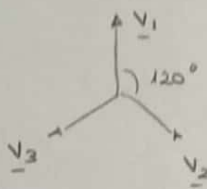
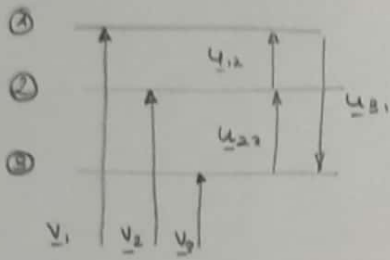


TRIFASIKA



$$\underline{V}_2 = \underline{V}_1 \cdot 1 \angle -120^\circ$$

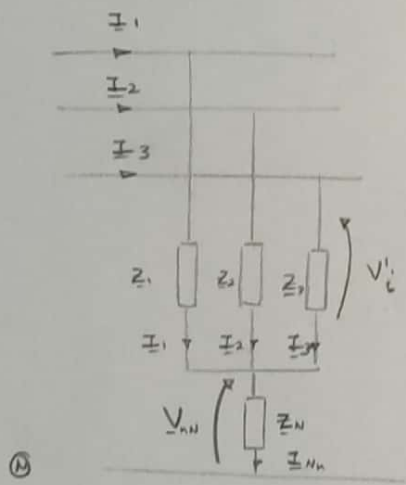
$$\underline{V}_3 = \underline{V}_1 \cdot 1 \angle 120^\circ$$

$$\underline{U}_{ij} = \underline{V}_i \cdot \sqrt{3} \angle 30^\circ$$

$$\underline{V}_1 + \underline{V}_2 + \underline{V}_3 = 0$$

$$\underline{U}_{12} + \underline{U}_{23} + \underline{U}_{31} = 0$$

- IZARRAK :



(Y)

$$\underline{V}'_i = \underline{V}_i - \underline{V}_{nN}$$

$$\underline{I}_i = \frac{\underline{V}'_i}{\underline{Z}_i}$$

$$\underline{S}_i = \underline{V}'_i \cdot \underline{I}_i^*$$

(N)

$$\underline{V}_{nN} = \frac{\sum \underline{V}_i \cdot \underline{Y}_i}{\sum \underline{Y}_i + \underline{Y}_N}$$

$$\underline{I}_{nN} = \sum \underline{I}_i$$

• SIMETRIKOA :

$$\underline{S}_\lambda = \sqrt{3} \angle -30^\circ \cdot \underline{U}_{ij} \cdot \underline{I}_i^*$$

$$S_\lambda = \sqrt{3} U \cdot I$$

(Y)

$$\underline{V}'_i = \underline{V}_i$$

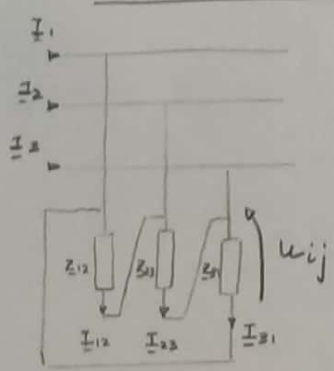
$$\underline{I}_i = \frac{\underline{V}_i}{\underline{Z}_i}$$

(N)

$$\underline{V}_{nN} = 0$$

$$\underline{I}_{nN} = 0$$

- TRIANGELUAK :



(Δ)

$$\underline{U}_{ij} = \underline{U}_{ij}$$

$$\underline{I}_{ij} = \frac{\underline{U}_{ij}}{\underline{Z}_{ij}}$$

• SIMETRIKOA

$$\underline{I}_i = \underline{I}_{ij} \cdot \sqrt{3} \angle -30^\circ$$

$$\underline{S}_\Delta = \sqrt{3} \angle -30^\circ \cdot \underline{U}_{ij} \cdot \underline{I}_i^*$$

$$P_\Delta = S_\Delta \cdot \cos \varphi$$

$$Q_\Delta = S_\Delta \cdot \sin \varphi$$

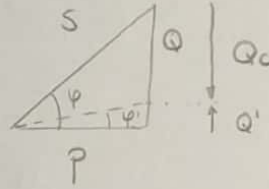
- MONOFASIKO EKBT

$$Z_{\lambda} = \frac{Z_{\Delta}}{3}$$

$$C_{\Delta} = \frac{C_{\lambda}}{3}$$

- POTENTZIA FAKTOREA

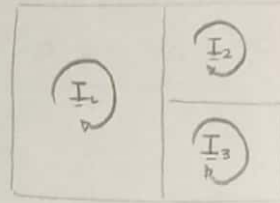
$$Q_c = P \cdot (\tan \varphi' - \tan \varphi)$$
$$Q_c = \begin{cases} -C_{\lambda} \omega u^2 \\ -3C_{\Delta} \cdot \omega \cdot u^2 \end{cases}$$



METODOAK

- MALLEN METODOA

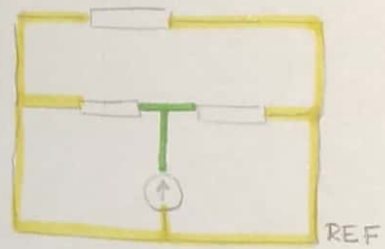
$$\{ \underline{E}_m \} = (\underline{Z}_{m \times m}) \cdot \{ \underline{I}_m \}$$



$m =$ malla kop.

- KORAPILO METODOA

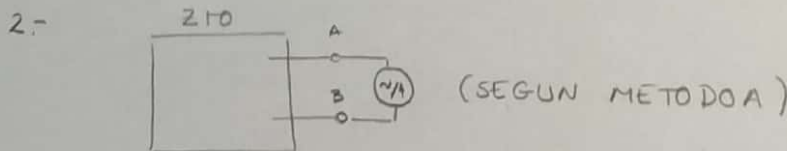
$$\{ \underline{J}_{N-1} \} = (\underline{Y}_{(N-1) \times (N-1)}) \cdot \{ \underline{V}_{N-1} \}$$



$N =$ korapilo kop.

- \underline{Z}_{th} EDO \underline{Y}_N LORTU

1.- ZTO-~~an~~ ITURRIAK KENDU :



→ (\underline{Z}_m) edo (\underline{Y}_N)
KALKULATU

3.-

$$\underline{Z}_{th}^{AB} = \frac{ | \underline{Z}_m | }{ \delta_{ii}^{(Z_m)} }$$

$$\underline{Y}_N^{AB} = \frac{ | \underline{Y}_N | }{ \delta_{ii}^{(Y_N)} }$$

(BETI $K \perp REF$)

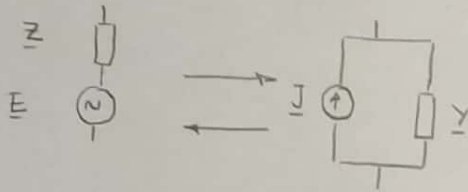
$(\underline{Y}_N$ KASUAN KTE
MANTENDU ZTO-AREN
 \underline{Y}_N -AREKIKO)

TEOREMAK

1. SUPERPOSIZIOA

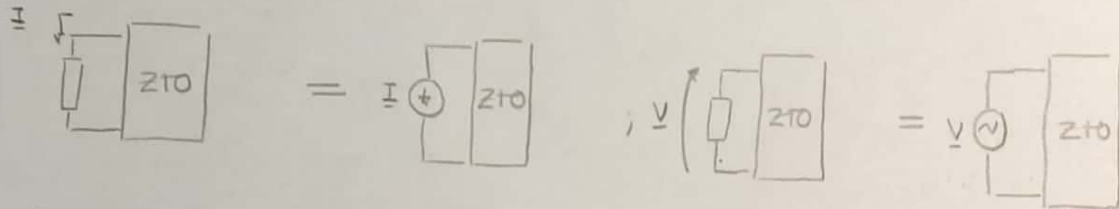
$$\boxed{\text{AC/DC}} = \boxed{\text{AC}} + \boxed{\text{DC}}$$

2. ITURRI TRANSFORMAKETA



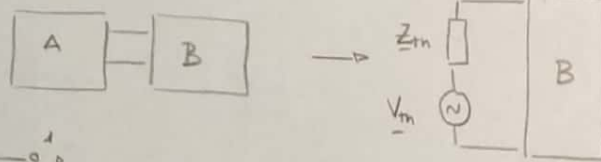
$$\begin{aligned} \rightarrow & \boxed{J = \frac{E}{Z} \quad Y = \frac{1}{Z}} \\ \leftarrow & \boxed{E = \frac{J}{Y} \quad Z = \frac{1}{Y}} \end{aligned}$$

3. ORDEZKAPENA



4. THEVENIN ETA NORTON

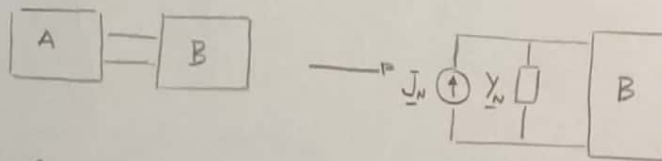
- THEVENIN [A]



• $V_m = V_{12}$

• $Z_m = Z_{eq}$ (ITURRI GUZTIAK KENDU)

- NORTON [A]

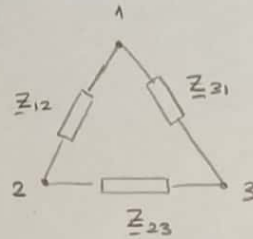
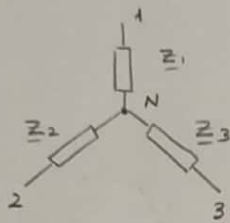


• $J_N = I_{12}$

• $Y_N = Y_{eq}$ (ITURRI GUZTIAK KENDU)

• $Z_m = \frac{1}{Y_N}$

5. KENNELLY EDO λ, Δ



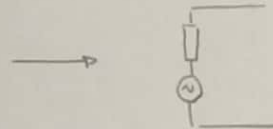
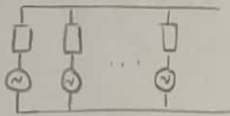
$\Delta \rightarrow \lambda$

$$Z_1 = \frac{Z_{12} \cdot Z_{31}}{Z_{12} + Z_{23} + Z_{31}}$$

$\lambda \rightarrow \Delta$

$$Y_{12} = \frac{Y_1 \cdot Y_2}{Y_1 + Y_2 + Y_3}$$

6. MILLMAN

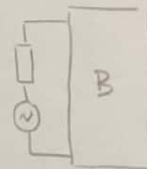
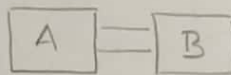


$$Z_{eq} = Z_1 \parallel Z_2 \parallel \dots \parallel Z_n = \frac{1}{\frac{1}{Z_1} + \frac{1}{Z_2} + \dots}$$

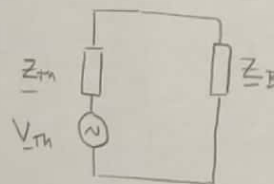
$$E_{eq} = \frac{E_1/Z_1 + E_2/Z_2 + \dots}{1/Z_1 + 1/Z_2 + \dots}$$

7. POTENZIA TRANSFERENTZIA MAXIMOA

1- THEVENIN [A]



2- B \rightarrow IMPEDANTZIA 1ERA

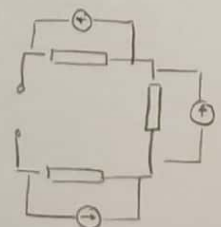
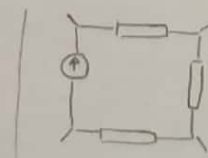
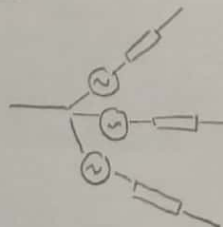
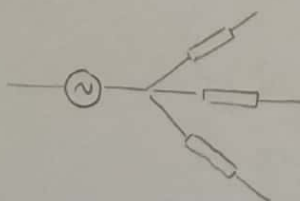


3- POTENZIA MAXIMOA

$$Z_{th}^* = Z_B \quad \text{BADA}$$

$$P_{max} = \frac{|V_{th}|^2}{4 R_{th}}$$

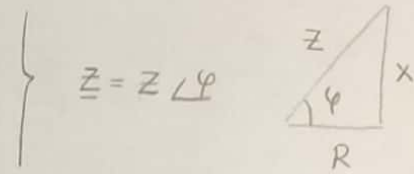
8. ITURRI TRANSLAZIOA



POTENTZIA

$$e(t) = E\sqrt{2} \cos(\omega t + \theta) = E \angle \theta$$

$$i(t) = I\sqrt{2} \cos(\omega t + \theta - \varphi) = I \angle \theta - \varphi$$

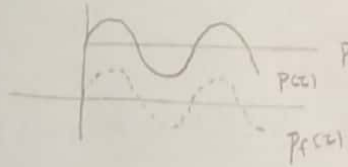


POTENTZIA INSTANTANEOA $p(t)$:

$$p(t) = P + p_f(t)$$

$$P = E \cdot I \cdot \cos \varphi$$

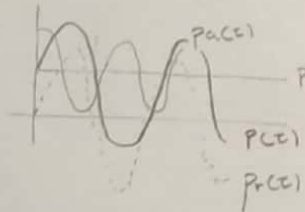
$$p_f(t) = E \cdot I \cdot \cos(2\omega t + 2\theta - \varphi)$$



$$p(t) = p_a(t) + p_r(t)$$

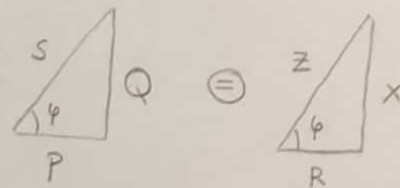
$$p_a(t) = P \cdot [1 + \cos(2\omega t + 2\theta)]$$

$$p_r(t) = Q \cdot \sin(2\omega t + 2\theta)$$



POTENTZIA APARENTE \underline{S} :

$$\underline{S} = P + jQ = S \angle \varphi = \underline{E} \underline{I}^*$$



• MODULUA: $S = E I = \sqrt{P^2 + Q^2}$

• ATAL ERREALA: $P = \text{Re} \{ E \cdot I^* \} = E \cdot I \cos \varphi$

• ATAL IRUDIKARIA: $Q = \text{Im} \{ E \cdot I^* \} = E \cdot I \sin \varphi$

- FORMULA LAGUN GARRIAK :

$P = R \cdot I^2$	$P = \frac{G}{G^2 + B^2} I^2$	$Q = X \cdot I^2$	$Q = \frac{-B}{G^2 + B^2} I^2$
$P = \frac{R}{R^2 + X^2} \cdot E^2$	$P = G \cdot E^2$	$Q = \frac{X}{R^2 + X^2} \cdot E^2$	$Q = -B E^2$

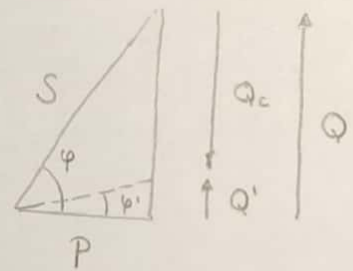
- BOUCHEROT

$\sum P_g = \sum P_z$	$\sum S_g = \sum S_z$
$\sum Q_g = \sum Q_z$	$\sum S_g \neq \sum S_z$

- POTENTZIA FAKTOREA COS φ :

$$Q_c = \begin{cases} = -C \cdot \omega \cdot V^2 \\ = P(\tan \varphi' - \tan \varphi) \end{cases}$$

$$C = - \frac{P \cdot (\tan \varphi' - \tan \varphi)}{\omega V^2}$$



$$[Q = P \cdot \tan \varphi]$$

$$[Q' = P \cdot \tan \varphi']$$

$$[Q' = Q + Q_c]$$

FUNTZIO SINUSOIDALAK GRAFIKO FASORIALAK

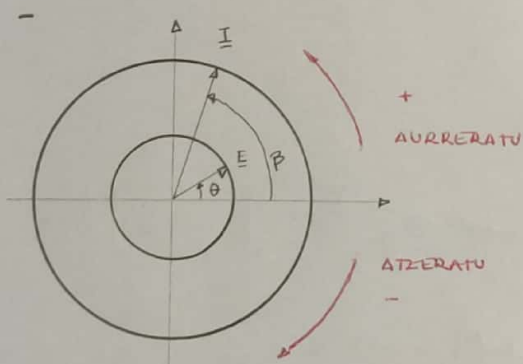
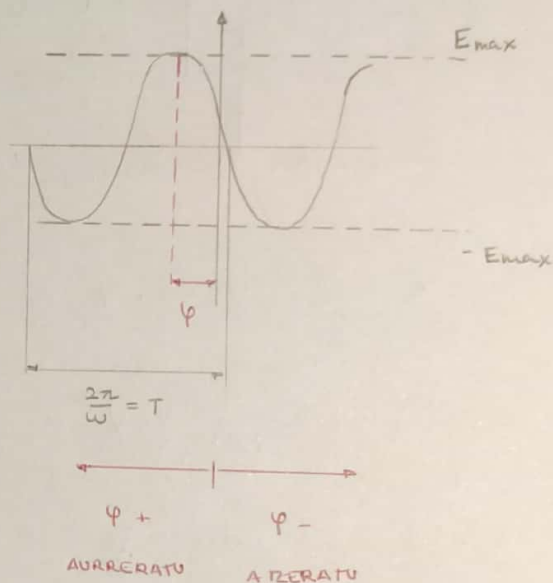
$$e(t) = E_{max} \cdot \cos(\omega t + \theta)$$

$$i(t) = I_{max} \cdot \cos(\omega t + \beta)$$

$$\varphi = Z \cdot \omega$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$E_{ef} = \frac{E_{max}}{\sqrt{2}}$$



$$\underline{E} = E \angle \theta \quad \underline{I} = I \angle \beta$$

- INPEDANTZIA: (Ω)

$$\underline{Z} = R + jX$$

RESISTENTZIA REAKTANTZIA

$X > 0 \rightarrow$ INDUKTIBOA
 $X < 0 \rightarrow$ KAPAZITIBOA

$$\underline{V} = R \cdot \underline{I} \quad : R$$

$$\underline{V} = j\omega L \cdot \underline{I} \quad : L$$

$$\underline{V} = \frac{1}{j\omega C} \cdot \underline{I} \quad : C$$

$$\underline{Z} = \frac{1}{\underline{Y}}$$

- ADMITANTZIA: (S)

$$\boxed{\underline{Y} = G + jB}$$

↑ ↑
KONDUKTANTZIA SUSZEPANTZIA

$$\left. \begin{array}{l} B > 0 \rightarrow \text{KAPAZITIBOA} \\ B < 0 \rightarrow \text{INDUKTIBOA} \end{array} \right\}$$

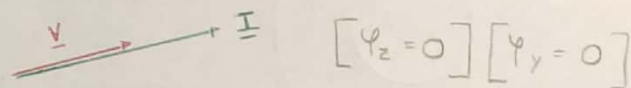
$$R: \underline{I} = \frac{1}{R} \cdot \underline{V}$$

$$L: \underline{I} = \frac{1}{j\omega L} \cdot \underline{V}$$

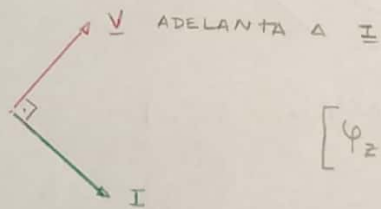
$$C: \underline{I} = j\omega C \cdot \underline{V}$$

- GRAFIKO FASORIALAK:

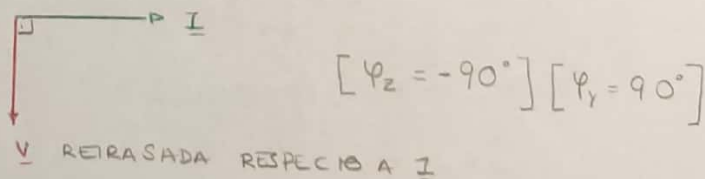
Ⓜ : RESISTENTZIA PURA : $\underline{Z} = R \angle 0^\circ$



Ⓛ : BOBINA PURA : $\underline{Z} = \omega L \angle 90^\circ$



ⓐ : CONDENSADOR PURO : $\underline{Z} = \frac{1}{\omega C} \angle -90^\circ$



RLC ASOZIAZIOA

ZATITZAILEAK :

- TENTSIOA :

$$\underline{V}_L = \underline{E} \cdot \frac{\underline{Z}_L}{\sum \underline{Z}_L}$$

- INTENSITATEA :

$$\underline{I}_L = \underline{J} \cdot \frac{\underline{Y}_L}{\sum \underline{Y}_L}$$

RESONANTZIA :

- SERIE :



- PARALELO :



$$\varphi = 0 \quad \omega L = \frac{1}{\omega C}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

NEURGAILUAK

⊙ : P

Ⓐ : |I|

Ⓥ : |V|

$$V_{af} = \sqrt{V_{afAC}^2 + V_{afDC}^2}$$

DC - RA TRANSFORMATU

