elektr zanjir sxemasi.

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E'TIBORLARINGIZ  
UCHUN RAHMAT!