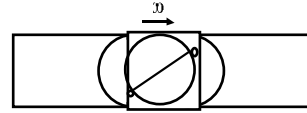


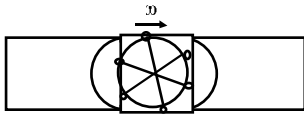
Lezione 40

I generatori



$$e_1(t) = E_{M1} \sin(\omega t)$$

I generatori polifasi

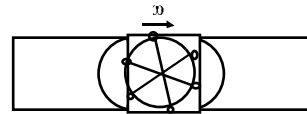


$$e_1(t) = E_{M1} \sin(\omega t)$$

$$e_2(t) = E_{M2} \sin(\omega t - 2\pi/3)$$

$$e_3(t) = E_{M3} \sin(\omega t - 4\pi/3)$$

I generatori trifasi

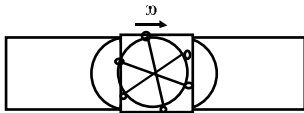


$$e_1(t) = \sqrt{2} E \sin(\omega t)$$

$$e_2(t) = \sqrt{2} E \sin(\omega t - 2\pi/3)$$

$$e_3(t) = \sqrt{2} E \sin(\omega t - 4\pi/3)$$

I generatori trifasi



$$e_1(t) = \sqrt{2} E \sin(\omega t)$$

$$e_2(t) = \sqrt{2} E \sin(\omega t - 2\pi/3)$$

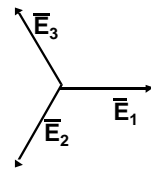
$$e_3(t) = \sqrt{2} E \sin(\omega t - 4\pi/3)$$

Terna simmetrica

$$e_1(t) = \sqrt{2} E \sin(\omega t)$$

$$e_2(t) = \sqrt{2} E \sin(\omega t - 2\pi/3)$$

$$e_3(t) = \sqrt{2} E \sin(\omega t - 4\pi/3)$$



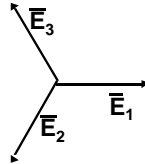
Terna simmetrica e diretta

Terna simmetrica

$$\bar{E}_1 = E e^{j\omega t}$$

$$\bar{E}_2 = E e^{j(\omega t - 2\pi/3)}$$

$$\bar{E}_3 = E e^{j(\omega t - 4\pi/3)}$$



Terna simmetrica e diretta

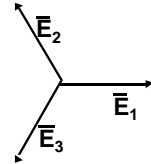
Introduzione ai circuiti aa 2003/2004 slide n.7

Terna simmetrica

$$\bar{E}_1 = E e^{j\omega t}$$

$$\bar{E}_2 = E e^{j(\omega t - 4\pi/3)} = E e^{j(\omega t + 2\pi/3)}$$

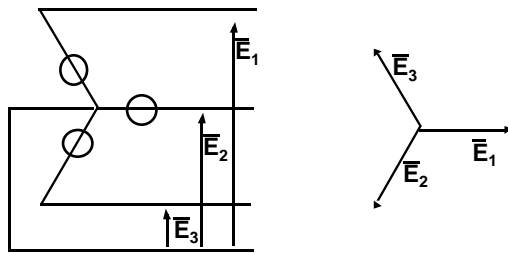
$$\bar{E}_3 = E e^{j(\omega t - 2\pi/3)} = E e^{j(\omega t + 4\pi/3)}$$



Terna simmetrica e inversa

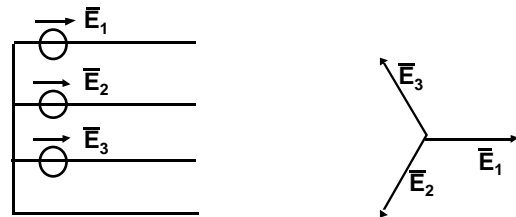
Introduzione ai circuiti aa 2003/2004 slide n.8

I generatori trifasi



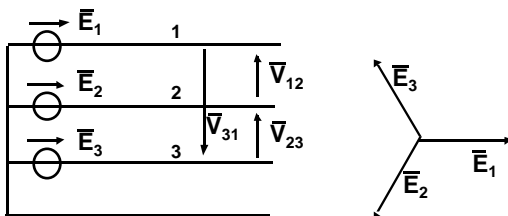
Introduzione ai circuiti aa 2003/2004 slide n.9

I generatori trifasi



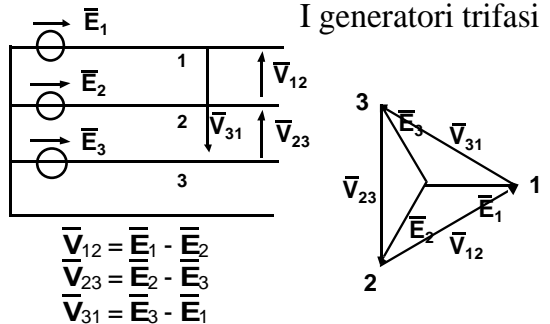
Introduzione ai circuiti aa 2003/2004 slide n.10

I generatori trifasi



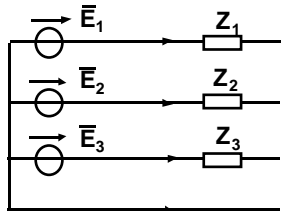
Introduzione ai circuiti aa 2003/2004 slide n.11

I generatori trifasi



Introduzione ai circuiti aa 2003/2004 slide n.12

Carico a stella

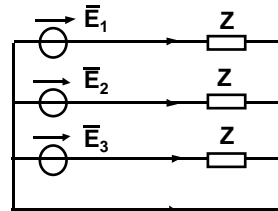


$$\bar{I}_r = \frac{\bar{E}_r}{Z_r}$$

Introduzione ai circuiti aa 2003/2004 slide n.13

Carico equilibrato

$$\bar{I}_r = \frac{\bar{E}_r}{Z}$$



$$\bar{I}_1 = I e^{j(\omega t - \varphi)}$$

$$\bar{I}_2 = I e^{j(\omega t - 2\pi/3 - \varphi)}$$

$$\bar{I}_3 = I e^{j(\omega t - 4\pi/3 - \varphi)}$$

$$I = \frac{E}{Z}$$

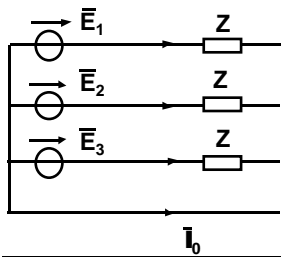
Introduzione ai circuiti aa 2003/2004 slide n.14

Carico equilibrato

$$\bar{I}_1 = I e^{j(\omega t - \varphi)}$$

$$\bar{I}_2 = I e^{j(\omega t - 2\pi/3 - \varphi)}$$

$$\bar{I}_3 = I e^{j(\omega t - 4\pi/3 - \varphi)}$$



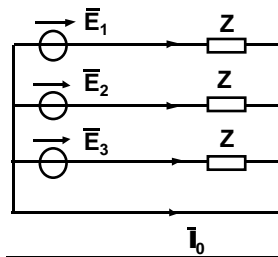
Introduzione ai circuiti aa 2003/2004 slide n.15

Carico equilibrato

$$\bar{I}_1 = I e^{j(\omega t - \varphi)}$$

$$\bar{I}_2 = I e^{j(\omega t - 2\pi/3 - \varphi)}$$

$$\bar{I}_3 = I e^{j(\omega t - 4\pi/3 - \varphi)}$$



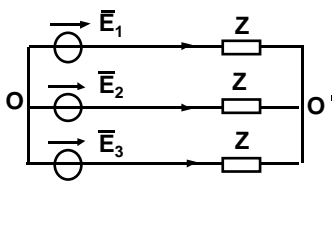
Introduzione ai circuiti aa 2003/2004 slide n.16

Carico equilibrato

$$\bar{I}_1 = I e^{j(\omega t - \varphi)}$$

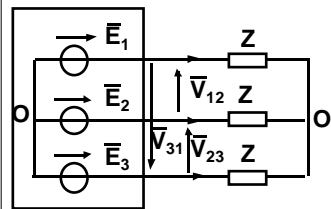
$$\bar{I}_2 = I e^{j(\omega t - 2\pi/3 - \varphi)}$$

$$\bar{I}_3 = I e^{j(\omega t - 4\pi/3 - \varphi)}$$



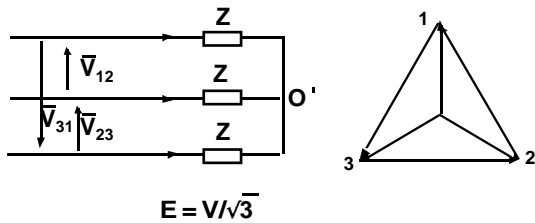
Introduzione ai circuiti aa 2003/2004 slide n.17

Carico equilibrato



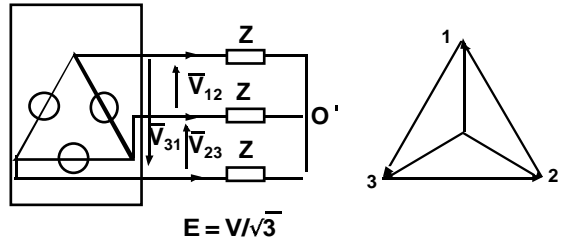
Introduzione ai circuiti aa 2003/2004 slide n.18

Carico equilibrato



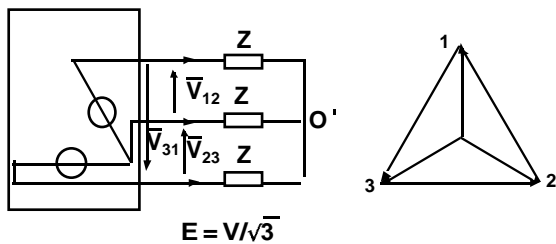
Introduzione ai circuiti aa 2003/2004 slide n. 19

Generatori a triangolo



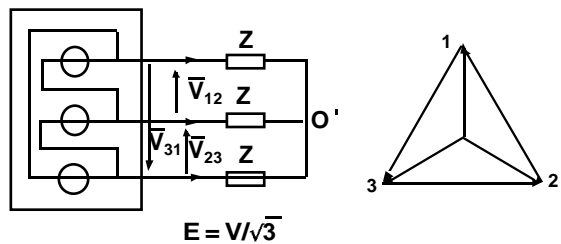
Introduzione ai circuiti aa 2003/2004 slide n. 20

Generatori a triangolo



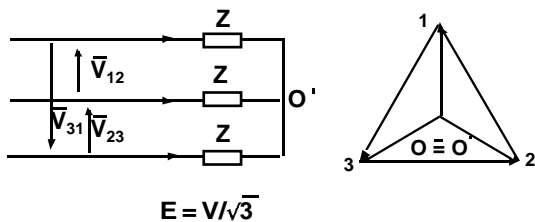
Introduzione ai circuiti aa 2003/2004 slide n. 21

Generatori a triangolo



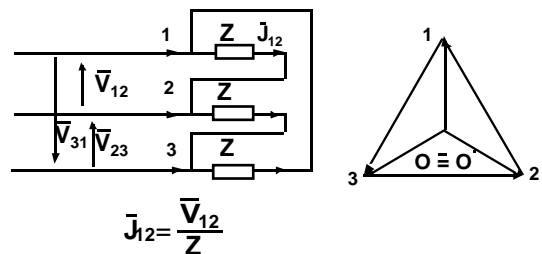
Introduzione ai circuiti aa 2003/2004 slide n. 22

Carico equilibrato



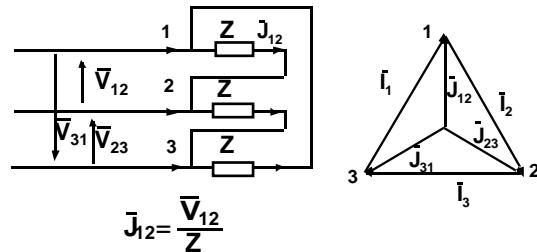
Introduzione ai circuiti aa 2003/2004 slide n. 23

Carico equilibrato a triangolo



Introduzione ai circuiti aa 2003/2004 slide n. 24

Carico equilibrato a triangolo



Introduzione ai circuiti aa 2003/2004 slide n. 25

La potenza nei sistemi trifasi

$$p(t) = e_1(t) i_1(t) + e_2(t) i_2(t) + e_3(t) i_3(t)$$

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La potenza nei sistemi equilibrati

$$p(t) = e_1(t) i_1(t) + e_2(t) i_2(t) + e_3(t) i_3(t)$$

$$p(t) = EI \left[\sin \omega t \sin(\omega t - \varphi) + \sin\left(\omega t - \frac{2\pi}{3}\right) \sin\left(\omega t - \frac{2\pi}{3} - \varphi\right) + \sin\left(\omega t - \frac{4\pi}{3}\right) \sin\left(\omega t - \frac{4\pi}{3} - \varphi\right) \right] = 3EI \cos \varphi + EI \left[\cos(2\omega t - \varphi) + \cos\left(2\omega t - \frac{4\pi}{3} - \varphi\right) + \cos\left(2\omega t - \frac{2\pi}{3} - \varphi\right) \right]$$

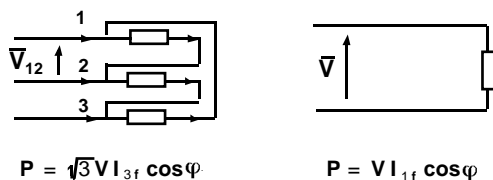
Introduzione ai circuiti aa 2003/2004 slide n. 27

La potenza nei sistemi equilibrati

- La potenza istantanea è uguale alla potenza media
- La potenza media è pari a $3EI \cos \varphi$ o $\sqrt{3}VI \cos \varphi$.

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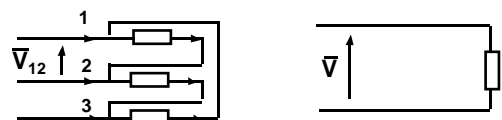
Confronto trifase/monofase



$$I_{1f} = \sqrt{3} I_{3f}$$

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Confronto trifase/monofase

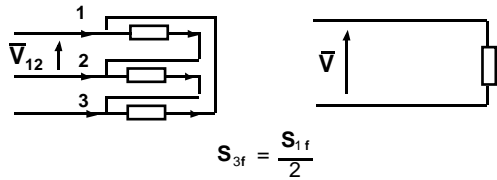


$$P_{3f}^d = 3 \rho \frac{L}{S_{3f}} (I_{3f})^2 \quad P_{1f}^d = 2 \rho \frac{L}{S_{1f}} (I_{1f})^2$$

$$S_{3f} = \frac{S_{1f}}{2}$$

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Confronto trifase/monofase



$$(\text{Vol})_{3f} = 3 L S_{3f} = \frac{3}{4} (2 L S_{1f}) = \frac{3}{4} (\text{Vol})_{1f}$$

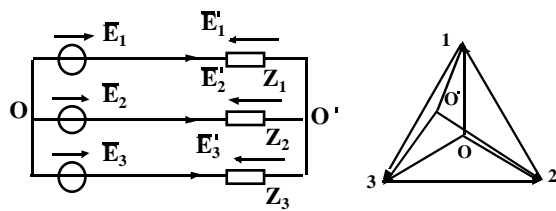
Introduzione ai circuiti aa 2003/2004 slide n.31

Riepilogo della Lezione 40

- I generatori trifasi;
- Sistemi simmetrici ed equilibrati;
- Sistemi con e senza filo neutro;
- Perché i sistemi trifasi
- Esercizi

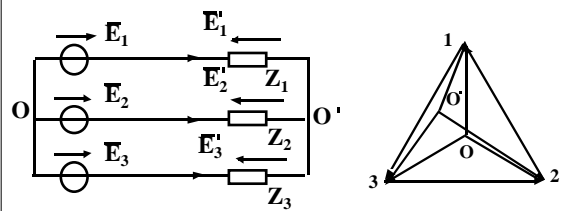
Introduzione ai circuiti aa 2003/2004 slide n.32

Carico squilibrato



Introduzione ai circuiti aa 2003/2004 slide n.33

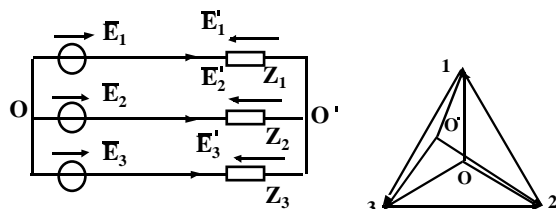
Carico squilibrato



$$\bar{E}'_1 = \bar{E}_1 - \bar{V}_{O'O}, \quad \bar{E}'_2 = \bar{E}_2 - \bar{V}_{O'O}, \quad \bar{E}'_3 = \bar{E}_3 - \bar{V}_{O'O}$$

Introduzione ai circuiti aa 2003/2004 slide n.34

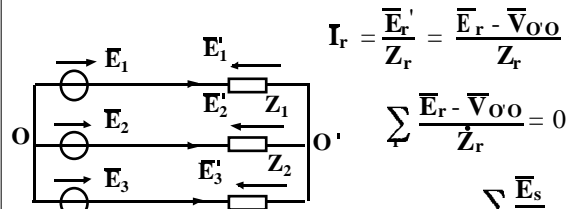
Carico squilibrato



$$\bar{I}_r = \frac{\bar{E}'_r}{\bar{Z}_r} = \frac{\bar{E}_r - \bar{V}_{O'O}}{\bar{Z}_r}$$

Introduzione ai circuiti aa 2003/2004 slide n.35

Carico squilibrato



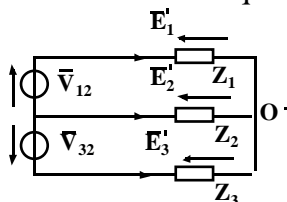
$$\bar{I}_r = \frac{\bar{E}'_r}{\bar{Z}_r} = \frac{\bar{E}_r - \bar{V}_{O'O}}{\bar{Z}_r}$$

$$\sum_r \frac{\bar{E}_r - \bar{V}_{O'O}}{\bar{Z}_r} = 0$$

$$\bar{V}_{O'O} = \frac{\sum_r \bar{E}_s}{\sum_r \frac{1}{\bar{Z}_r}}$$

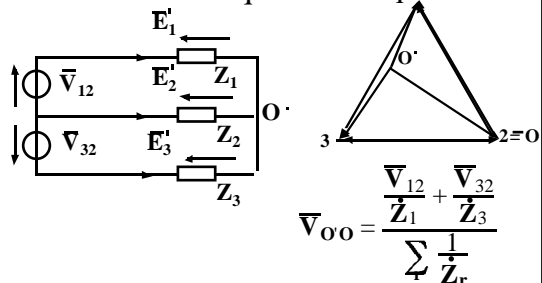
Introduzione ai circuiti aa 2003/2004 slide n.36

Carico squilibrato



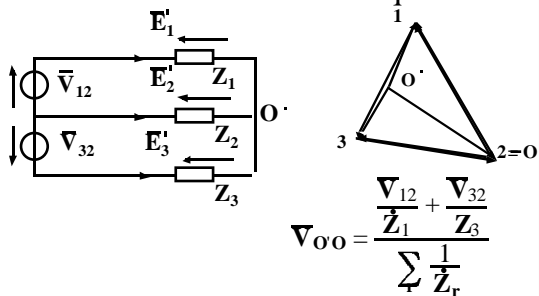
Introduzione ai circuiti aa 2003/2004 slide n.37

Carico squilibrato



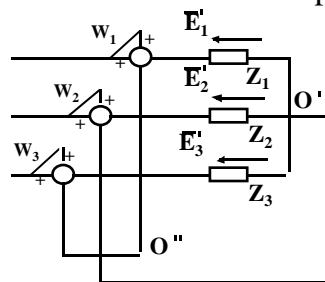
Introduzione ai circuiti aa 2003/2004 slide n.38

Terna dissimmetrica e carico squilibrato



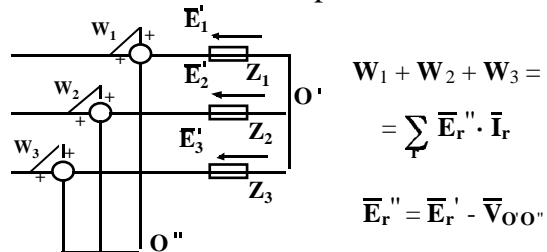
Introduzione ai circuiti aa 2003/2004 slide n.39

Misura della potenza



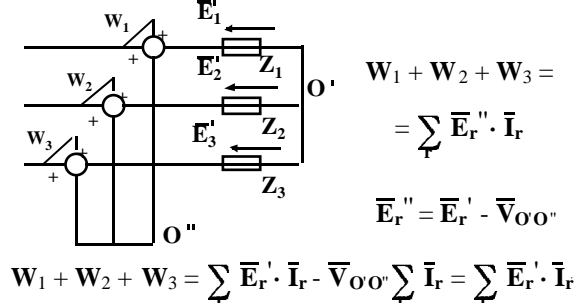
Introduzione ai circuiti aa 2003/2004 slide n.40

Misura della potenza

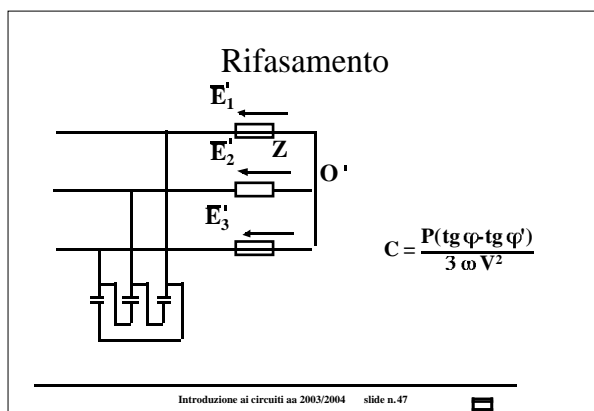
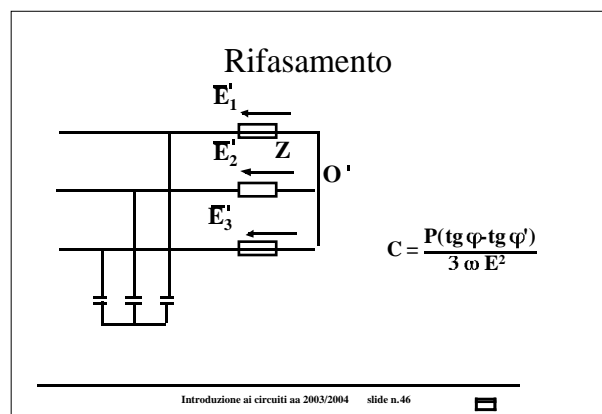
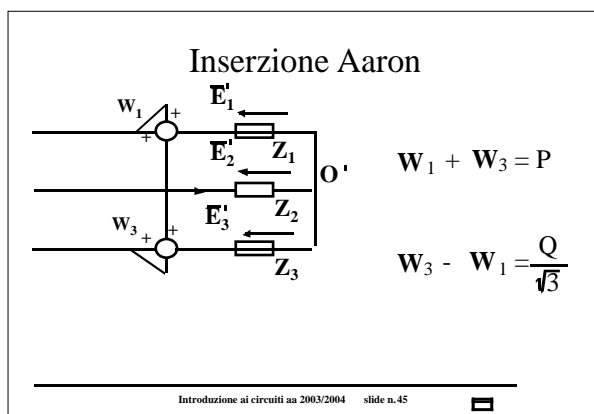
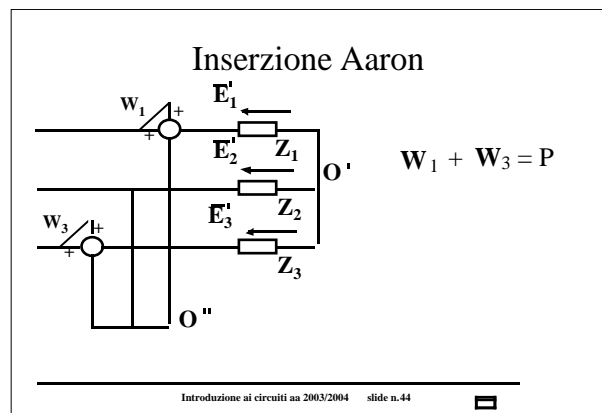
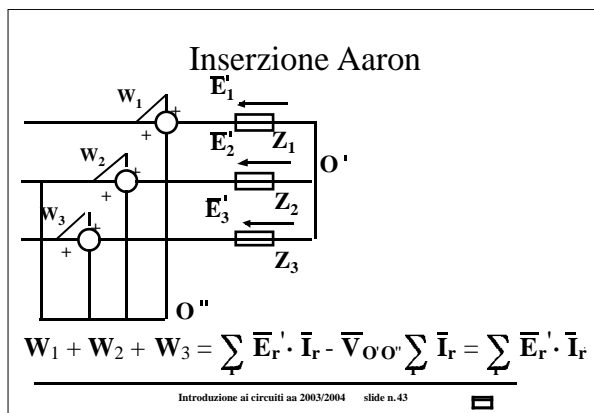


Introduzione ai circuiti aa 2003/2004 slide n.41

Teorema di Aaron



Introduzione ai circuiti aa 2003/2004 slide n.42



Riepilogo della Lezione 41

- I sistemi trifasi squilibrati;
- Lo spostamento del centro stella;
- I sistemi trifasi dissimmetrici;
- Misura della potenza nei sistemi trifasi;
- Rifasamento nei sistemi trifasi;
- Esercizi.

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