

54



5



1.

Y

;

2.

;

3.

4.

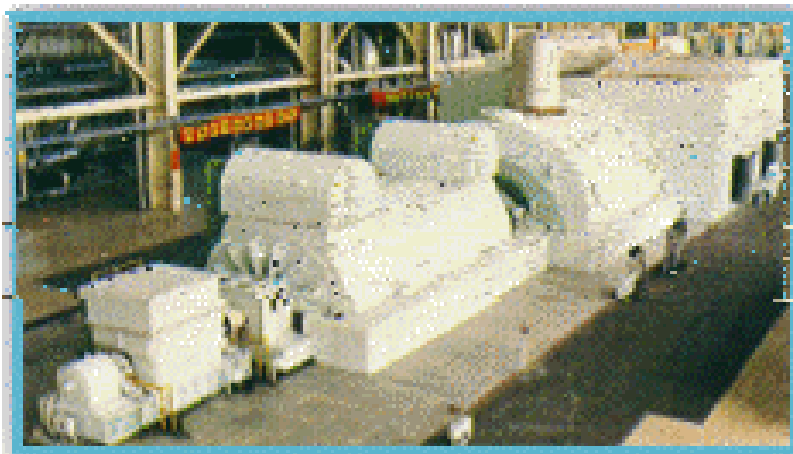
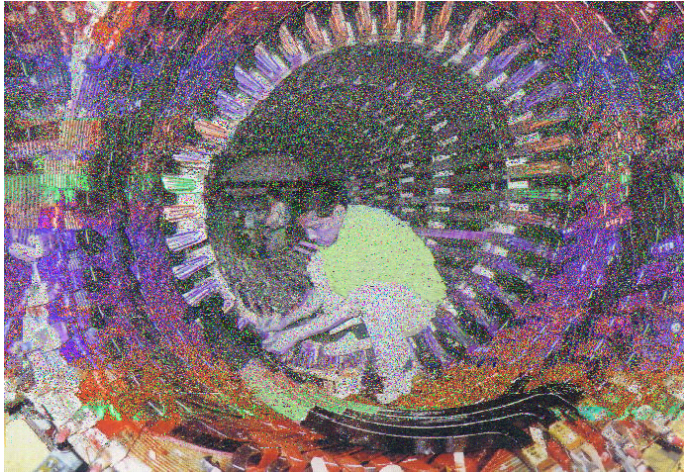
5.1



50%
25



5.1.1



300MW



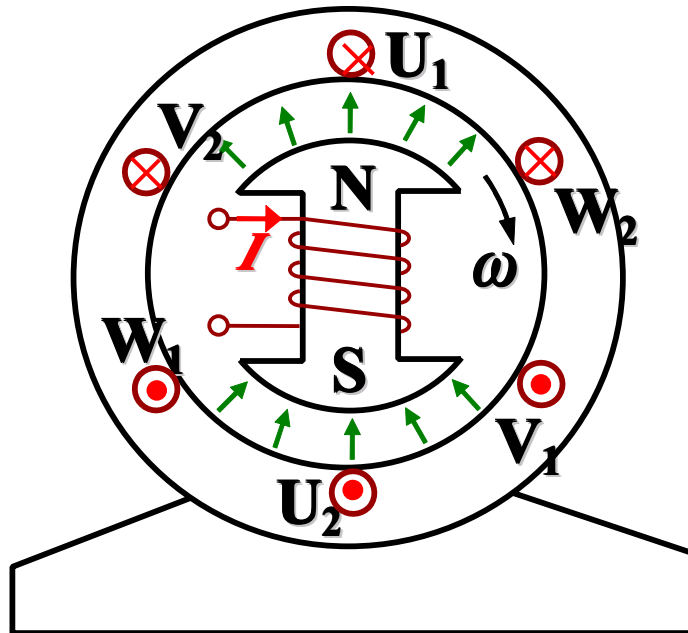
1.



120°

()

ω



120°



2.

(1)

~~$\sin(\sin^{-1}(x)) = x$~~

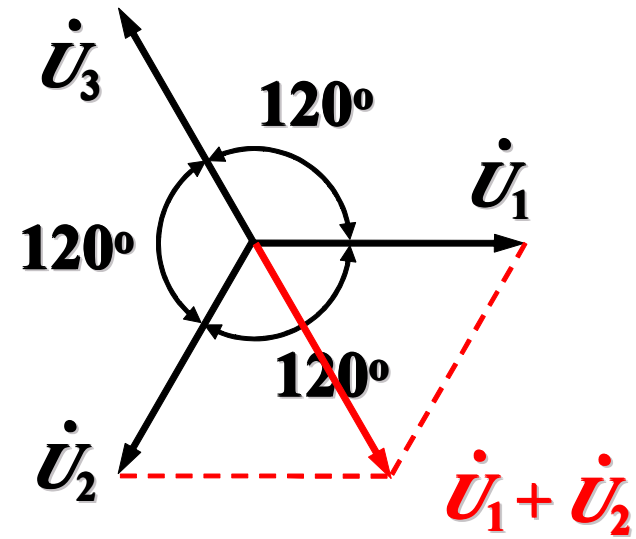
2.

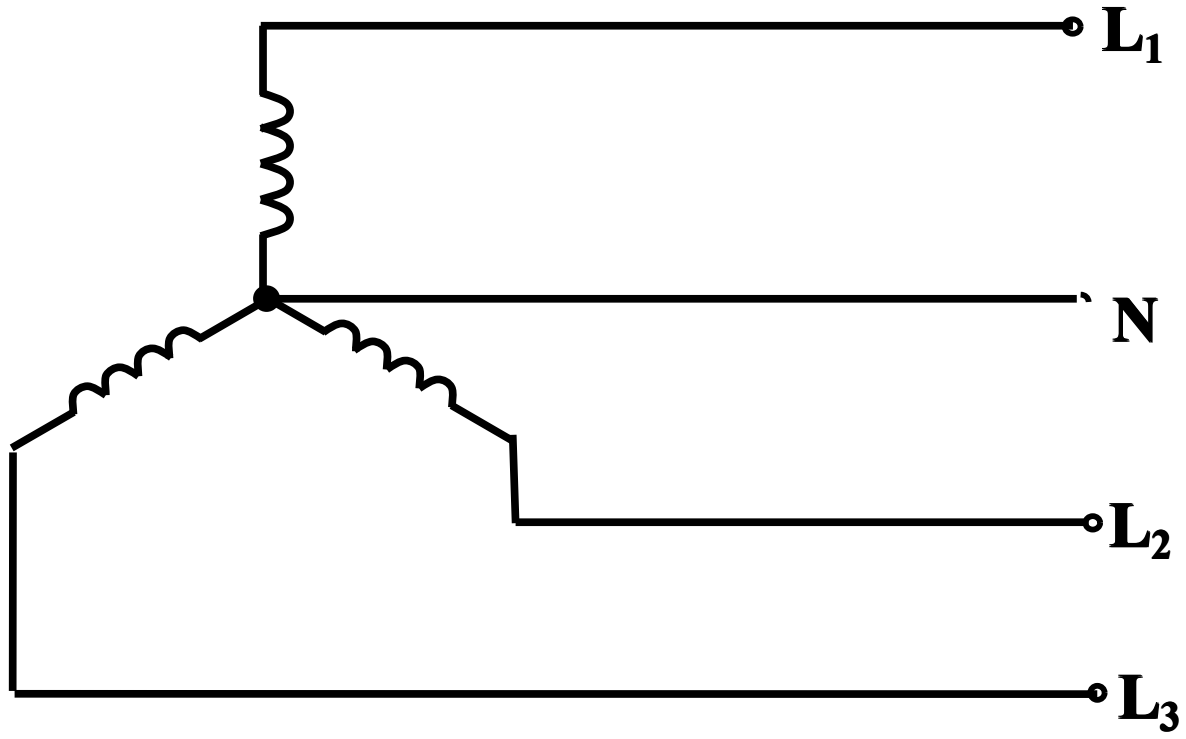


4.

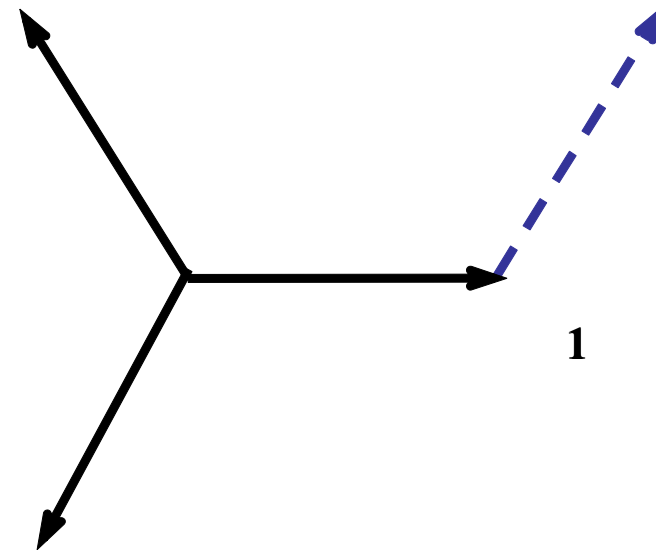
$$\dot{U}_1 + \dot{U}_2 + \dot{U}_3 = 0$$

$$\dot{U}_1 + \dot{U}_2 + \dot{U}_3 = 0$$





(2)



KVL

$$\dot{U}_{12} = \dot{U}_1 - \dot{U}_2$$

$$\dot{U}_{23} = \dot{U}_2 - \dot{U}_3$$

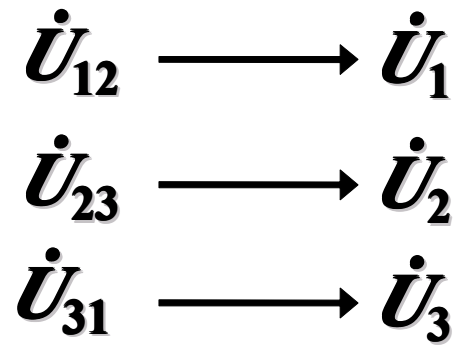
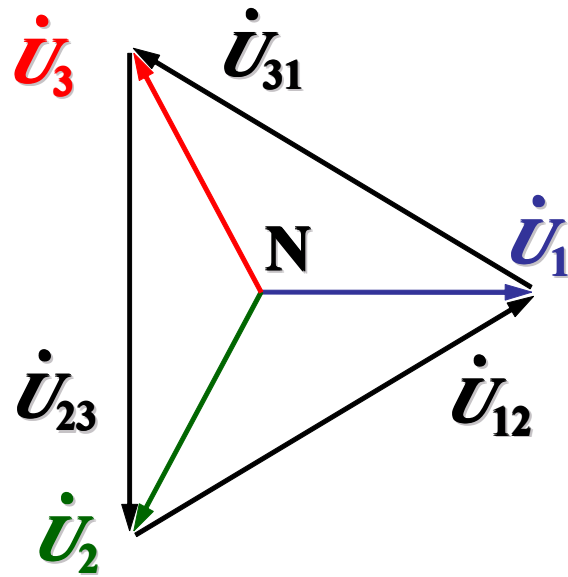
$$\dot{U}_{31} = \dot{U}_3 - \dot{U}_1$$

$$\dot{U}_{12} = \sqrt{3}\dot{U}_1 \underline{/30^\circ}$$



$\sqrt{3}$
 30°

“ ”



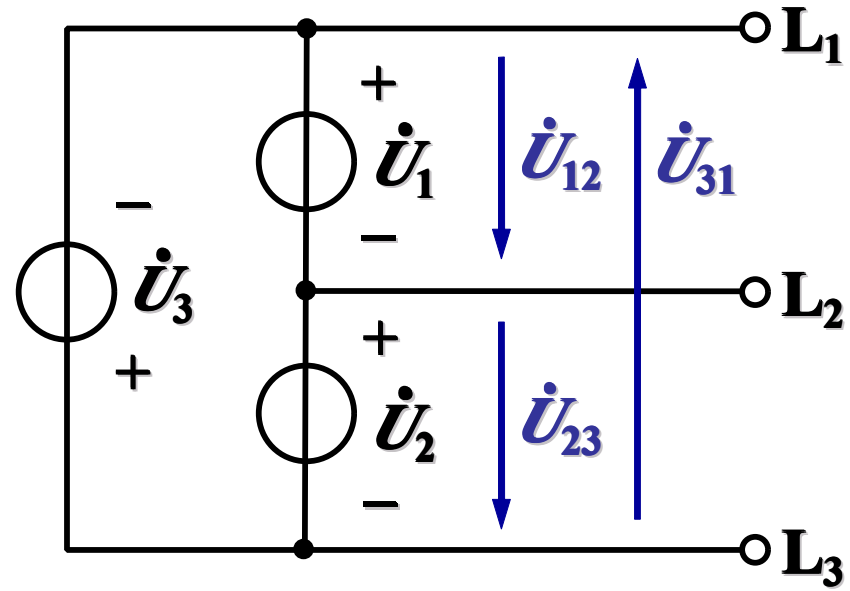
6.

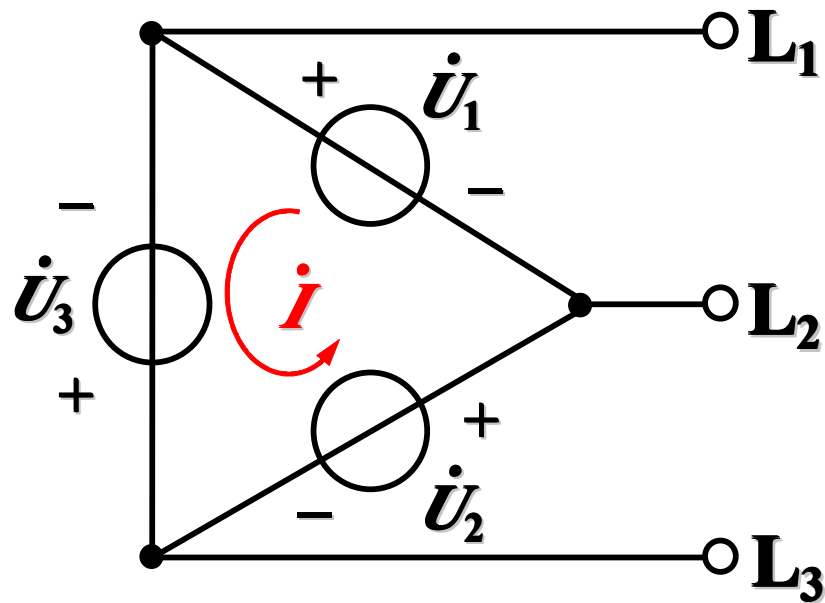


$$\dot{U}_{12} = \dot{U}_1$$

$$\dot{U}_{23} = \dot{U}_2$$

$$\dot{U}_{31} = \dot{U}_3$$

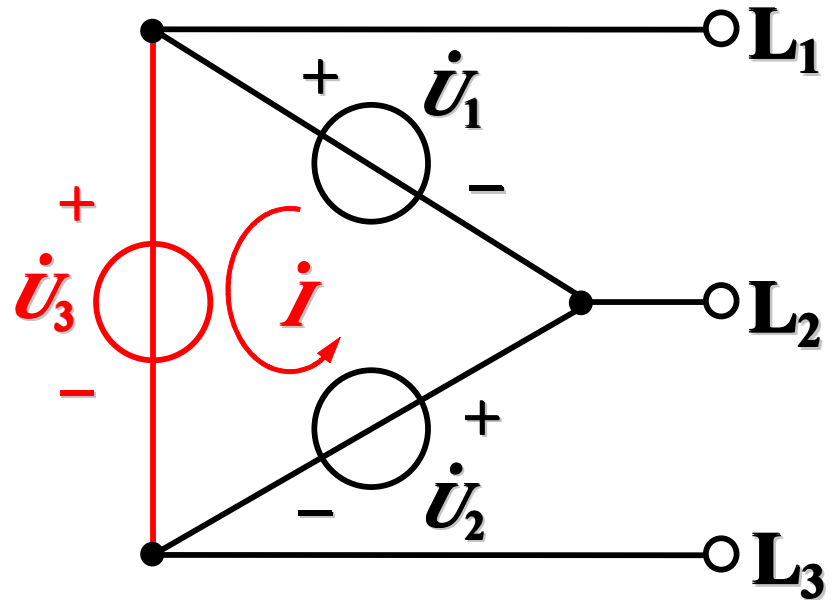




$$\dot{U}_1 + \dot{U}_2 + \dot{U}_3 = 0$$

$$\dot{I} = 0$$

()



$$\begin{aligned} & \dot{U}_1 + \dot{U}_2 - \dot{U}_3 \\ &= \dot{U}_1 + \dot{U}_2 + \dot{U}_3 - 2\dot{U}_3 \\ &= -2\dot{U}_3 \quad \dot{I} \quad 0 \end{aligned}$$



5.1.2

1.

{

{

$$1 = 2 = 3$$

$$1 = 2 = 3$$

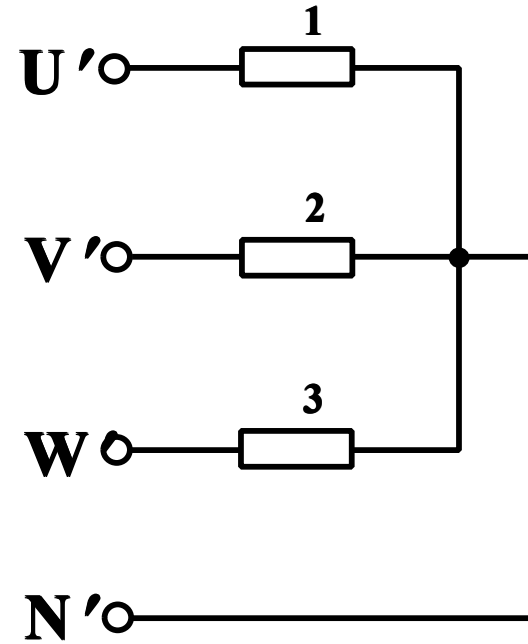
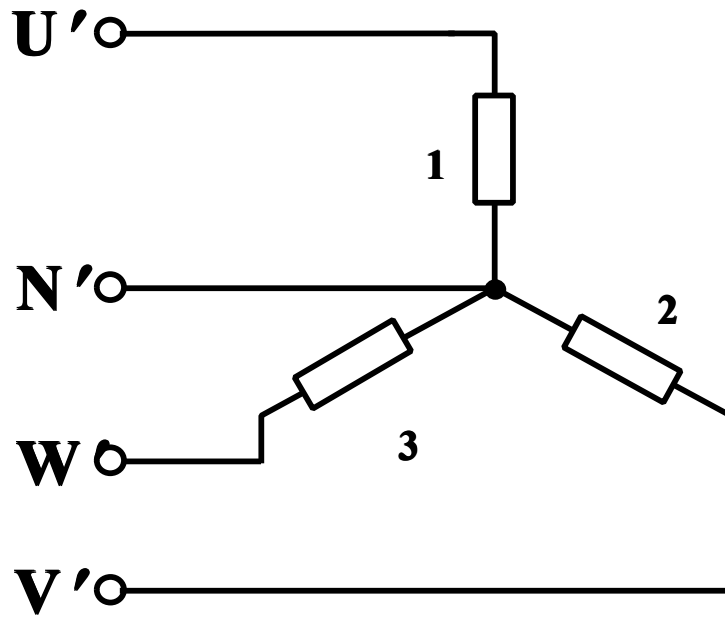


2.



Y Δ

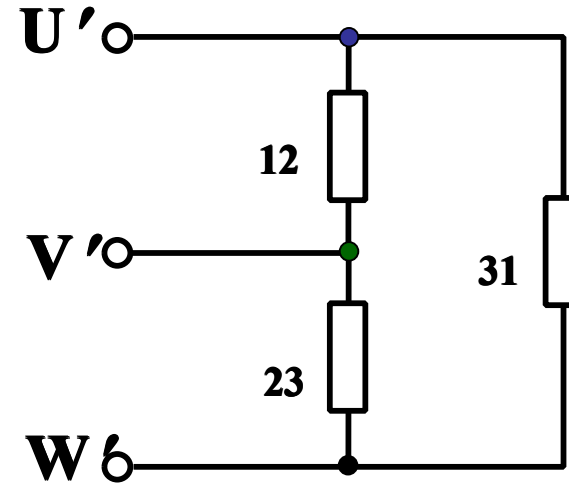
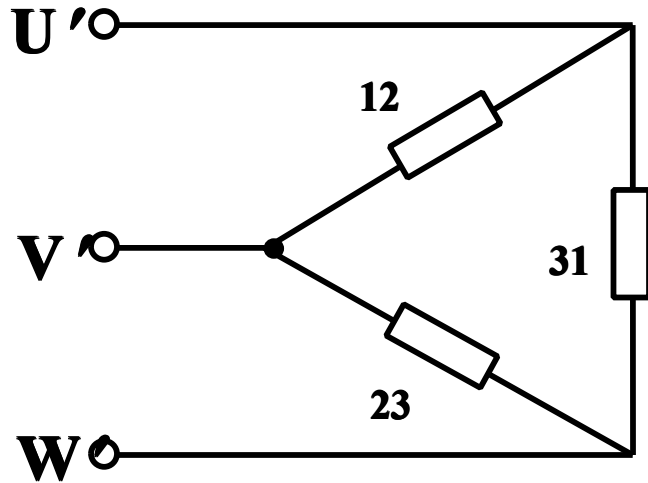
(1) (Y)



$1 = 2 = 3$



(2) ()



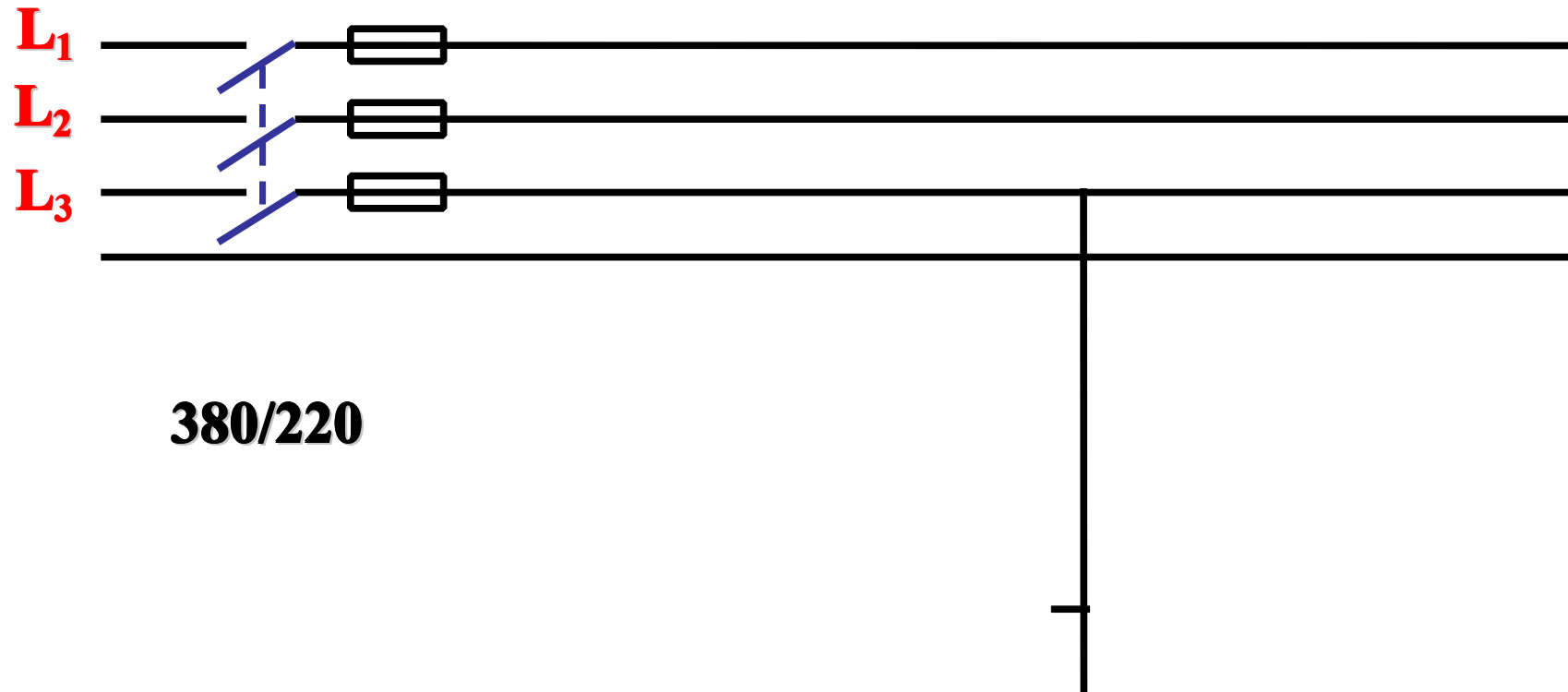
$\text{①} \quad 12 = 23 = 31$



(1)

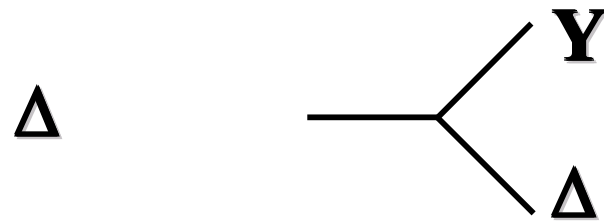
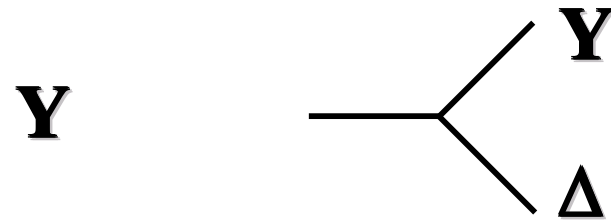
=

(2)



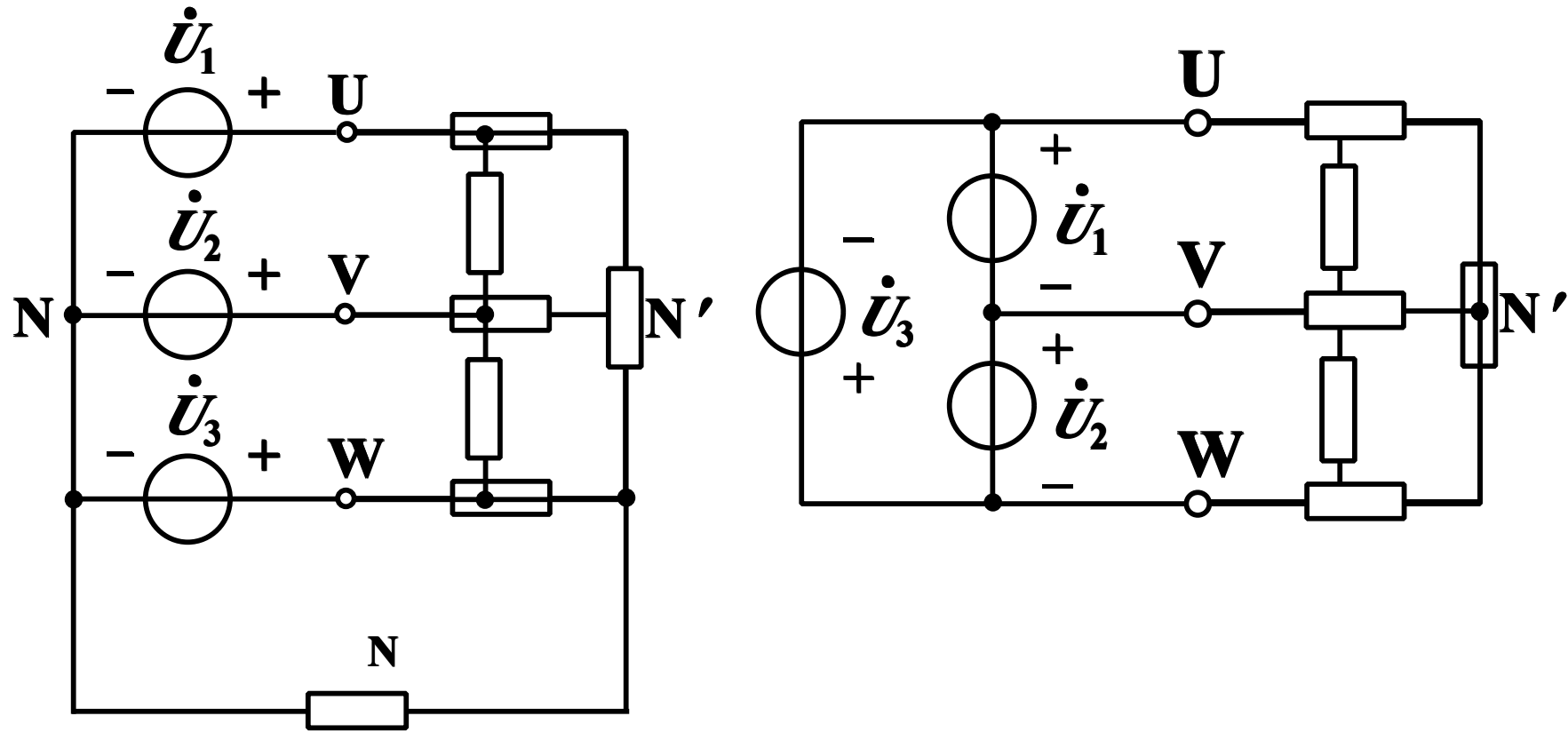
380/220

5.1.3





1. _____ $Y-N$ $Y-Y$ - $-Y$



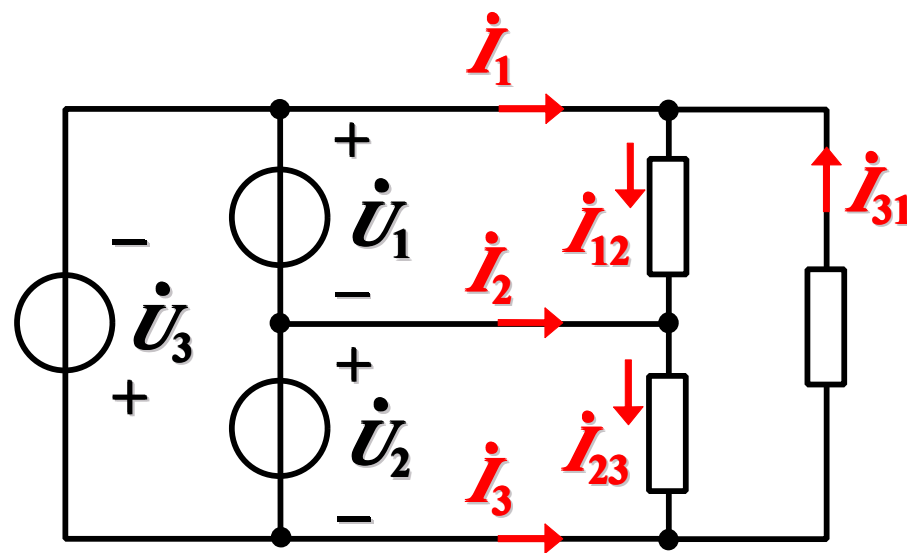
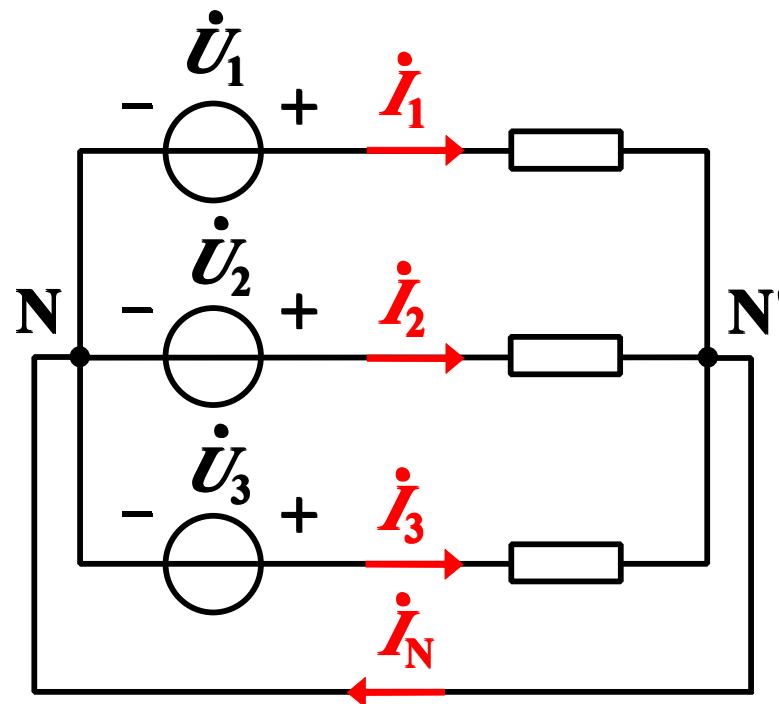
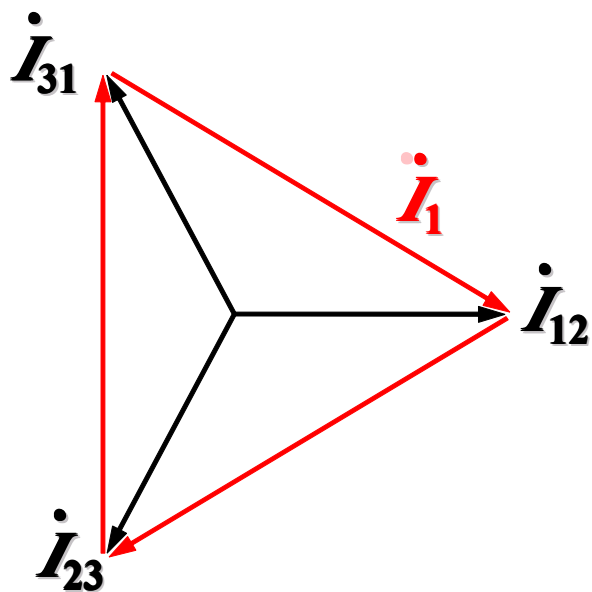
2. _____ $Y_{N'}-Y_{N'}$ $Y-Y$

3.

(1) Y

(2)

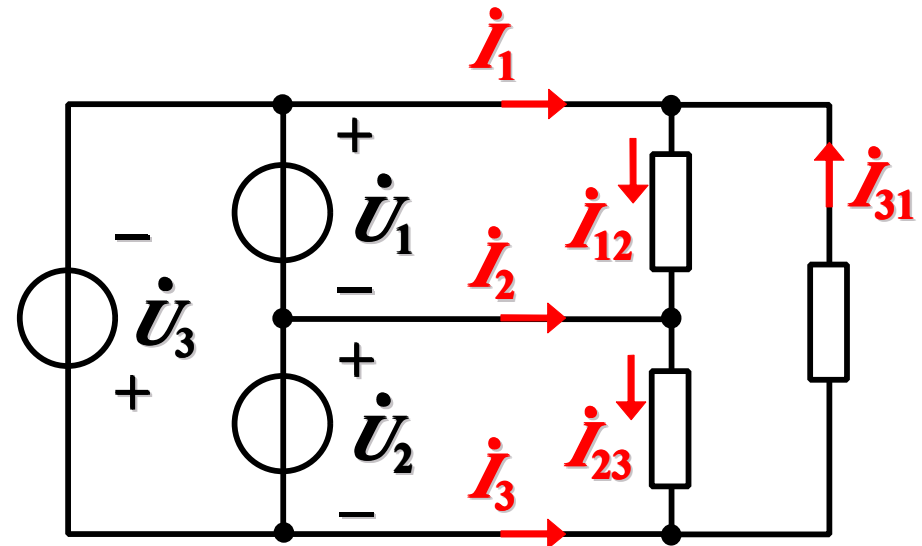
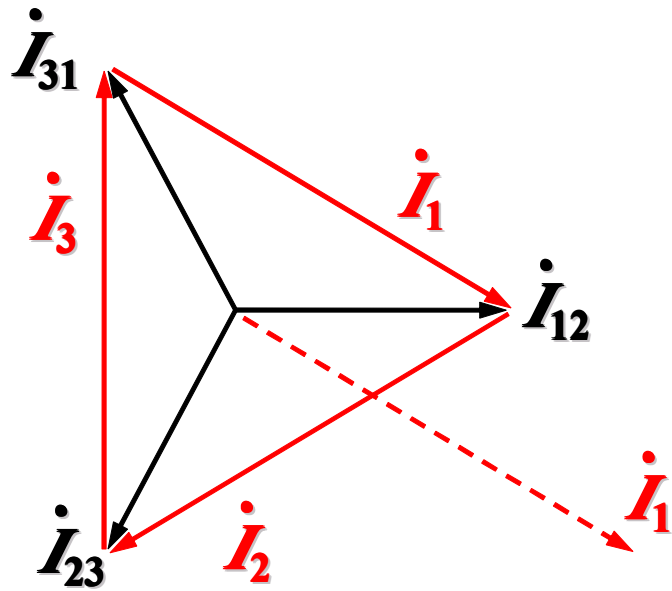
$$\dot{I}_1 = \dot{I}_{12} - \dot{I}_{31} = \sqrt{3} \angle -30^\circ$$





$\sqrt{3}$

30°



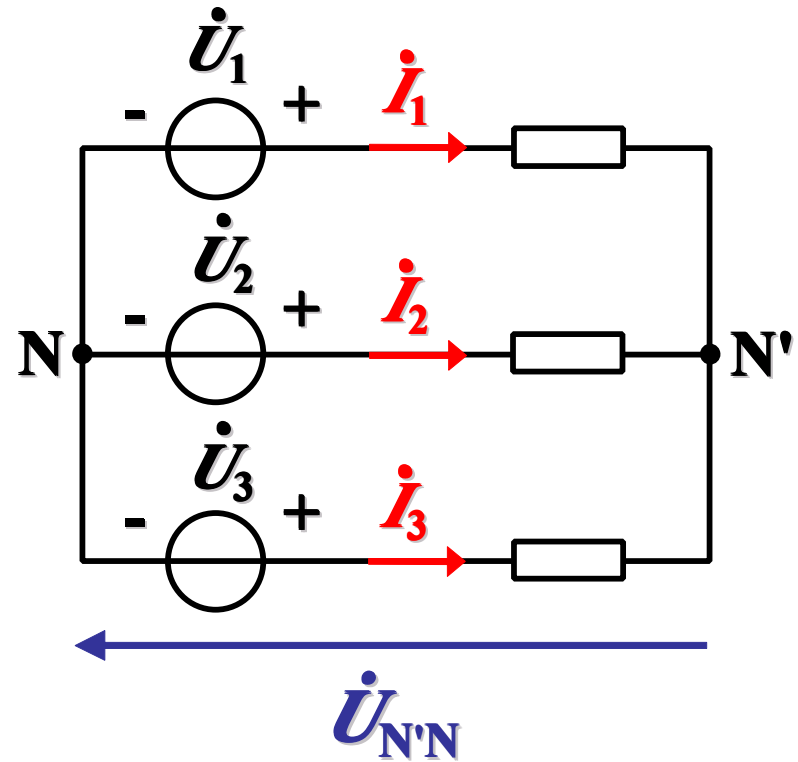
5.2



1. Y-Y $Y_N - Y_{N'}$

$$\dot{U}_{N'N} = \frac{\underline{1} (\dot{U}_1 + \dot{U}_2 + \dot{U}_3)}{\underline{3}} = 0$$

N N'





1) (

2.

Y-

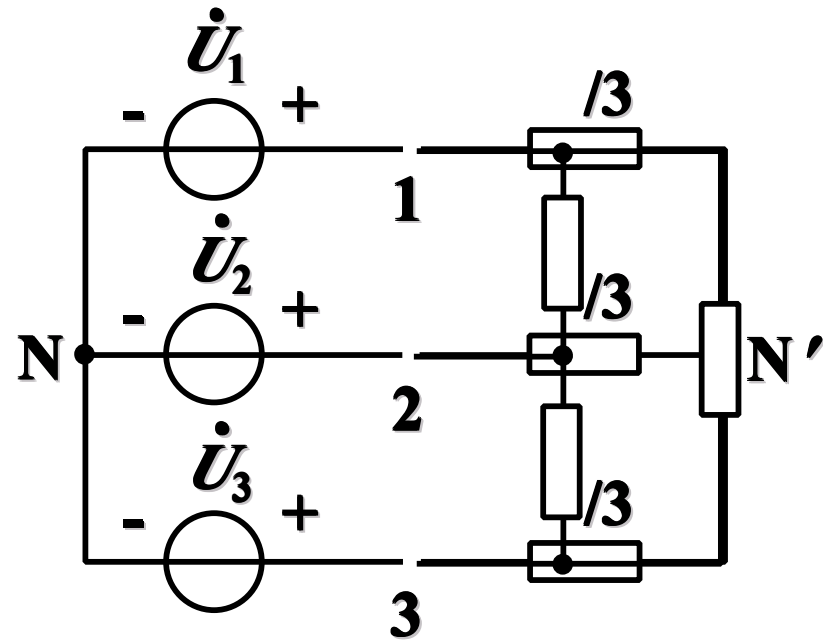
1

Y

(2 3)

Y-Y

$$Y = \frac{1}{3}$$



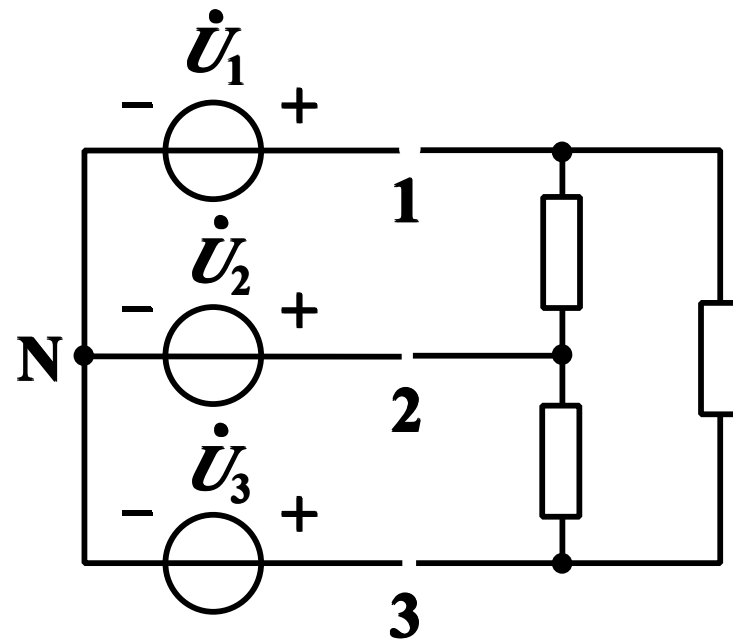
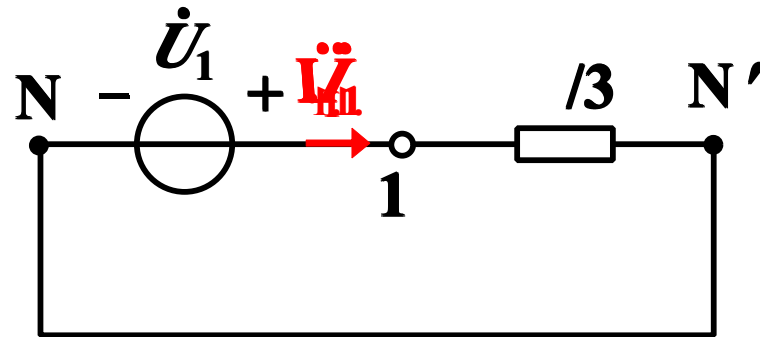
$$\dot{I}_1 = \frac{\dot{U}_{1N'}}{\sqrt{3}} = \frac{3U_1}{\sqrt{3}} \angle -\varphi$$

$$\dot{I}_1 = \sqrt{3} \dot{I} \angle -30^\circ$$

$$\dot{I} = \frac{\dot{I}_1}{\sqrt{3}} \angle 30^\circ$$

$$= \frac{\sqrt{3} U_1}{\sqrt{3}} \angle 30^\circ - \varphi$$

$$\dot{U} = \sqrt{3} \dot{U}_{1N'} \angle 30^\circ$$





2

$$\dot{U}_1 = U \underline{0^\circ}$$

$$\dot{U}_2 = U \underline{-120^\circ}$$

$$\dot{U}_3 = U \underline{120^\circ}$$

$$= | \quad | \underline{\varphi}$$

$$\dot{U} = \dot{U}_{12} = \sqrt{3} U \underline{30^\circ}$$

$$\dot{U} = \dot{U}_{23} = \sqrt{3} U \underline{-90^\circ}$$

$$\dot{U} = \dot{U}_{31} = \sqrt{3} U \underline{150^\circ} \quad \text{N 3} =$$

$$\dot{I} = \frac{\dot{U}}{\dots}$$

$$\dot{I}_1 = \dot{I} - \dot{I} \\ = \sqrt{3}$$

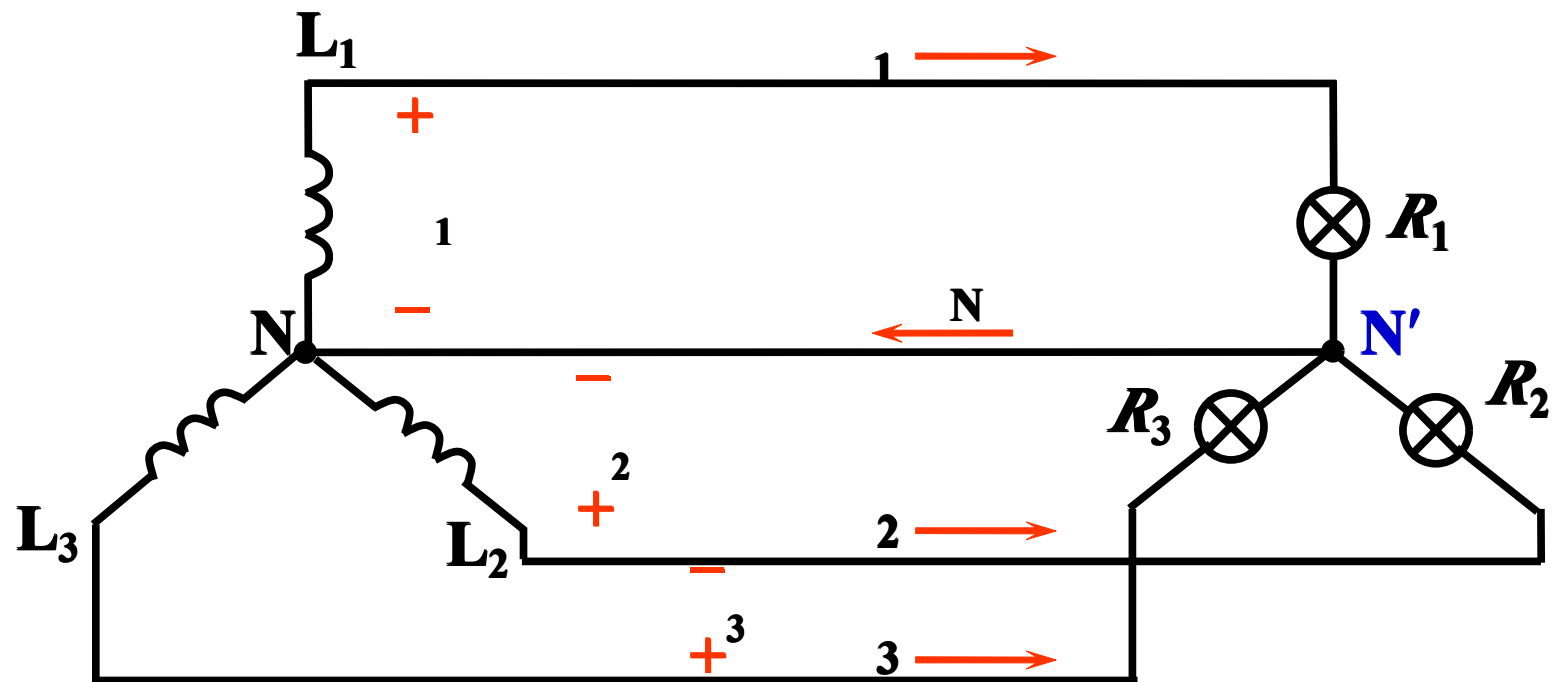


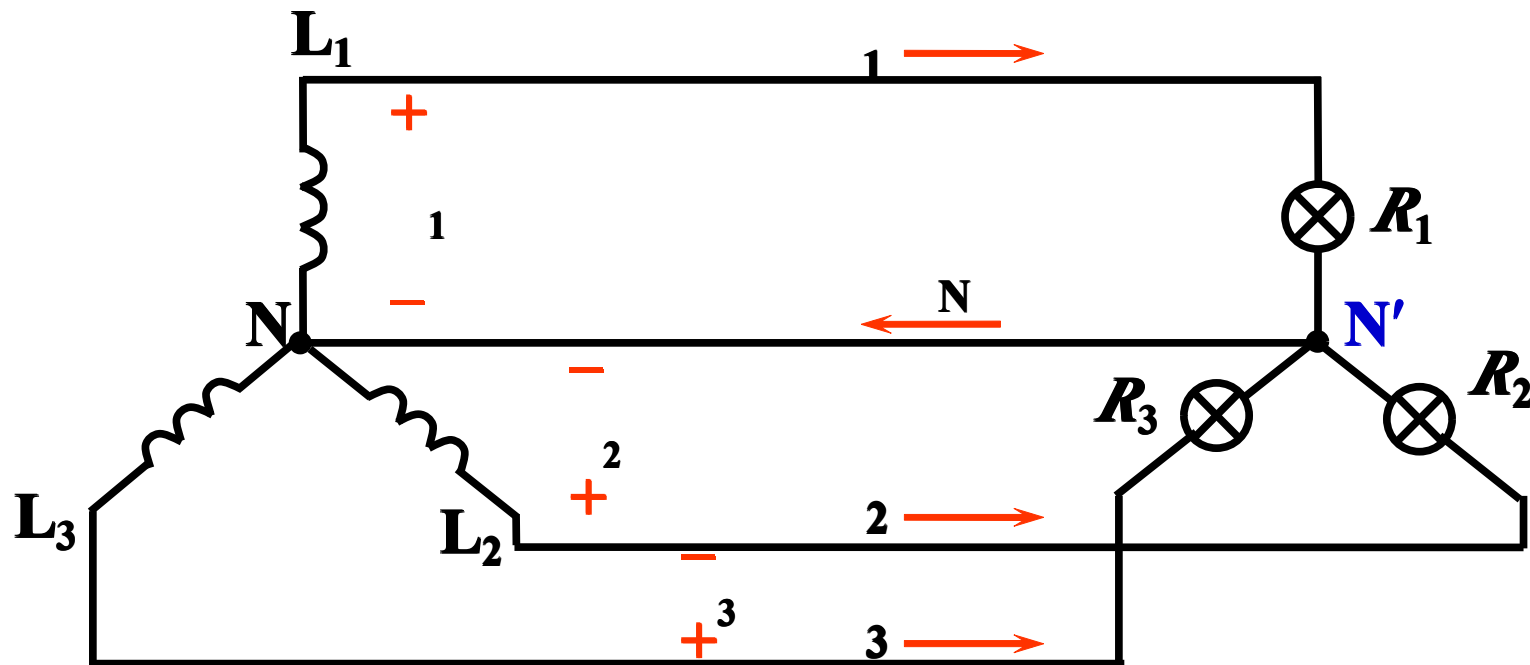
1

$$u_{12} = 380\sqrt{2} \sin(314t + 30^\circ) \text{ V}$$

$$R_1 = R_2 = R_3 = 5\Omega$$

I_N





$$\dot{U}_{12} = 380 \angle 30^\circ \text{ V} \quad \dot{U}_1 = 220 \angle 0^\circ \text{ V}$$

$$\dot{I}_1 = \frac{\dot{U}_1}{R_1} = \frac{220 \angle 0^\circ}{5} = 44 \angle 0^\circ \text{ A}$$

$$\dot{I}_2 = 44 \angle -120^\circ \text{ A} \quad \dot{I}_3 = 44 \angle +120^\circ \text{ A}$$

$$\dot{I}_N = \dot{I}_1 + \dot{I}_2 + \dot{I}_3 = 0$$

5.3



()
()



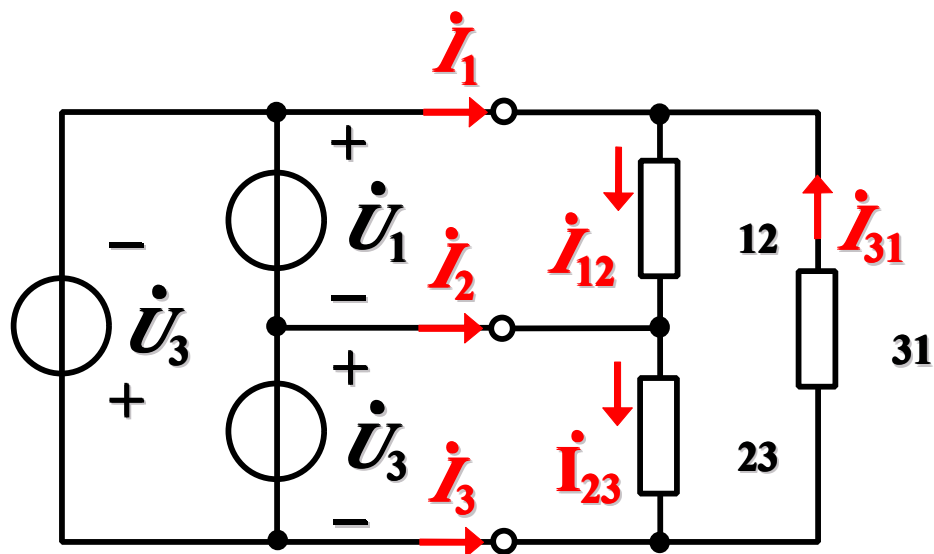
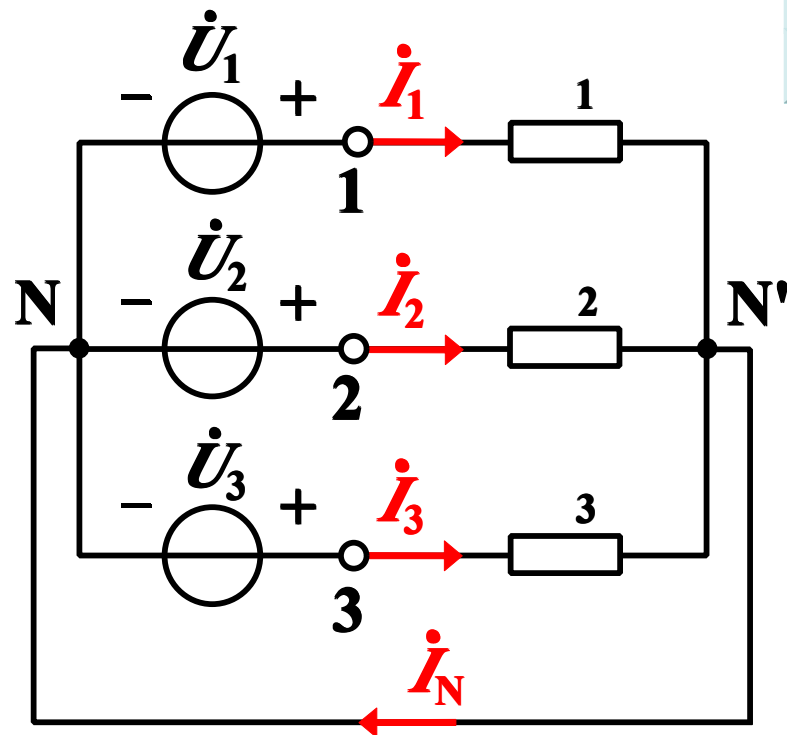
()





(1) $Y_N - Y_{N'}$

$$U_{NN'} = 0$$



(2) -



(3) Y-Y

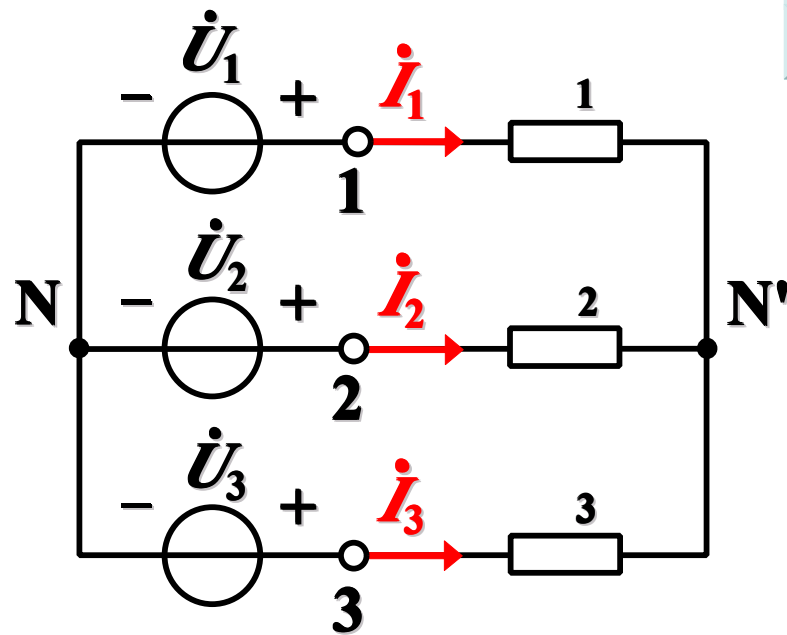
$$U_{NN'} = 0$$

N N'

$$\dot{U}_{NN'}$$

$$\dot{U}_{N'N} = \frac{\dot{U}_{11} + \dot{U}_{22} + \dot{U}_{33}}{1 + 2 + 3}$$

$$\left. \begin{aligned} \dot{U}_{1N'} &= \dot{U}_1 - \dot{U}_{N'N} \\ \dot{U}_{2N'} &= \dot{U}_2 - \dot{U}_{N'N} \\ \dot{U}_{3N'} &= \dot{U}_3 - \dot{U}_{N'N} \end{aligned} \right\} \rightarrow$$



1

220V

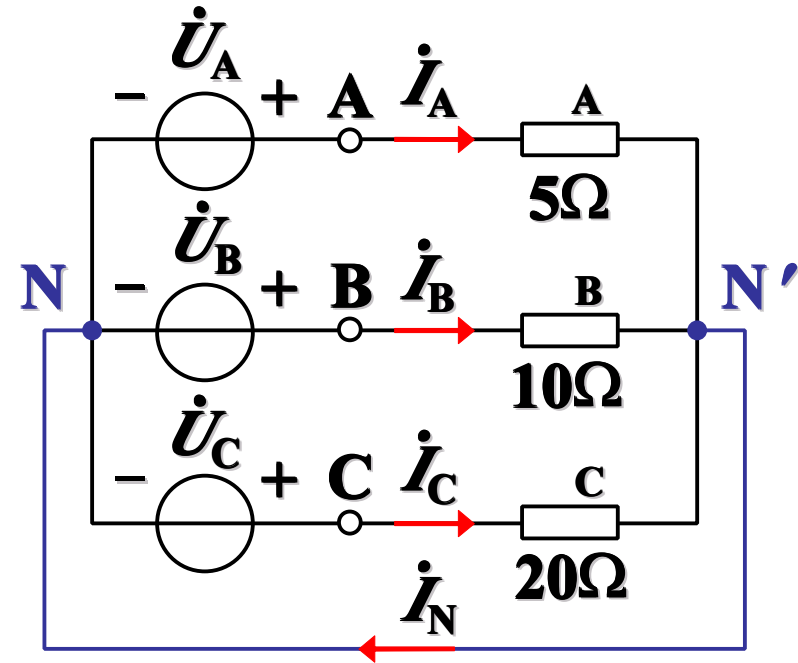
1

$N=0$

$$\dot{U}_A = 220 \angle 0^\circ \text{ V}$$

$$\dot{I}_A = \frac{\dot{U}_A}{Z_A} = \frac{220 \angle 0^\circ}{5} \\ = 44 \angle 0^\circ \text{ A}$$

$$\dot{I}_B = \frac{\dot{U}_B}{Z_B} = 22 \angle -120^\circ \text{ A}$$



$$\dot{I}_C = \frac{\dot{U}_C}{Z_C} = 11 \angle 120^\circ \text{ A}$$

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

$$= 44 \angle 0^\circ + 22 \angle -120^\circ + 11 \angle 120^\circ$$

$$= 29.1 \angle -19^\circ \text{ A}$$

2

A

A

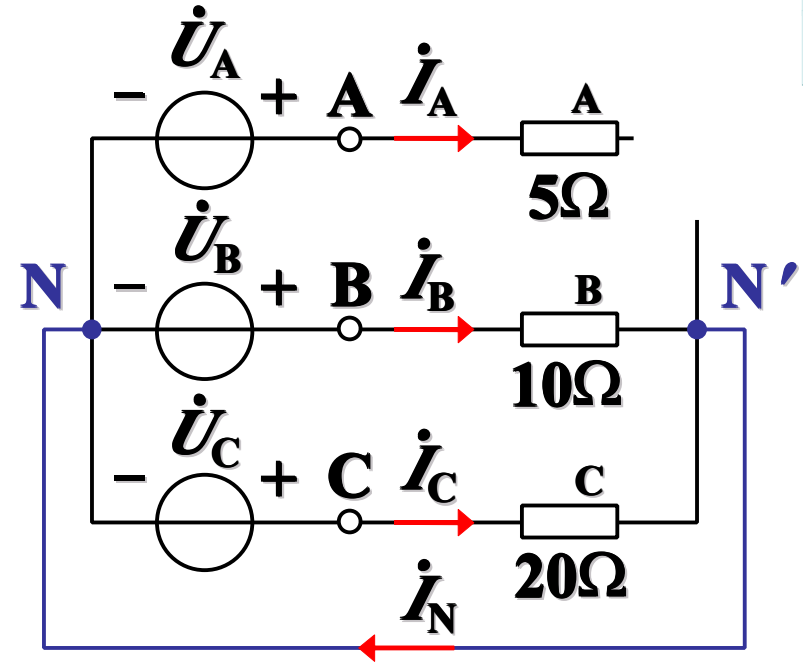
$$, \dot{I}_A = 0$$



B C

$$\dot{I}_B = \frac{\dot{U}_B}{B} = 22 / -120^\circ \text{ A}$$

$$\dot{I}_C = \frac{\dot{U}_C}{C} = 11 / 120^\circ \text{ A}$$



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

$$= 22 / -120^\circ + 11 / 120^\circ$$

$$= 19.01 / -150.2^\circ \text{ A}$$

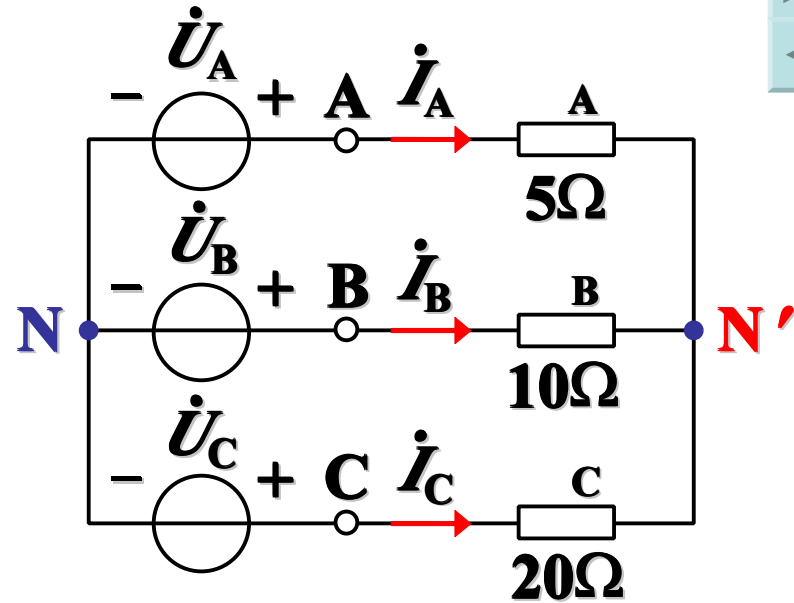
3

$$\begin{aligned}\dot{U}_{N'N} &= \frac{\dot{U}_A \quad A + \dot{U}_B \quad B + \dot{U}_C \quad C}{A + B + C} \\ &= \frac{1 \quad \dot{I}_N}{0.35} = \underline{83.1 / -19^\circ \text{ V}}\end{aligned}$$

$$\dot{U}_{AN'} = \dot{U}_A - \dot{U}_{N'N} = \underline{144 / 10.8^\circ \text{ V}}$$

$$\dot{U}_{BN'} = \dot{U}_B - \dot{U}_{N'N} = \underline{250 / -139.1^\circ \text{ V}}$$

$$\dot{U}_{CN'} = \dot{U}_C - \dot{U}_{N'N} = \underline{288 / 131^\circ \text{ V}}$$

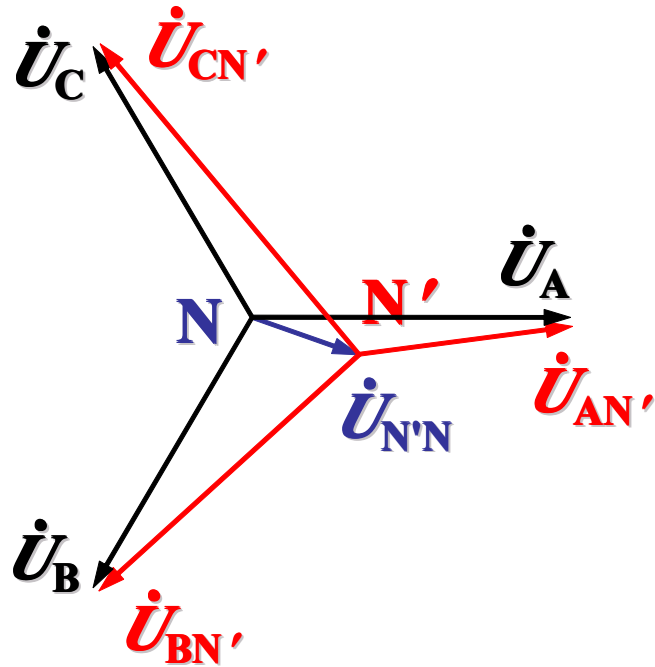
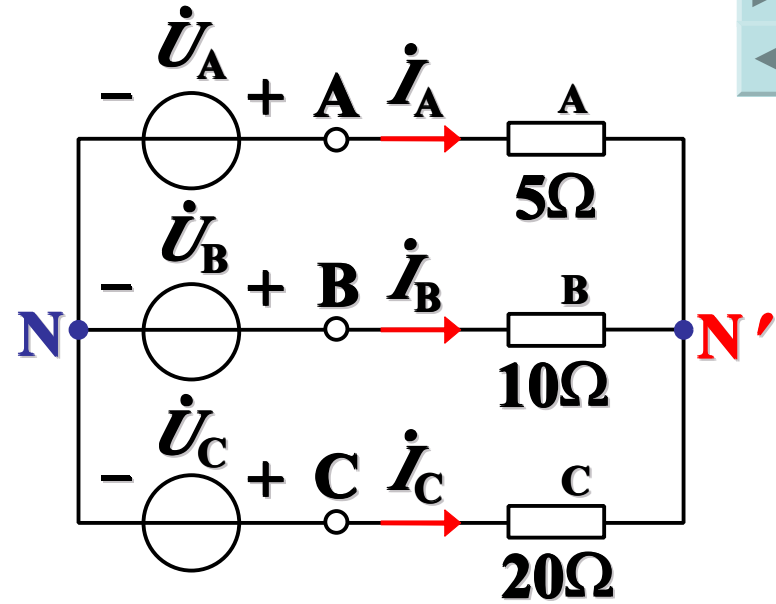




$$\dot{U}_{AN'} = \dot{U}_A - \dot{U}_{N'N}$$

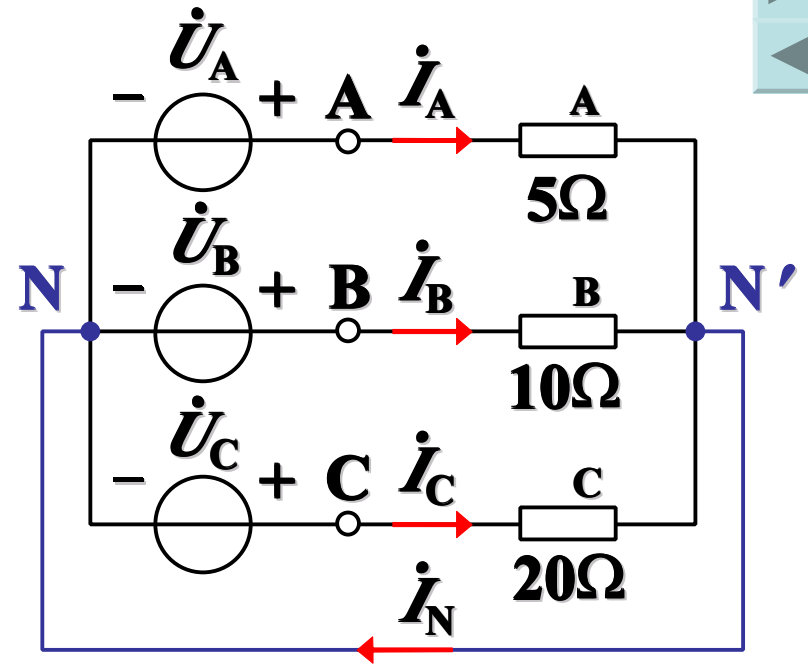
$$\dot{U}_{BN'} = \dot{U}_B - \dot{U}_{N'N}$$

$$\dot{U}_{CN'} = \dot{U}_C - \dot{U}_{N'N}$$

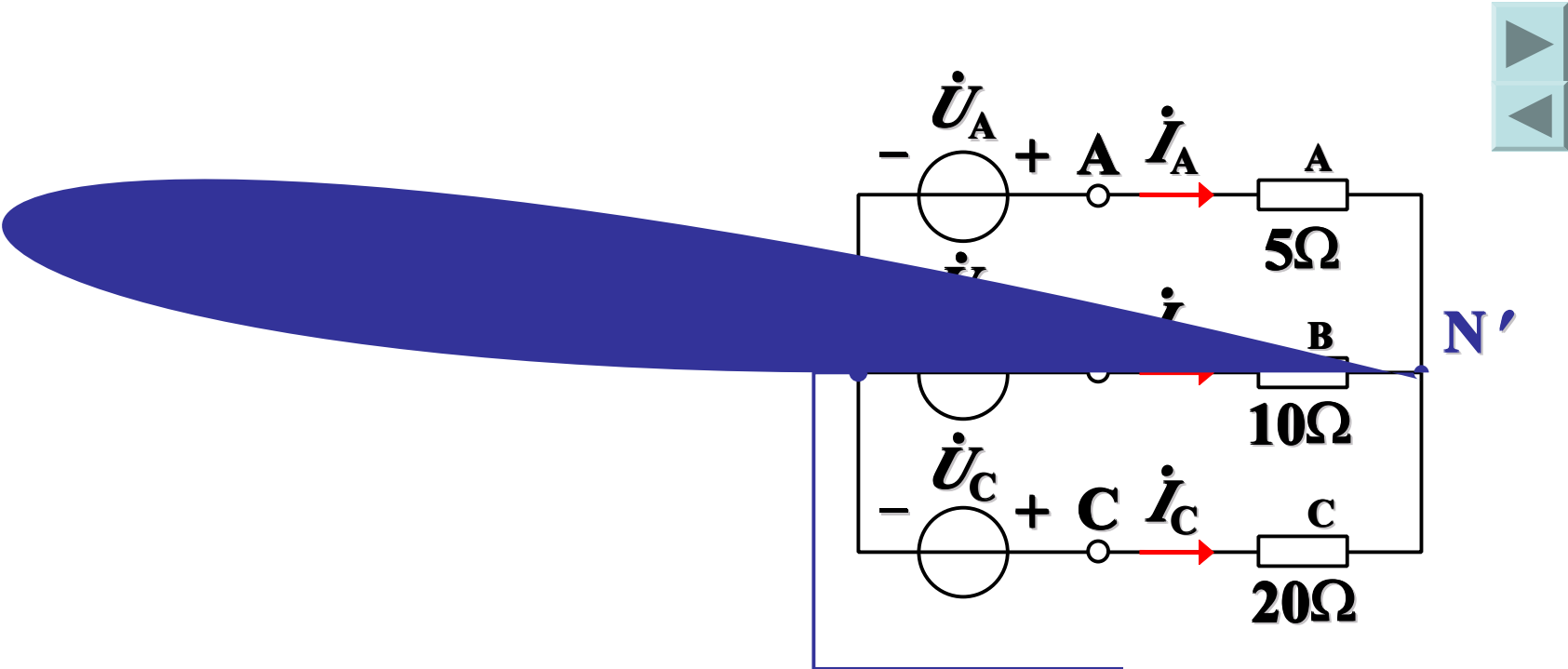


(N 0)





Y



4

A

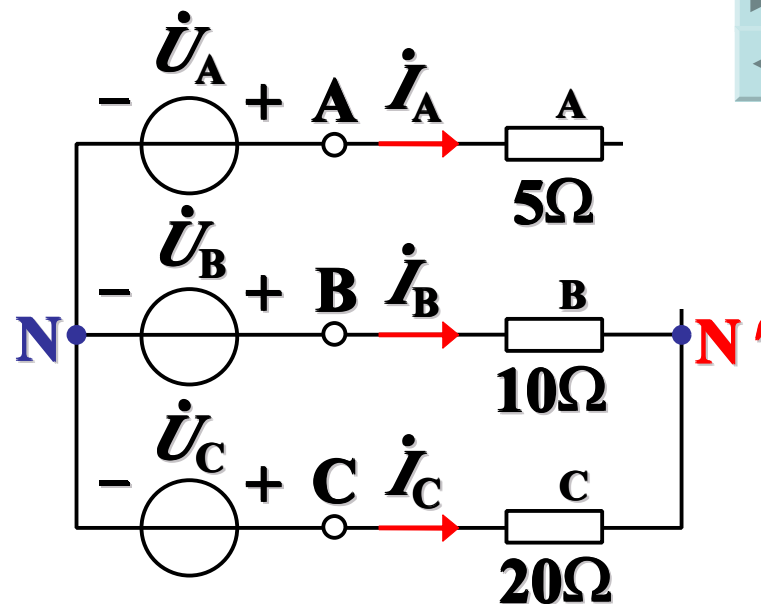


(1)

B

C

$$U_{BC}$$



$$U_{BN'} = \frac{B}{B+C} U_{BC} = \frac{10 \times 380}{30} = 126.7V$$

$$U_{CN'} = \frac{C}{B+C} U_{BC} = 253.3V$$

$$U_{BN'} = U_{CN'} = 190V$$

(2)A

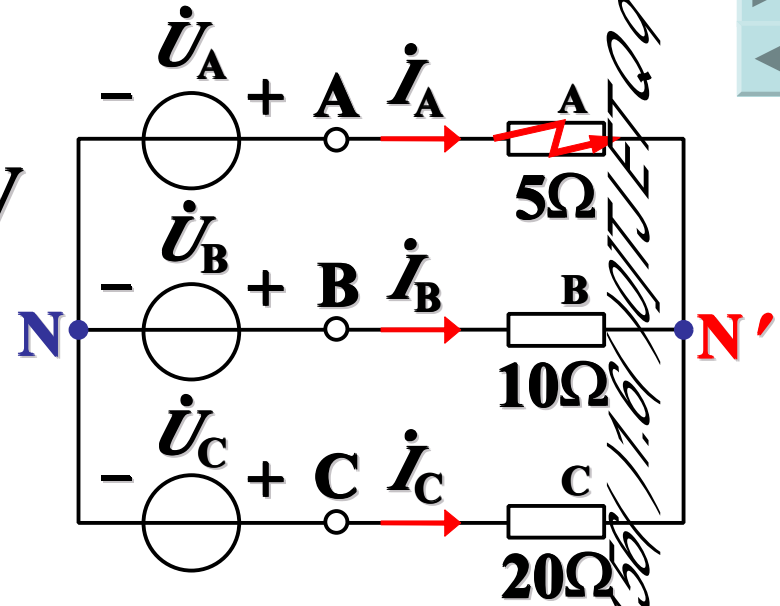
$$\dot{U}_{BN} = \dot{U}_{BA} = \dot{U}_{CN} = \dot{U}_{CA} = 380\text{V}$$

(220V)

$$\dot{U}_A = 220 \angle 0^\circ$$

$$\dot{I}_B = \frac{\dot{U}_{BA}}{10} = \frac{380 \angle 30^\circ}{10}$$

$$\dot{I}_C = \frac{\dot{U}_{CA}}{20} = \frac{380 \angle 150^\circ}{20}$$



;

385 1011 E T Q Q 9 5 144 361 11.61 1011 E T Q Q 9 100

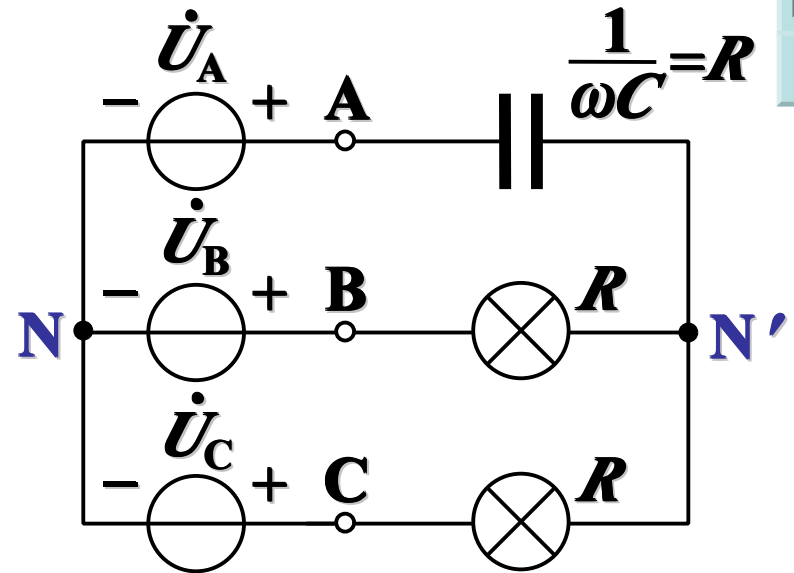
2

$$\dot{U}_{N'N} = \frac{j\omega C \dot{U}_A + G(\dot{U}_B + \dot{U}_C)}{j\omega C + 2G}$$

$$\dot{U}_A = U \quad 0^\circ$$

$$\dot{U}_{N'N} = 0.63U / \underline{108.4^\circ} \text{ V}$$

$$\begin{aligned} \dot{U}_{BN'} &= \dot{U}_{BN} - \dot{U}_{N'N} \\ &= \underline{1.5U / -101.5^\circ} \text{ V} \end{aligned}$$



$$\begin{aligned} \dot{U}_{CN'} &= \dot{U}_{CN} - \dot{U}_{N'N} \\ &= \underline{0.4U / 133.4^\circ} \text{ V} \end{aligned}$$



A
B
C



5.4



Y

$$P_p = U_p I_p \cos \phi_p$$

$$P = 3U_p I_p \cos \phi_p$$

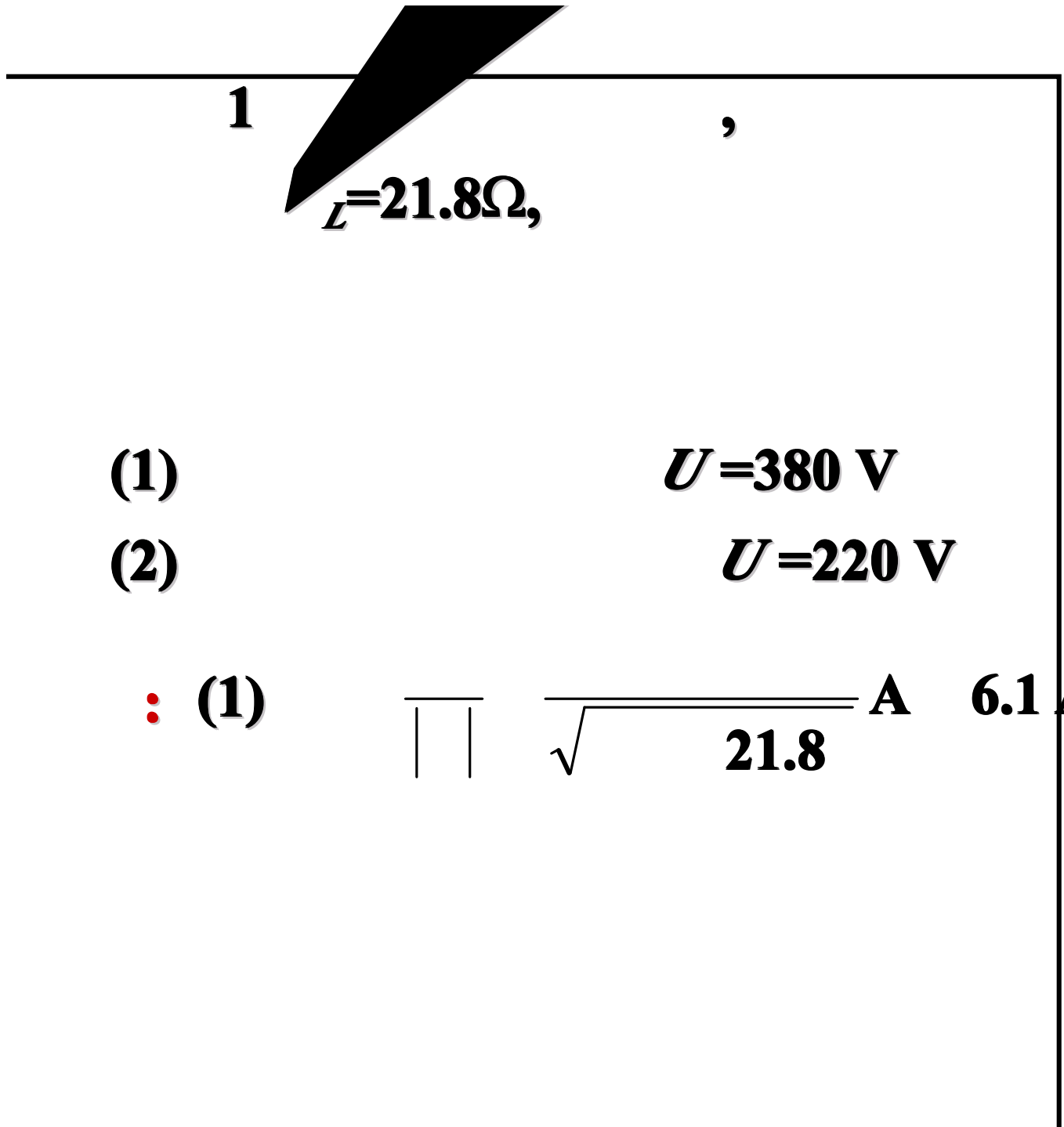
Y $U_p = \frac{1}{\sqrt{3}} U, \quad I_p = I$

Δ $U_p = U, \quad I_p = \frac{1}{\sqrt{3}} I$

$$P = 3U_p I_p \cos \phi_p = \sqrt{3} U I \cos \phi_p$$

$$Q = 3U_p I_p \sin \phi_p = \sqrt{3} U I \sin \phi_p$$

$$S = \sqrt{P^2 + Q^2} = 3U_p I_p = \sqrt{3} U I$$



1

$L=21.8\Omega,$

$R=29\Omega,$



(1)

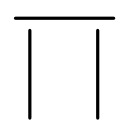
$U=380\text{ V}$

;

(2)

$U=220\text{ V}$

: (1)



$\sqrt{21.8}\text{ A}$ 6.1 A



$$(2) \quad I_P = \frac{U_P}{\sqrt{29^2 + 21.8^2}} = \frac{220}{\sqrt{29^2 + 21.8^2}} \text{ A} = 6.1 \text{ A}$$

$$I = \sqrt{3} I_P = 10.5 \text{ A}$$

$$P = \sqrt{3} U I \cos\varphi = \sqrt{3} \times 220 \times 10.5 \times 0.8 \text{ W} = 3.2 \text{ kW}$$

(1), (2) :

, 220/380 V

380 V ,

220 V ,

,

$\sqrt{3}$

2

U 380 V



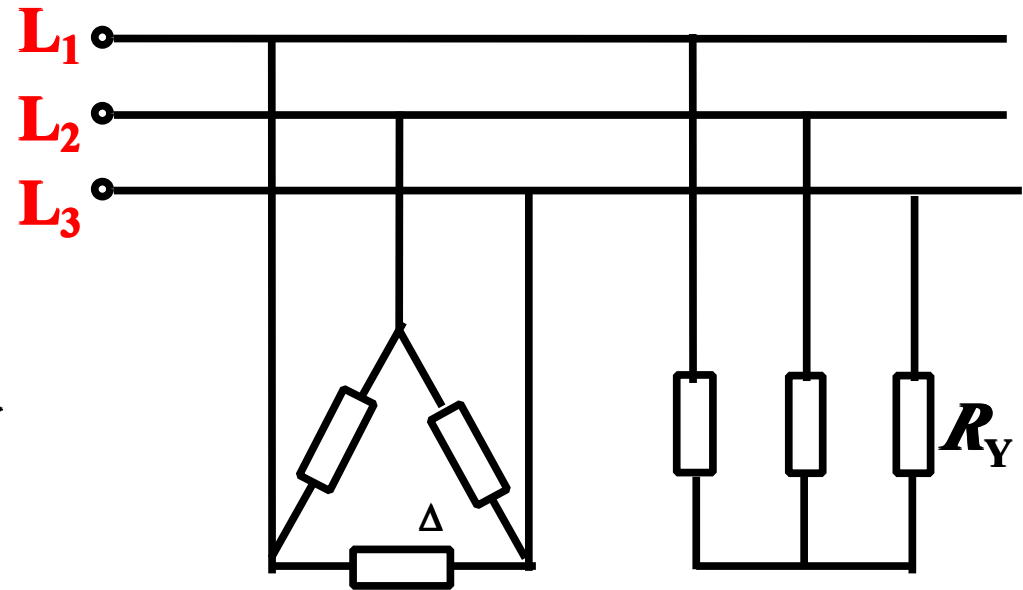
$$\Delta = 36.3 \angle 37^\circ \Omega ;$$
$$R = 10 \Omega,$$

(2)

(3)

$$\dot{U}_{12} = 380 \angle 0^\circ \text{ V}$$

$$\dot{U}_1 = 220 \angle -30^\circ \text{ V}$$





$$\dot{I}_{12\Delta} = \frac{\dot{U}_{12}}{Z_{\Delta}} = \frac{380/0^{\circ}}{36.3/37^{\circ}} \text{ A} = 10.47/-37^{\circ} \text{ A}$$

$$\dot{I}_{1Y} = \frac{\dot{U}_1}{R_Y} = 22/-30^{\circ} \text{ A}$$

(2)

$$\sqrt{A} \quad Y \quad 18.13 \quad 67 \quad A$$



3

$U=220V$

S_1



S_2

17.3A

$P=4.5 kW$

:

1)

2) S_1

S_2

,

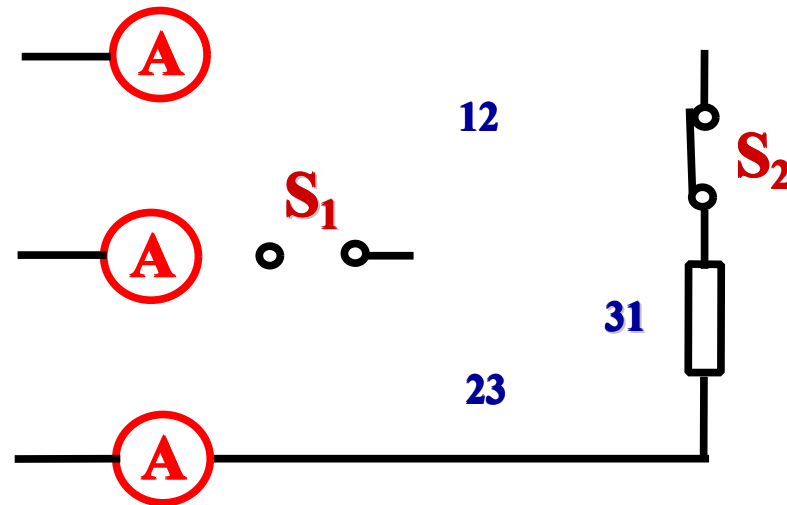
P

3) S_1

S_2

,

P



(1)

$$|Z| = \frac{U_P}{I_P} = \frac{220}{17.2}$$

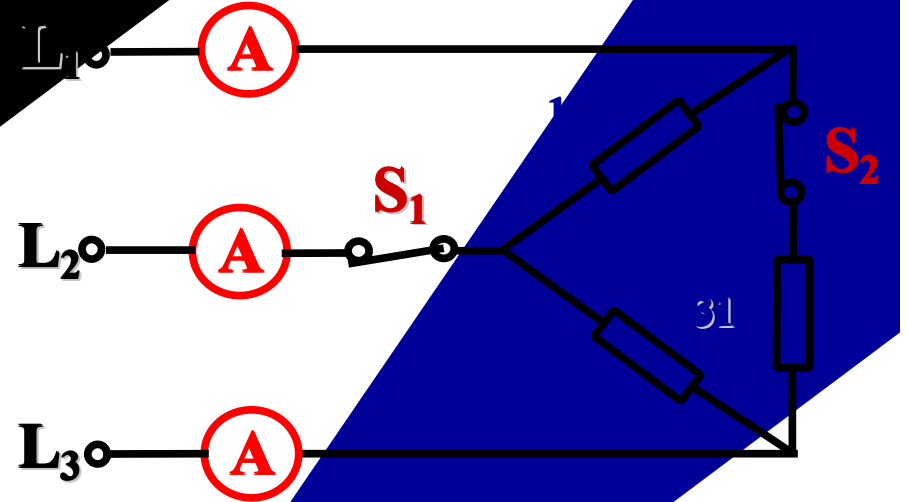
$$\cos \varphi = \frac{R}{|Z|}$$

$$R = |Z| \cos \varphi = 22 \times 0.68 = 15 \Omega$$

$$L = |Z| \sin \varphi = 22 \times 0.733 = 16.1 \Omega$$

$$P = I^2 R$$

$$P = UI \cos \varphi \quad \varphi = \arctan L/R$$



(2) S₁

S₂

L₁



$$\therefore I_1 = I_3 = 10\text{A} \quad I_2 = 17.32 \text{ A}$$

(3) S₁ S₂

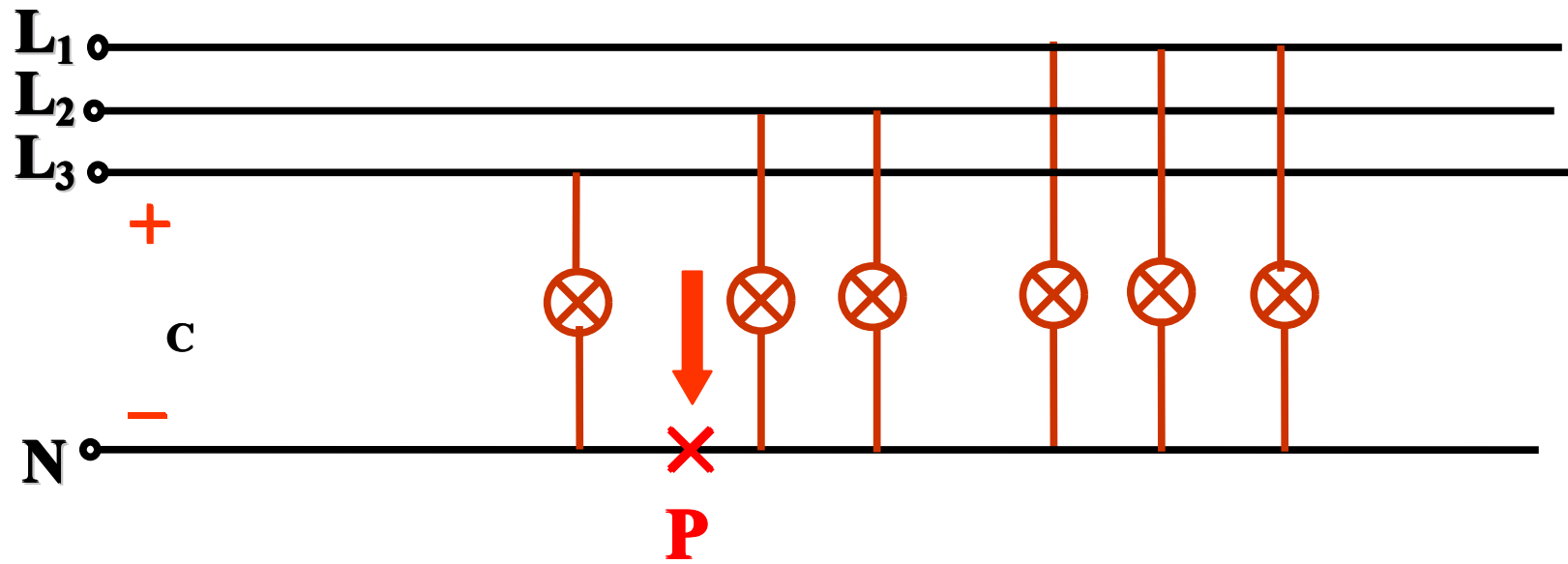
$$**I_2 = 0A**$$

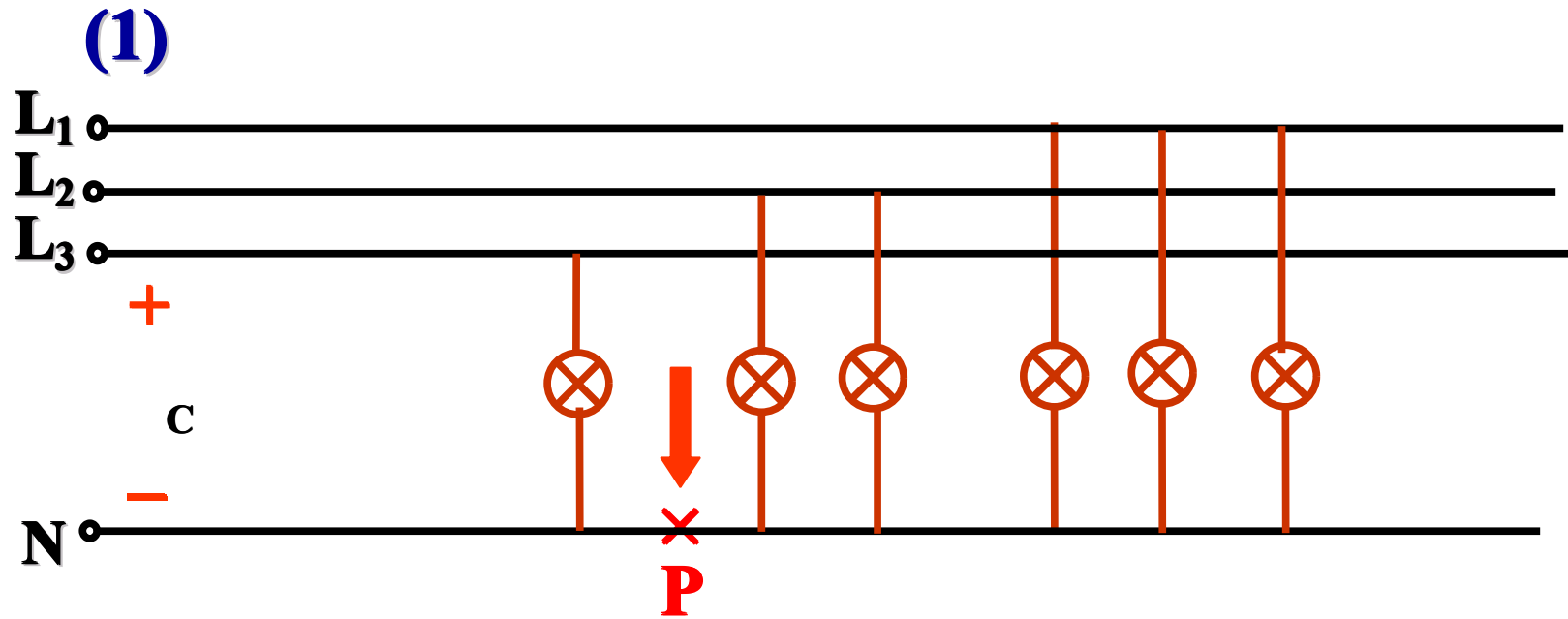


4



(1)





(2) P

380V
220V

(3)

$$R_3 < R_2,$$

