

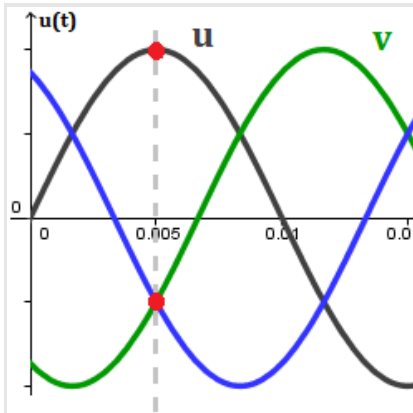
# AC

## 3-FASET

## SYMMETRISK

## BELASTNING

- Én definition
- Stjerneklede symmetriske belastninger
- Trekantsklede symmetriske belastninger



KELD DÝRMOSE



# AAMS

Aarhus Maskinmesterskole  
Aarhus School of Marine and Technical Engineering

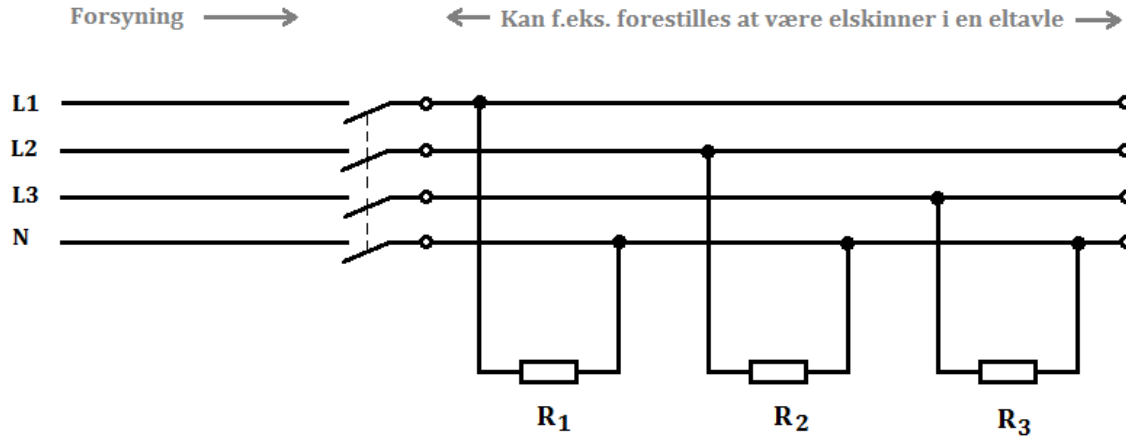
# AC 3 faset symmetrisk belastning

## Én definition af betingelser for symmetri:

- Netstrømmene er lige store i de 3 faser
- Netstrømmene har samme faseforskydningsvinkel

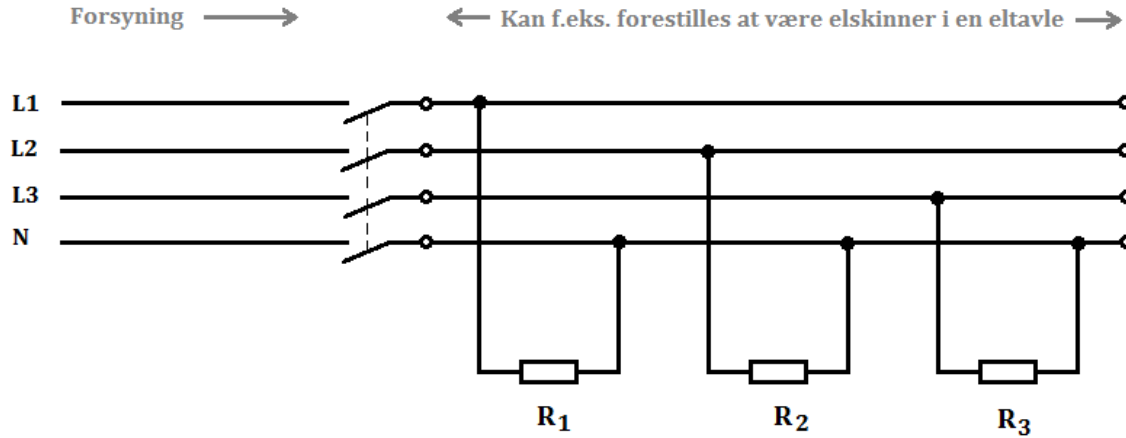
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Et fuldstreks kredsskema over stjernekoblet symmetrisk belastning:



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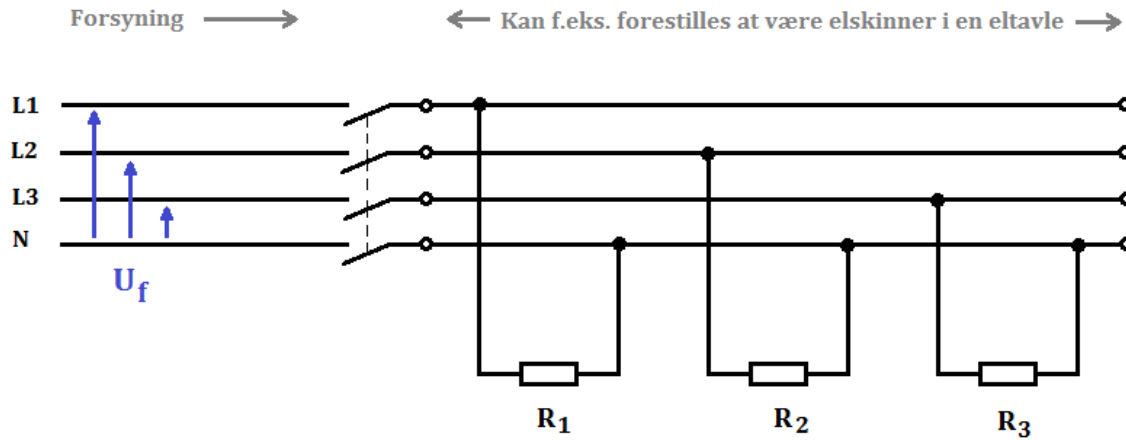
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Lad os antage følgende om kredsen:

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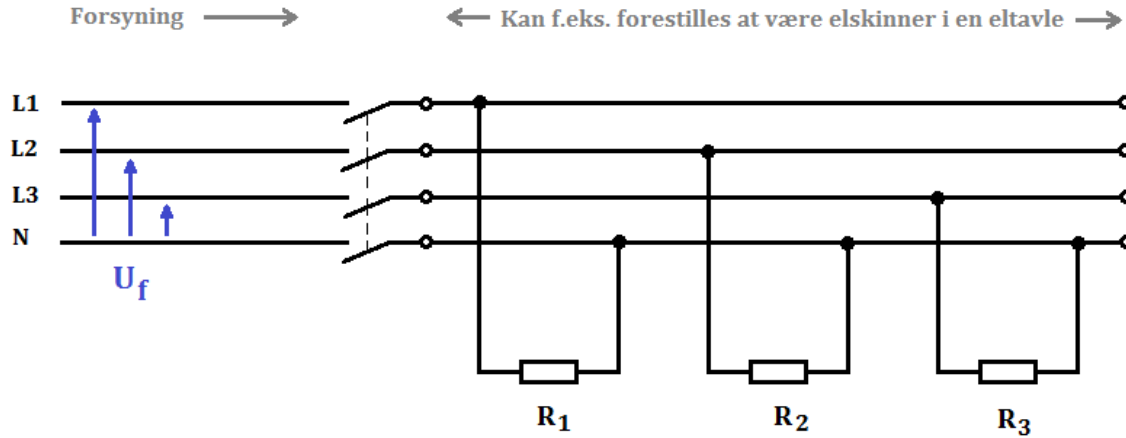


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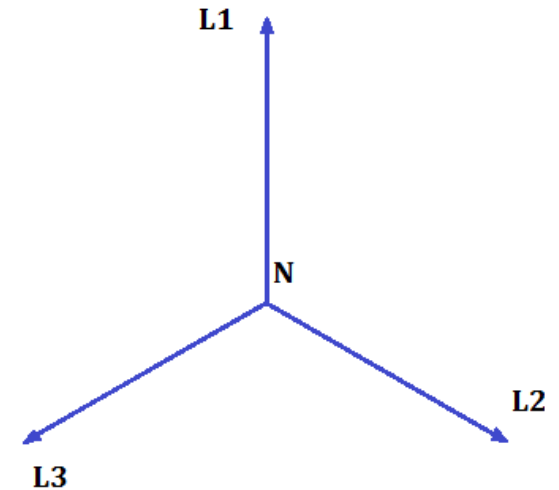
$$U_f = 231 \text{ V}$$

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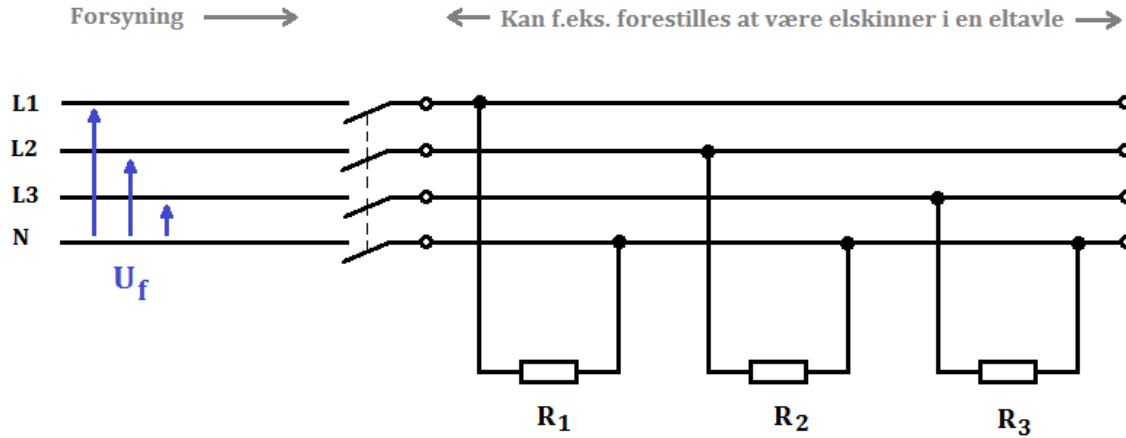


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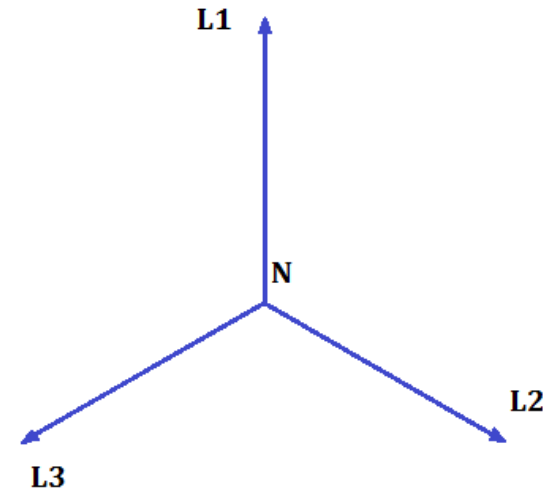
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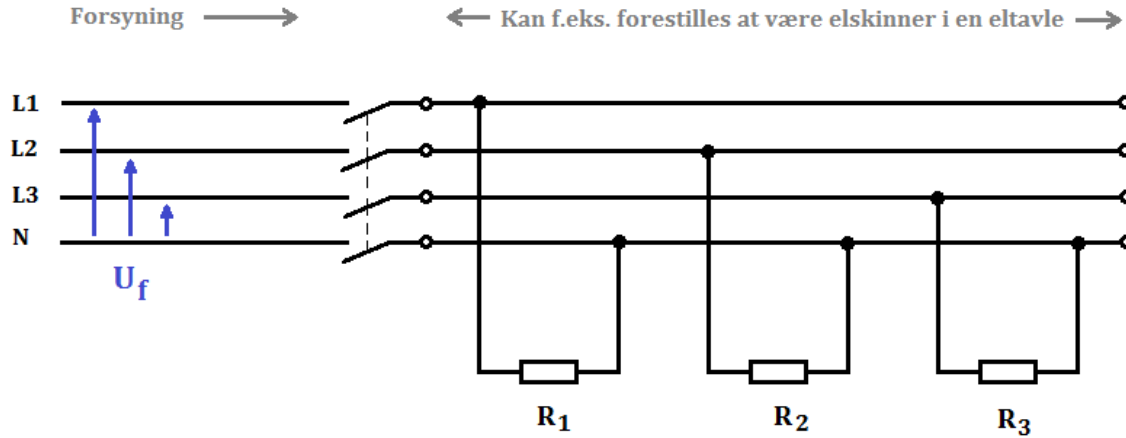
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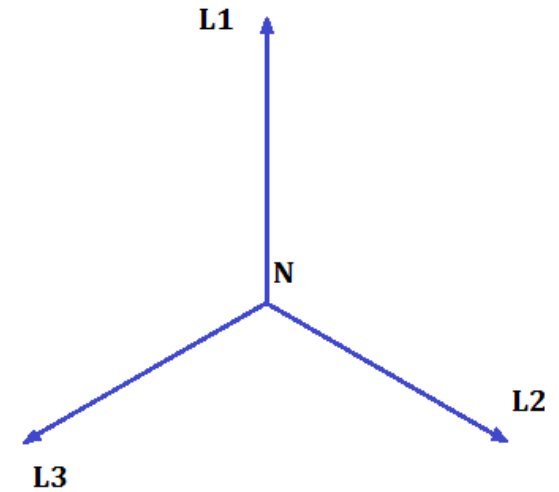
$$R_1 = R_2 = R_3 = 33 \Omega$$

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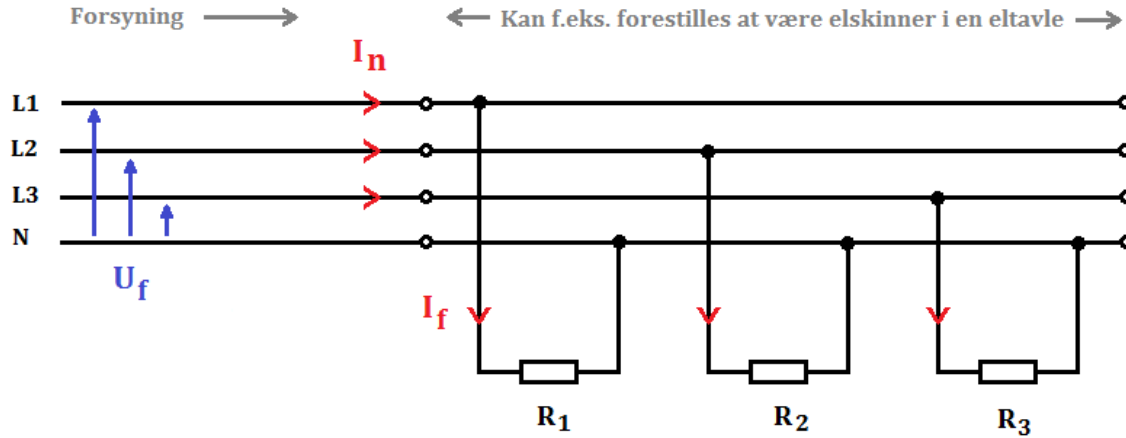
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Kontakten slutes



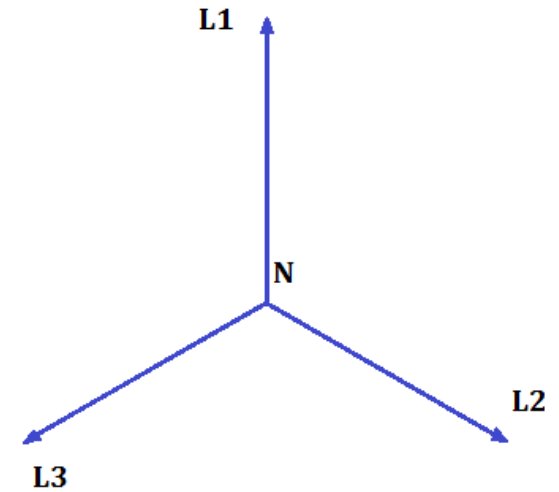
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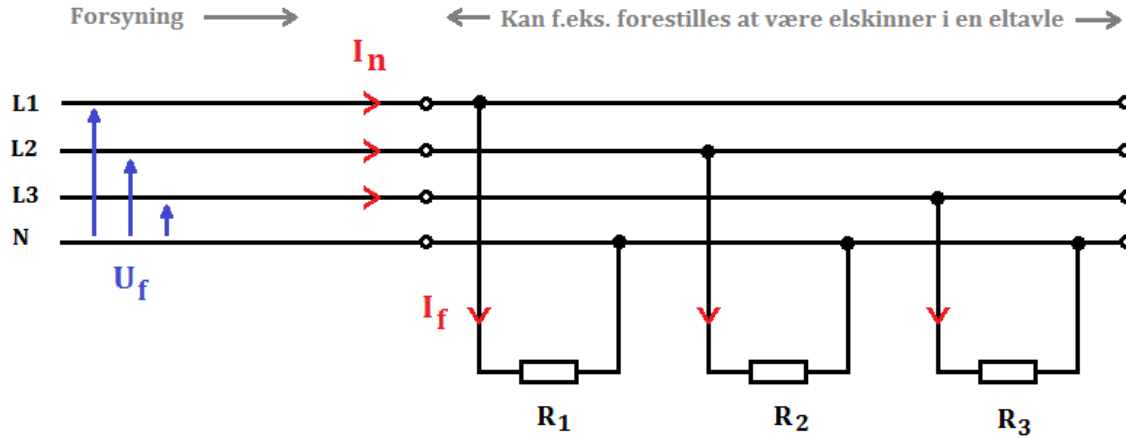


Fasestrømmen:

$$I_f = \frac{U_f}{R} \Rightarrow$$

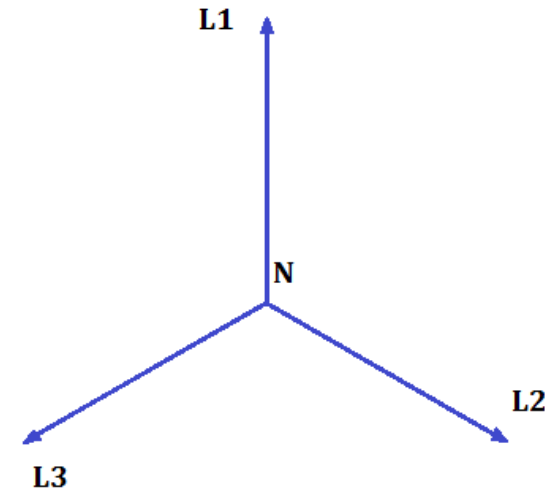
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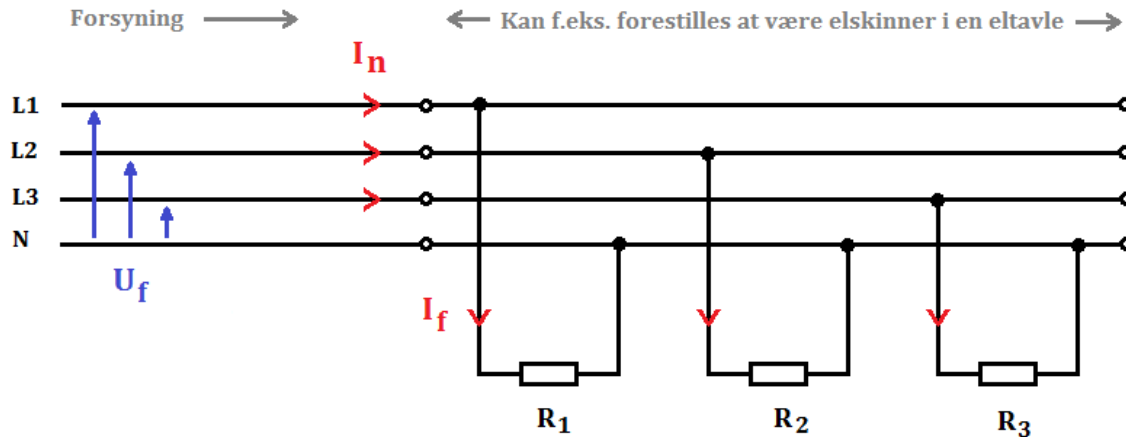


Fasestrømmen:

$$I_f = \frac{U_f}{R} \Rightarrow I_f = \frac{231}{33} = 7 \text{ A}$$

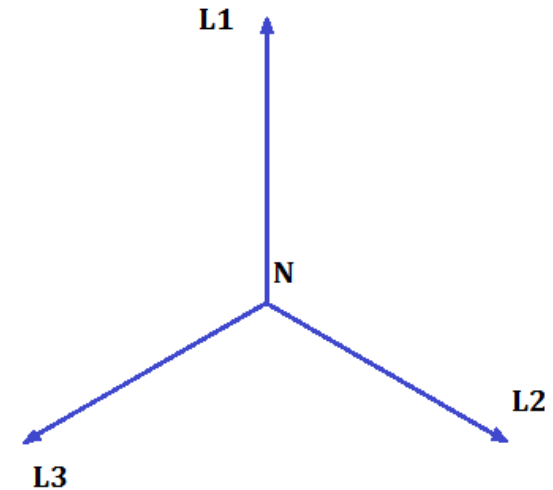
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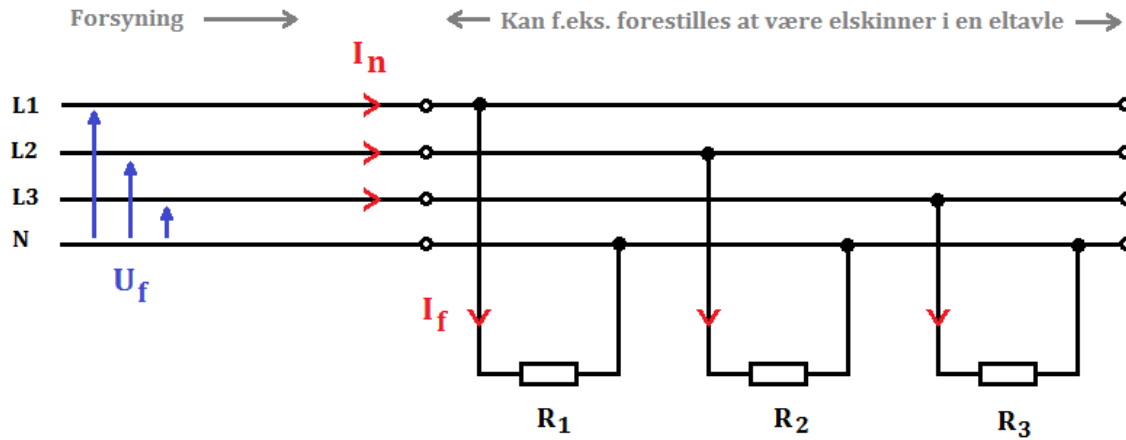
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Netstrømmen:

Ved stjerneforbundne symmetriske belastninger er  $I_f = I_n$

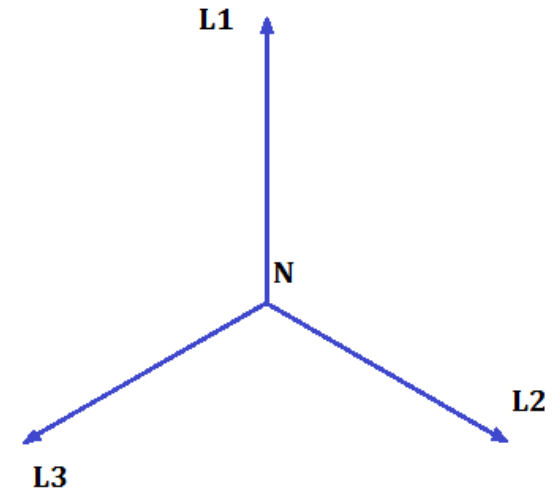
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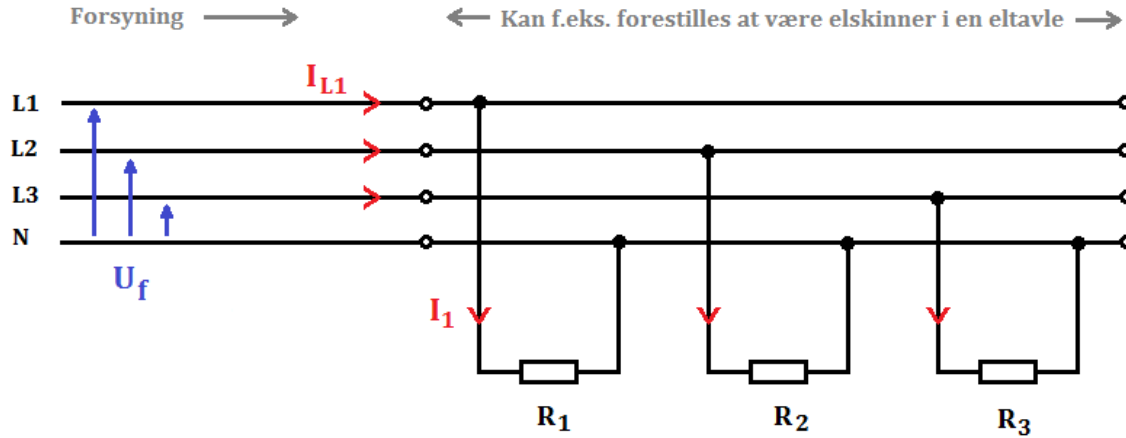
Vektordiagram:



Lad os indeksere strømmene og tegne dem ind i vektordiagrammet én fase ad gangen:

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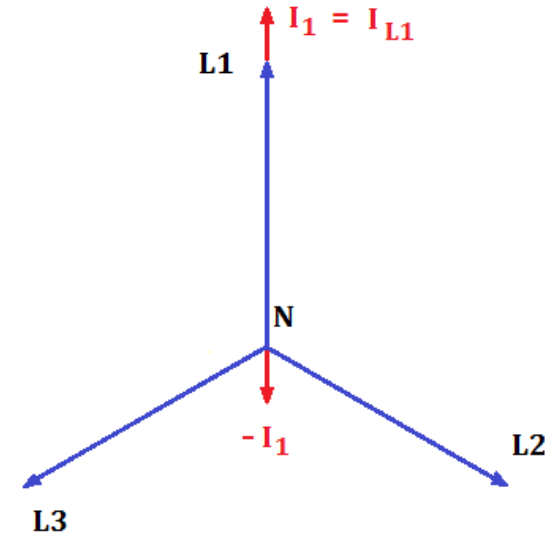


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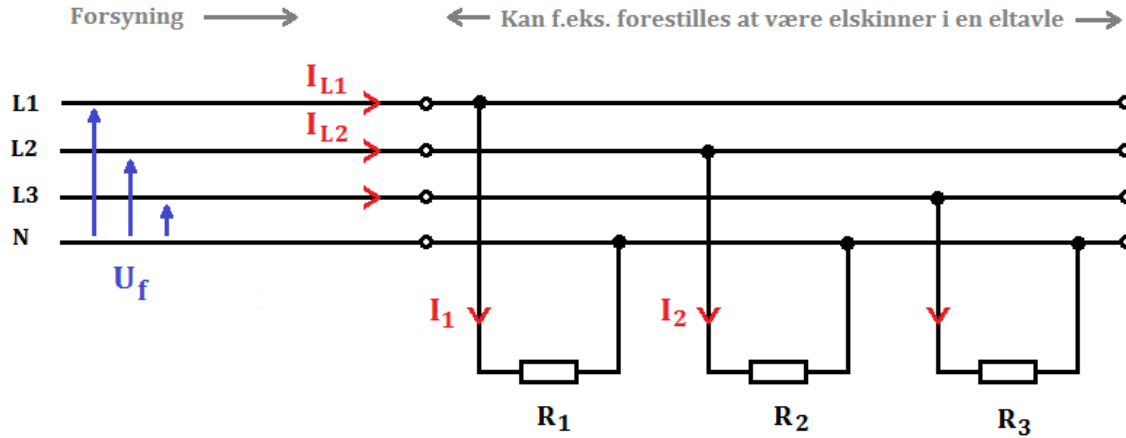
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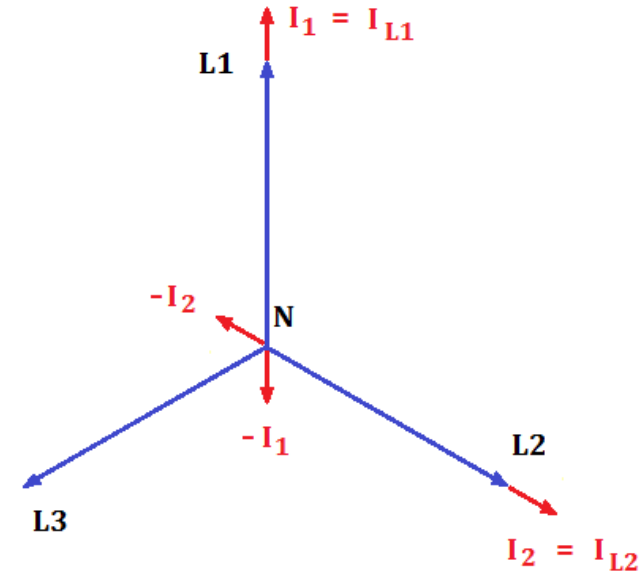


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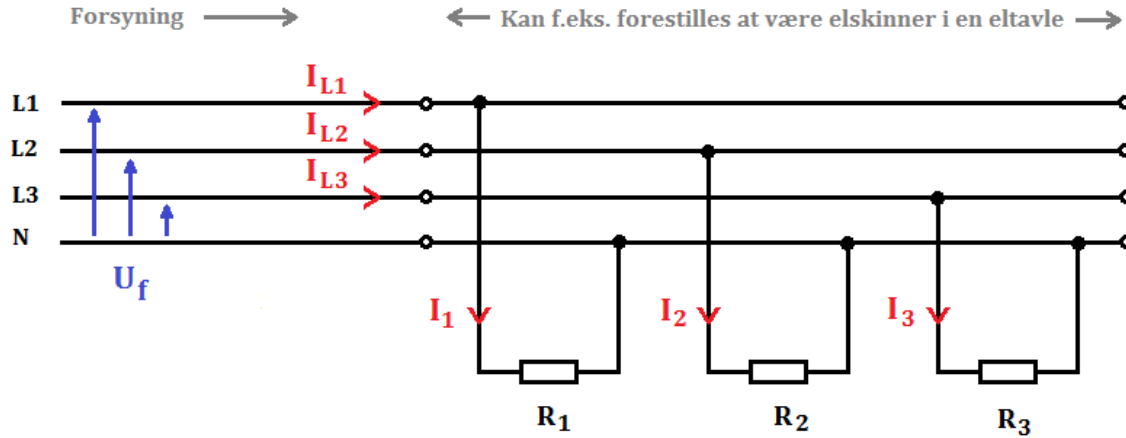
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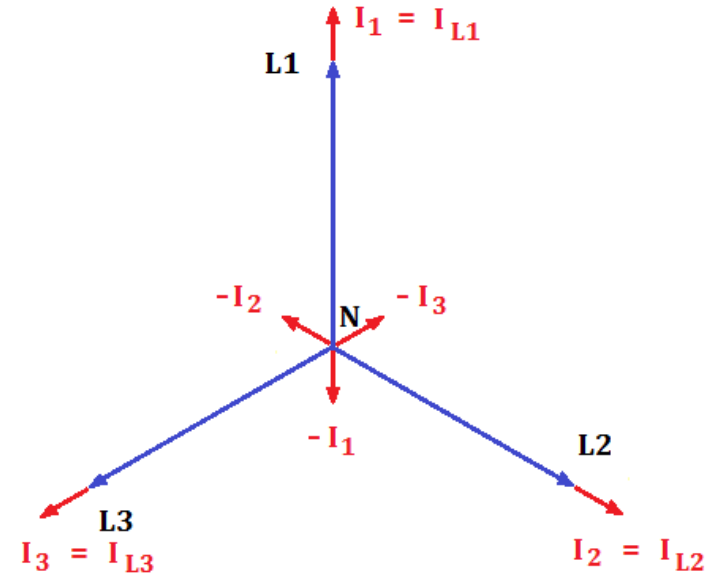


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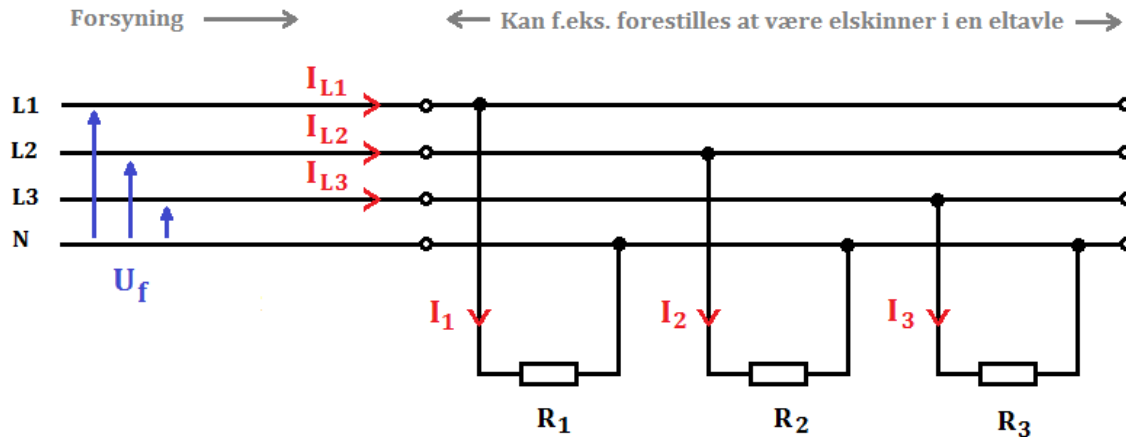
Som det ses er den vektorielle sum af strømmene i nullederen = 0 A (ved symmetriske belastninger)

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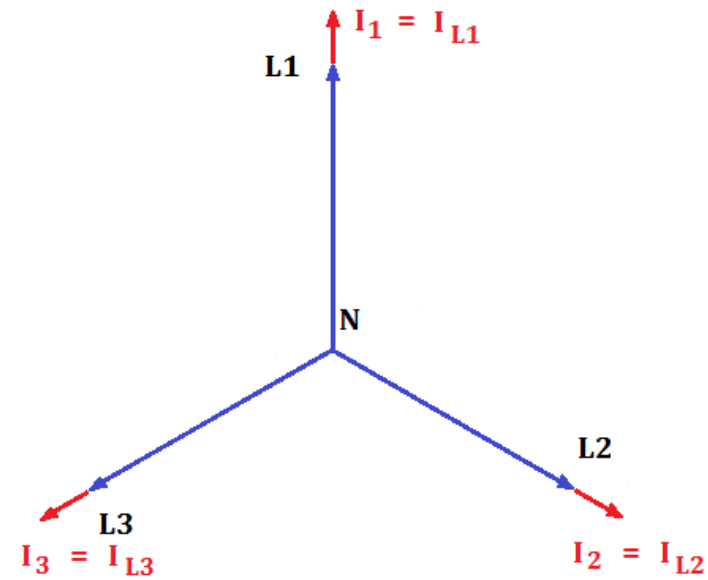
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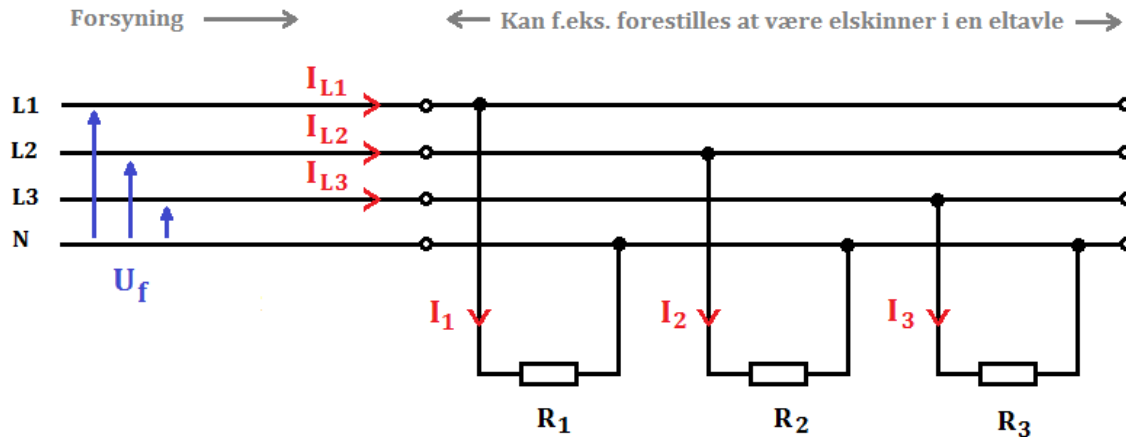


Som det ses er den vektorielle sum af strømmene i nullederen = 0 A (ved symmetrisk belastninger) og vektordiagrammet kan derfor blot tegnes som:



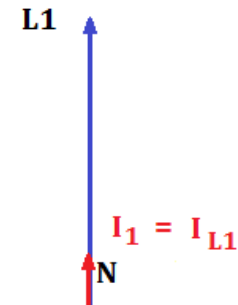
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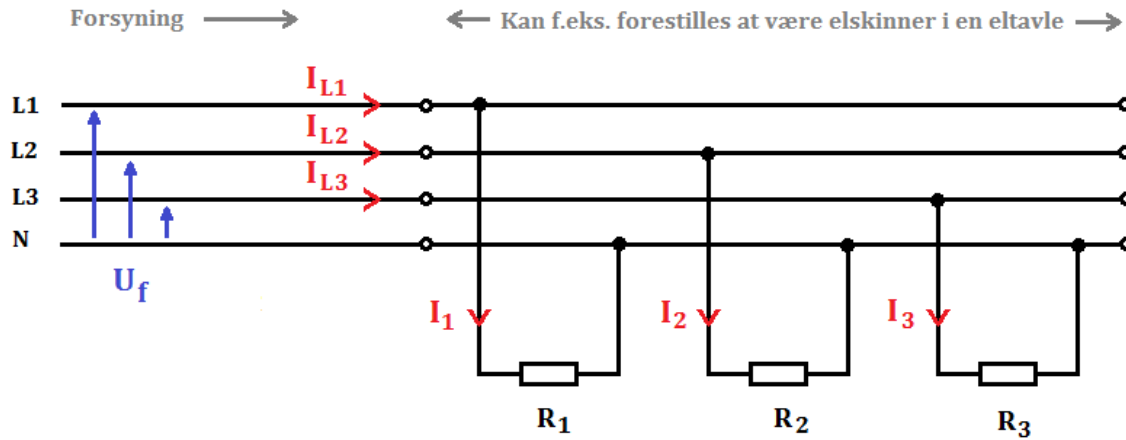


Da det trefasede vektordiagram jo netop er symmetrisk ved trefasede symmetriske belastninger, må man gerne blot tegne vektordiagrammet for én enkelt fase, f.eks.:

Strømvektoren flyttes traditionelt ned i bunden af spændingsvektoren, når man overgår til blot at tegne 1 fase i stedet for 3

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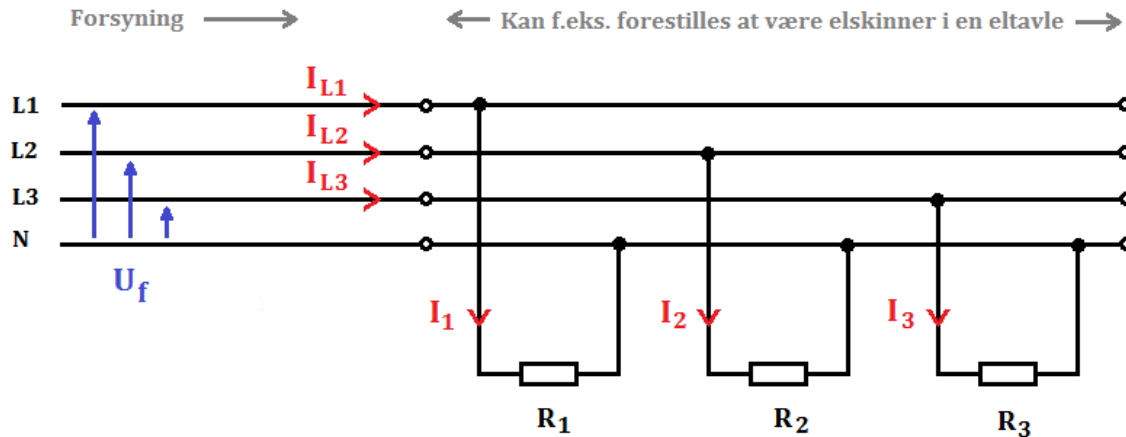
Vektordiagram:



Man vil endvidere typisk ikke indeksere specifikt, da vektordiagrammet ene fasevisning nu gælder alle faser:

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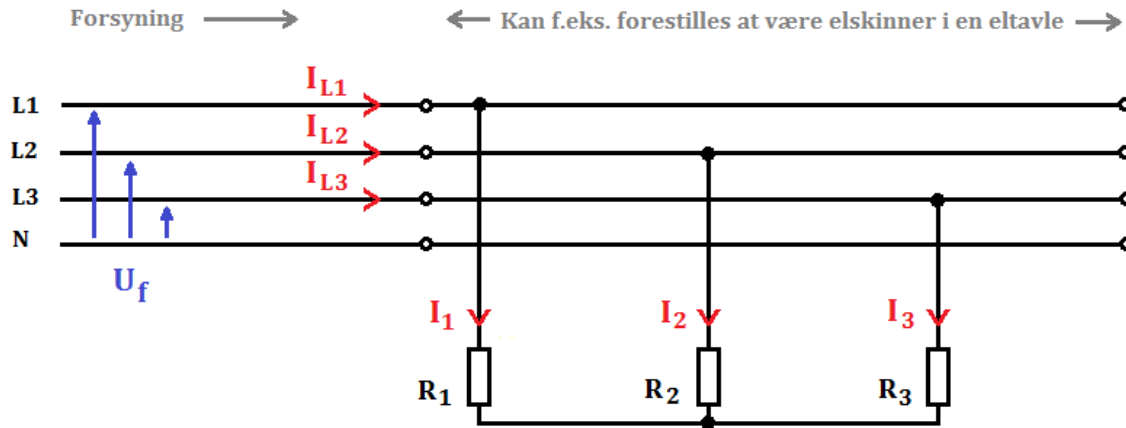
Vektordiagram:



Kredsskemaet kan evt. også ændres idet der jo alligevel ikke løber nogen strøm i nullederen, kan man blot samle de tre punkter der er koblet til nullederskinnen i et punkt - et stjernepunkt

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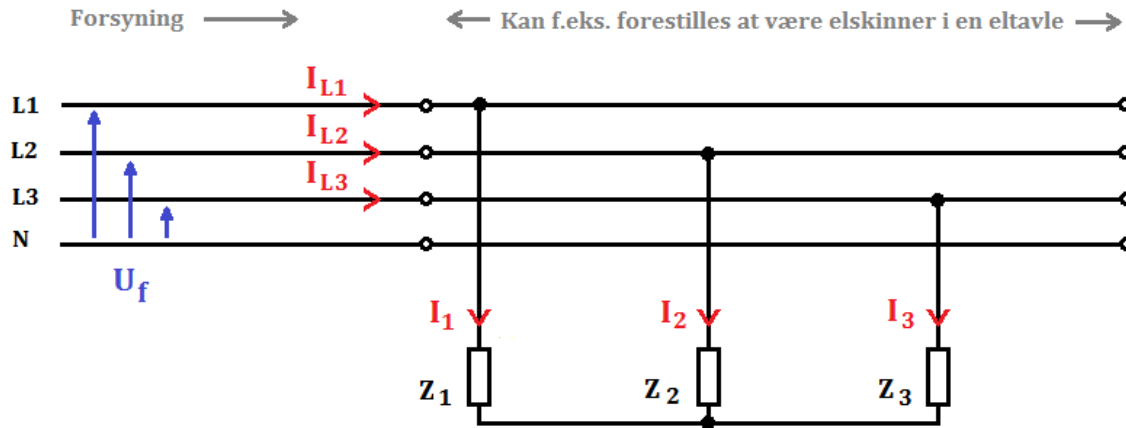
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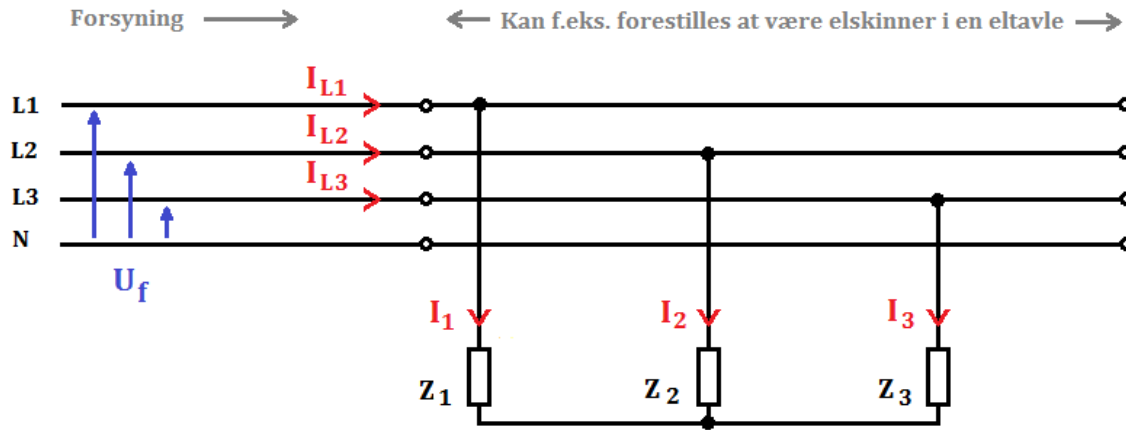
Vektordiagram:

I stedet for en resistiv belastning R, indsætter vi nu 3 impedanser med værdierne:

$$Z_1 = Z_2 = Z_3 = 50 \Omega \angle 35^\circ \text{ induktiv}$$

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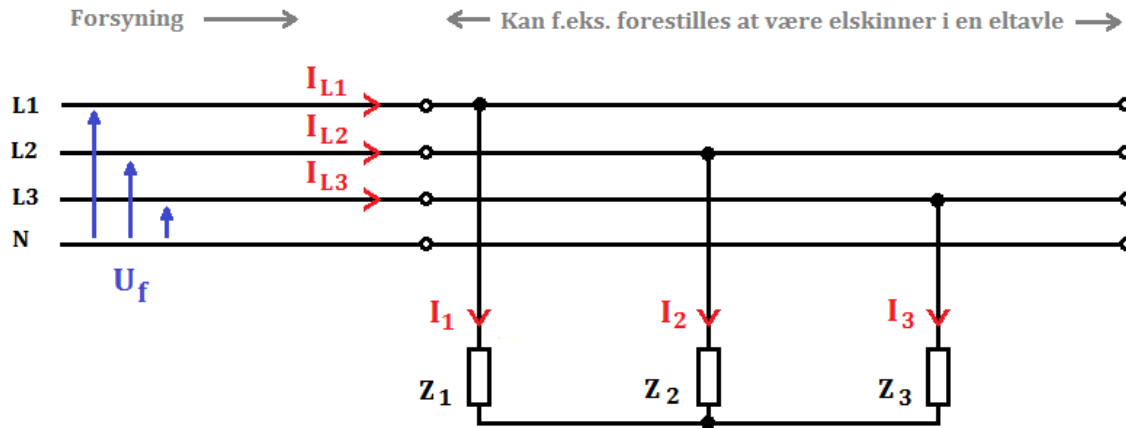
Vektordiagram:

Strømmen er nu:

$$I_n = I_f = \frac{U_f}{Z} \Rightarrow I = \frac{231}{50} = 4,62 \text{ A}$$

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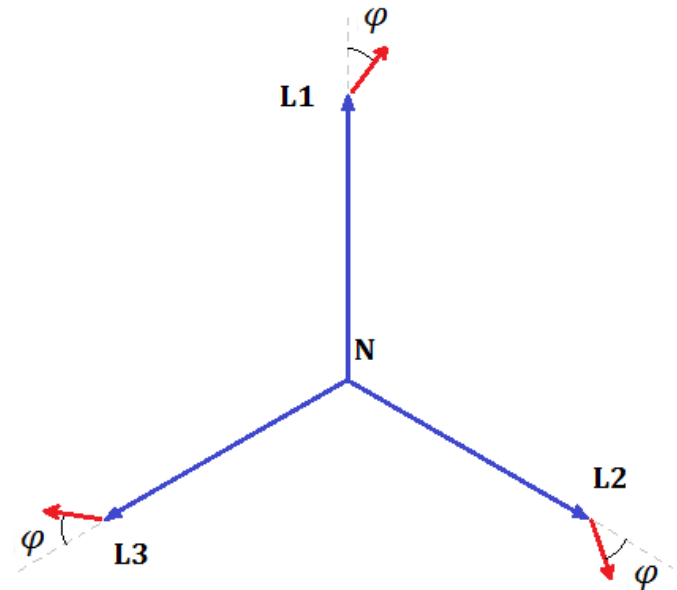
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Skriv ligningen her.

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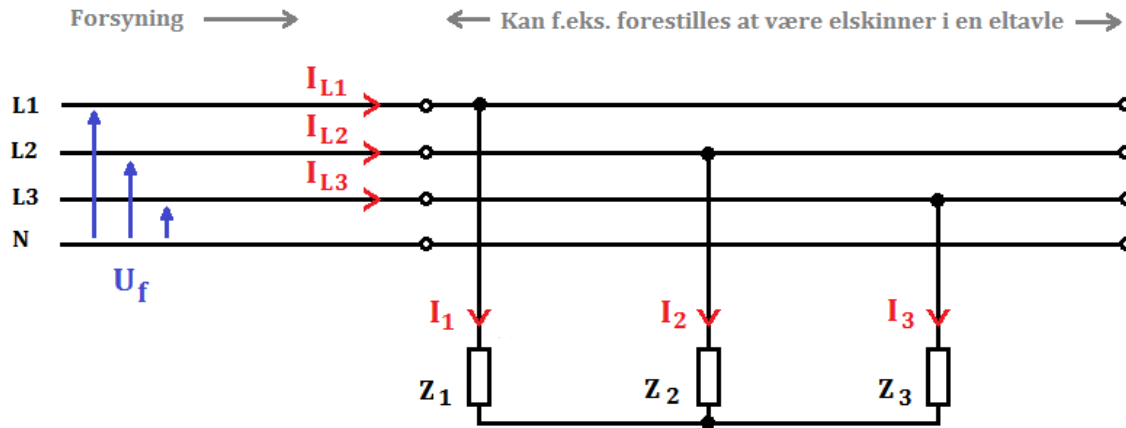
og vektorerne..

Vektordiagram:



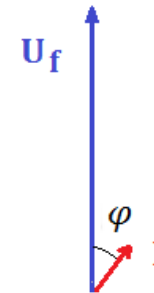
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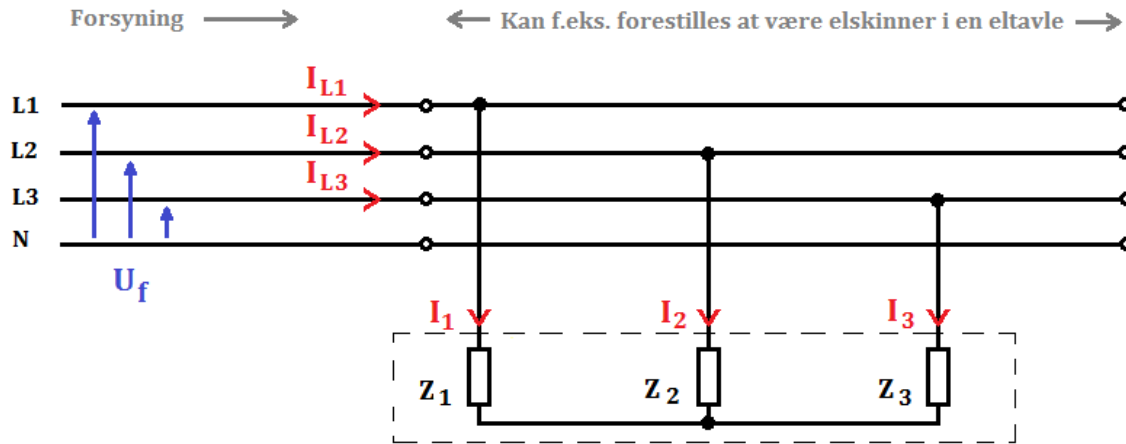
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og vektorerne.. Som også kan illustreres tilfredsstillende med en enkelt fase vist:



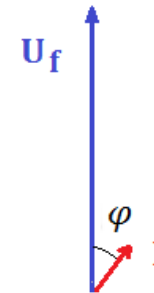
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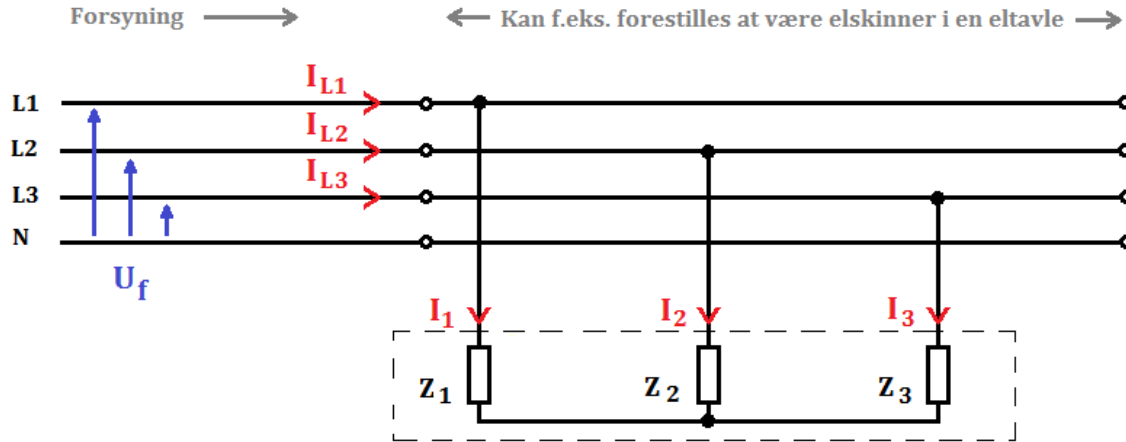
Vektordiagram:



Hvis vi nu betragtede de 3 impedanser som én samlet 3-faset symmetrisk belastning, så kunne man spørge hvilken effekt (S, P og Q) der afsættes i denne belastning!

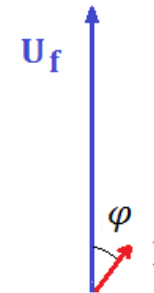
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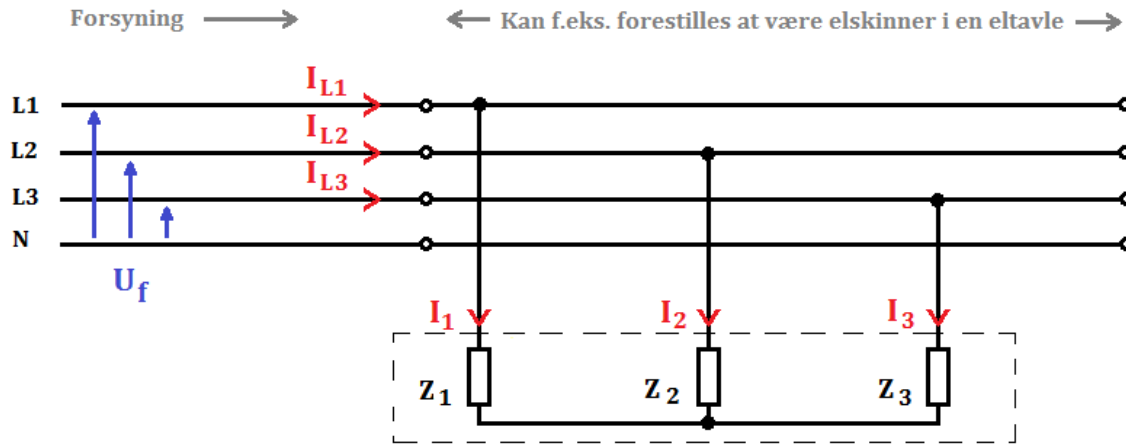


Den tilsyneladende effekt (S):

$$S = 3 \cdot U_f \cdot I_f \quad \Leftrightarrow$$

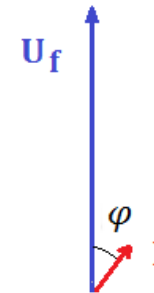
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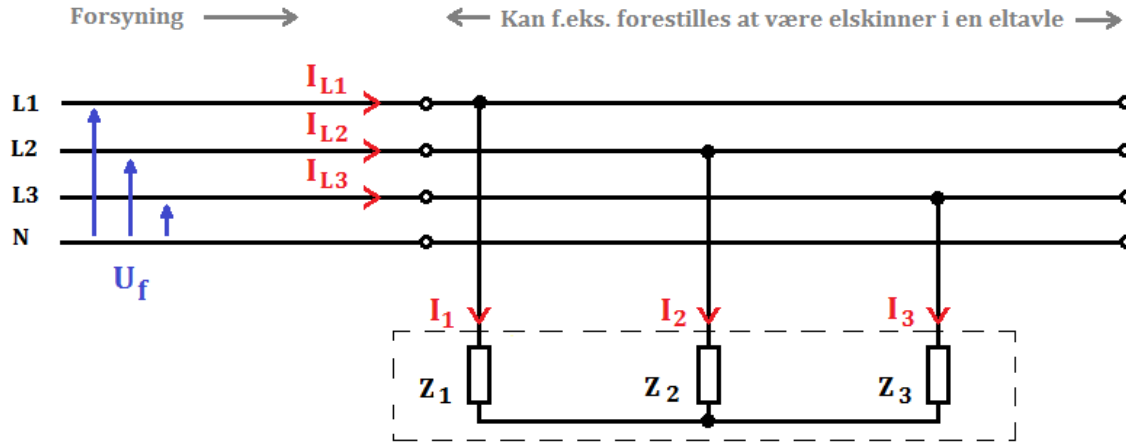


Den tilsyneladende effekt (S):

$$S = 3 \cdot U_f \cdot I_f \quad \Leftrightarrow \quad S = 3 \cdot \frac{U_n}{\sqrt{3}} \cdot I_n \quad \Leftrightarrow$$

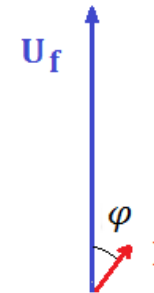
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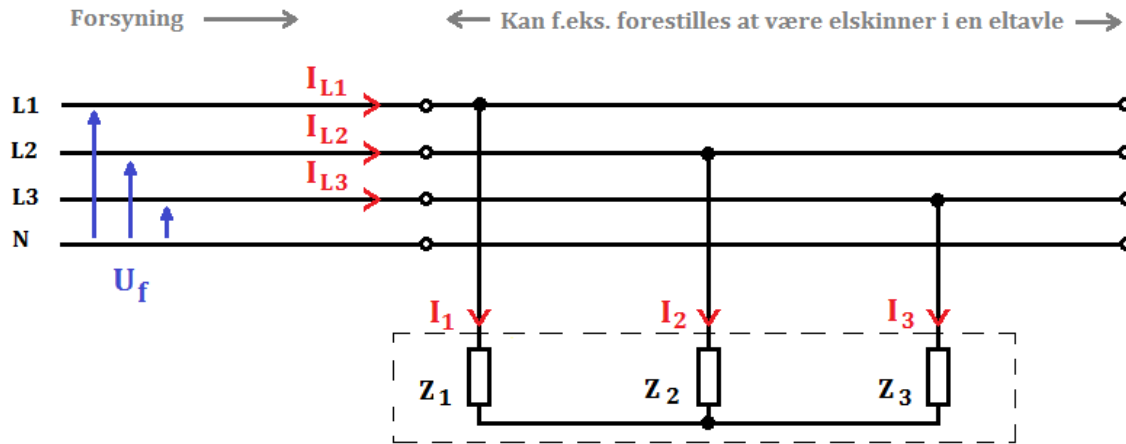
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$$S = \sqrt{3} \cdot U_n \cdot I_n \quad [VA]$$

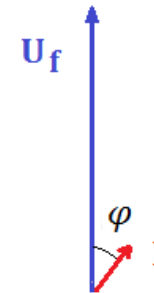
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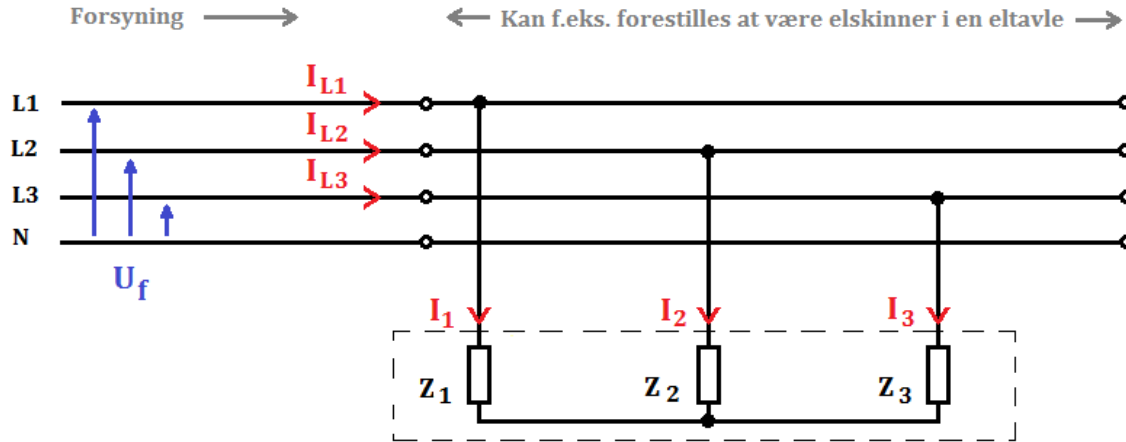


Virkeeffekten (P):

$$P = 3 \cdot U_f \cdot I_f \cdot \cos(\varphi) \quad \Leftrightarrow$$

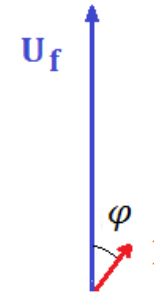
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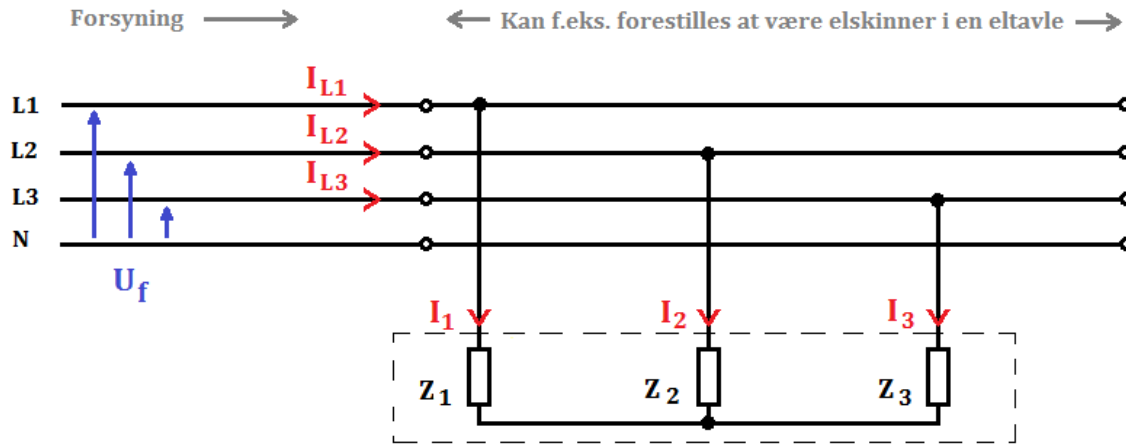


Virkeeffekten (P):

$$P = 3 \cdot U_f \cdot I_f \cdot \cos(\varphi) \quad \Leftrightarrow \quad P = 3 \cdot \frac{U_n}{\sqrt{3}} \cdot I_n \cdot \cos(\varphi) \quad \Leftrightarrow$$

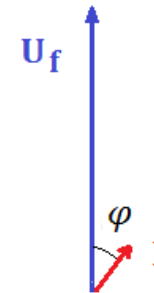
# AC 3 faset symmetrisk belastning

Et fuldstreks kredsskema over stjernekoblet symmetrisk belastning:



$$U_f = 231 \text{ V}$$
$$Z = 50 \Omega \angle 35^\circ$$
$$I = 4,62 \text{ A}$$

Vektordiagram:



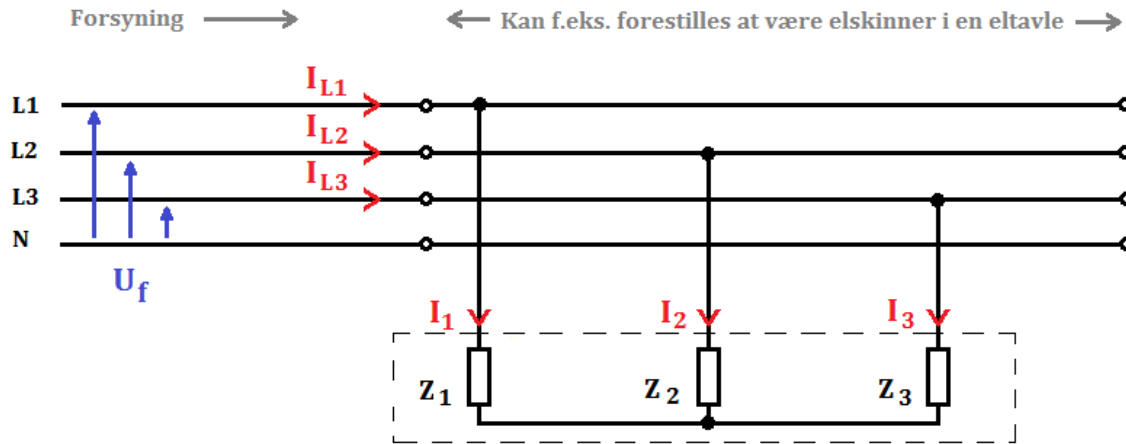
Virkeeffekten (P):

$$P = 3 \cdot U_f \cdot I_f \cdot \cos(\varphi) \quad \Leftrightarrow \quad P = 3 \cdot \frac{U_n}{\sqrt{3}} \cdot I_n \cdot \cos(\varphi) \quad \Leftrightarrow$$

$$P = \sqrt{3} \cdot U_n \cdot I_n \cdot \cos(\varphi) \quad [W]$$

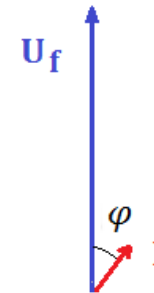
# AC 3 faset symmetrisk belastning

Et fuldstreks kredsskema over stjernekoblet symmetrisk belastning:



$$U_f = 231 \text{ V}$$
$$Z = 50 \Omega \angle 35^\circ$$
$$I = 4,62 \text{ A}$$

Vektordiagram:



Den reaktive effekt (Q):

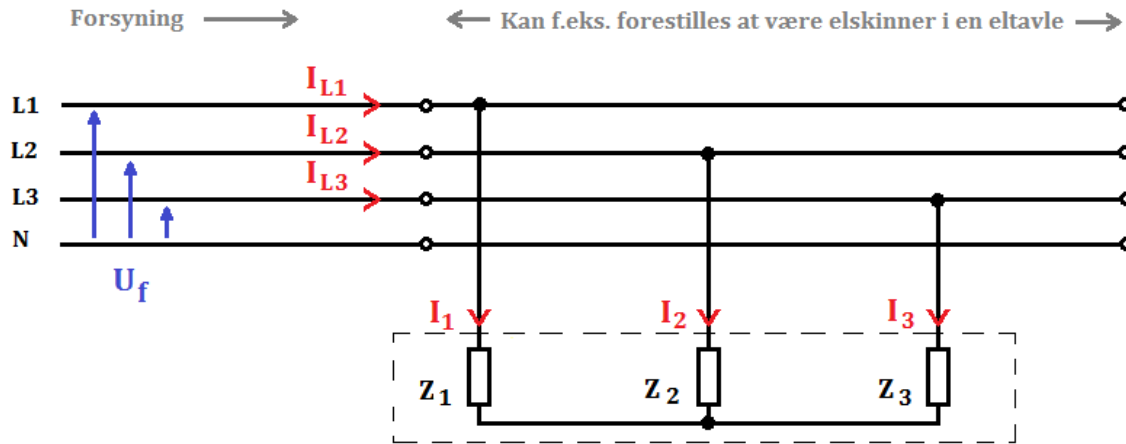
$$Q = 3 \cdot U_f \cdot I_f \cdot \sin(\varphi) \quad \Leftrightarrow \quad Q = 3 \cdot \frac{U_n}{\sqrt{3}} \cdot I_n \cdot \sin(\varphi) \quad \Leftrightarrow$$

$$Q = \sqrt{3} \cdot U_n \cdot I_n \cdot \sin(\varphi) \quad [\text{var}]$$



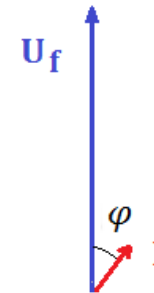
# AC 3 faset symmetrisk belastning

Et fuldstreks kredsskema over stjernekoblet symmetrisk belastning:



$$U_f = 231 \text{ V}$$
$$Z = 50 \Omega \angle 35^\circ$$
$$I = 4,62 \text{ A}$$

Vektordiagram:



Opsummerende beregnes de samlede effekter for 3 fasede symmetriske belastninger (komponenter) som:

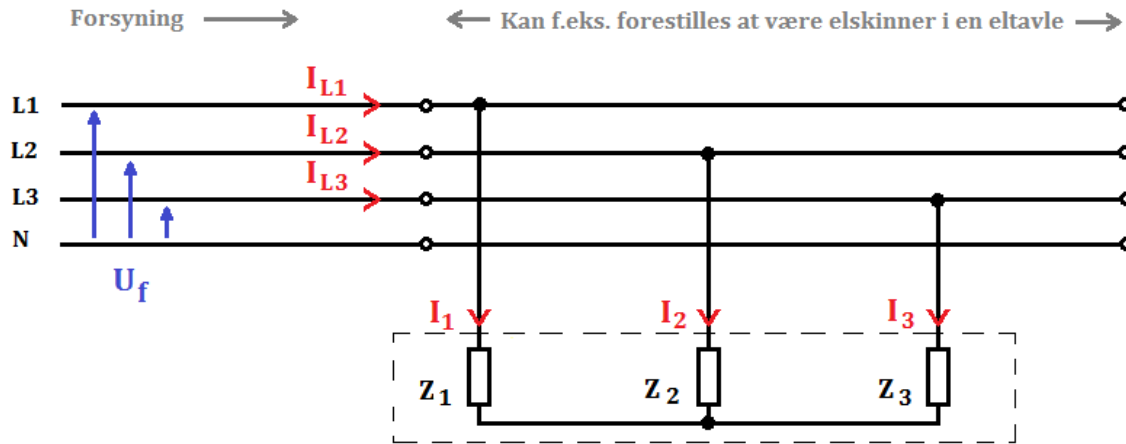
$$S = \sqrt{3} \cdot U_n \cdot I_n \quad [VA]$$

$$P = \sqrt{3} \cdot U_n \cdot I_n \cdot \cos(\varphi) \quad [W]$$

$$Q = \sqrt{3} \cdot U_n \cdot I_n \cdot \sin(\varphi) \quad [var]$$

# AC 3 faset symmetrisk belastning

Et fuldstreks kredsskema over stjernekoblet symmetrisk belastning:



$$U_f = 231 \text{ V}$$
$$Z = 50 \Omega \angle 35^\circ$$
$$I = 4,62 \text{ A}$$

Vektordiagram:

Effekterne i aktuelle eksempel:

$$S = \sqrt{3} \cdot U_n \cdot I_n = \sqrt{3} \cdot (\sqrt{3} \cdot 231) \cdot 4,62 = \mathbf{3200} \quad [\text{VA}]$$

$$P = \sqrt{3} \cdot U_n \cdot I_n \cdot \cos(\varphi) = \sqrt{3} \cdot (\sqrt{3} \cdot 231) \cdot 4,62 \cdot \cos(35) = \mathbf{2620} \quad [\text{W}]$$

$$Q = \sqrt{3} \cdot U_n \cdot I_n \cdot \sin(\varphi) = \sqrt{3} \cdot (\sqrt{3} \cdot 231) \cdot 4,62 \cdot \sin(35) = \mathbf{1840} \quad [\text{var}]$$