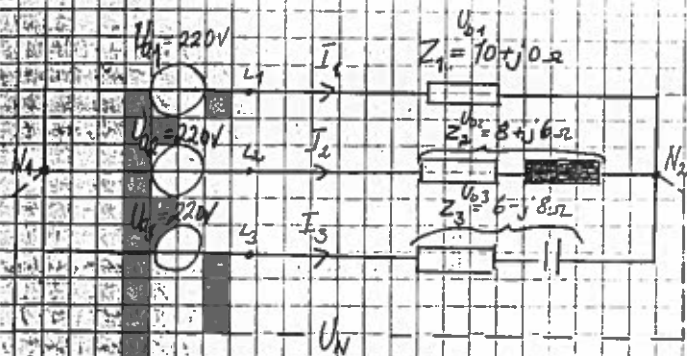


3.5.1



- Finn strømmene i kretsen og fase-
forskyvningsvinklene i hver fase
- Bereg spenningen mellom
stjernepunktene og vinkelen mellom
en av de påtrykte spenningene og
spenningen U_N
- Hva blir fase-spenningen over
belastningene
- Tegn vektor diagram for hele kretsen
- Finn hovedspenningene i kretsen og tegn
inn vektorene i diagrammet i d)

$$\vec{I}_1 = \vec{U}_{a1} \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_2 + (1/2 + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_3}{\vec{Z}_1(\vec{Z}_2 + \vec{Z}_3) + \vec{Z}_2 \cdot \vec{Z}_3}$$

$$\vec{I}_1 = 220V \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot (8\Omega + j6\Omega) + (1/2 + j\frac{\sqrt{3}}{2}) \cdot (6\Omega - j8\Omega)}{(10\Omega + j0) \cdot (8\Omega + j6\Omega + 6\Omega - j8\Omega) + (8\Omega + j6\Omega) \cdot (6\Omega - j8\Omega)}$$

$$\vec{I}_1 = 220V \frac{(12\Omega + j9\Omega - j6\Omega + 5,2\Omega) + (9\Omega - j12\Omega + j5,2\Omega + 6,93\Omega)}{80\Omega^2 + j60\Omega^2 + 60\Omega^2 - j80\Omega^2 + 48\Omega^2 - j64\Omega^2 + j36\Omega^2 + 48\Omega^2}$$

$$\vec{I}_1 = 220V \frac{33,13\Omega - j4,73\Omega}{2,36\Omega^2 - j48\Omega^2} = 220V \cdot \frac{33,5\Omega \angle -8,1^\circ}{240,8\Omega^2 \angle -11,5^\circ} = 30,57A \angle 3,4^\circ$$

$$q = \phi_n - \phi_b = 11,5^\circ - 8,1^\circ = 3,4^\circ \text{ (foran } U_{a1})$$

$$\vec{I}_2 = \vec{U}_{a2} \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_3 + (1/2 + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_1}{\vec{Z}_2(\vec{Z}_3 + \vec{Z}_1) + \vec{Z}_3 \cdot \vec{Z}_1}$$

$$\vec{I}_2 = 220V \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot (6\Omega - j8\Omega) + (1/2 + j\frac{\sqrt{3}}{2}) \cdot (10\Omega + j0)}{(8\Omega + j6\Omega) \cdot (6\Omega - j8\Omega + 10\Omega + j0) + (6\Omega - j8\Omega) \cdot (10\Omega + j0)}$$

$$\vec{I}_2 = 220V \frac{(9\Omega - j12\Omega - j5,2\Omega - 6,93\Omega) + (15\Omega + j8,66\Omega)}{(8\Omega + j6\Omega) \cdot (16\Omega - j8\Omega) + (6\Omega - j8\Omega) \cdot (10\Omega + j0)}$$

$$\vec{I}_2 = 220V \frac{17,07\Omega - j8,54\Omega}{128\Omega^2 - j64\Omega^2 + j96\Omega^2 + 48\Omega^2 + 60\Omega^2 - j80\Omega^2} = 220V \cdot \frac{17,07\Omega - j8,54\Omega}{2,36\Omega^2 - j48\Omega^2} = 220V \cdot \frac{19,09\Omega \angle -26,6^\circ}{240,8\Omega^2 \angle -11,5^\circ}$$

$$\vec{I}_2 = 17,74A \angle -15,1^\circ \text{ (etter } U_{a2})$$

$$\vec{I}_3 = \vec{U}_{a3} \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_1 + (1/2 + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_2}{\vec{Z}_3(\vec{Z}_1 + \vec{Z}_2) + \vec{Z}_1 \cdot \vec{Z}_2}$$

$$\vec{I}_3 = 220V \frac{(1/2 - j\frac{\sqrt{3}}{2}) \cdot (10\Omega + j0) + (1/2 + j\frac{\sqrt{3}}{2}) \cdot (8\Omega + j6\Omega)}{(6\Omega - j8\Omega) \cdot (10\Omega + j0 + 8\Omega + j6\Omega) + (10\Omega + j0) \cdot (8\Omega + j6\Omega)}$$

$$\vec{I}_3 = 220V \frac{(15\Omega - j8,66\Omega) + (12\Omega + j9\Omega + j6,93\Omega - 5,2\Omega)}{(6\Omega - j8\Omega) \cdot (18\Omega + j6\Omega) + (80\Omega^2 + j60\Omega^2)}$$

$$\vec{I}_3 = 220V \frac{21,8\Omega + j7,27\Omega}{108\Omega^2 + j36\Omega^2 - j44\Omega^2 + 48\Omega^2 + 80\Omega^2 + j60\Omega^2} = 220V \cdot \frac{21,8\Omega + j7,27\Omega}{2,36\Omega^2 + j48\Omega^2} = 220V \cdot \frac{22,92\Omega \angle 18,4^\circ}{240,8\Omega^2 \angle -11,5^\circ}$$

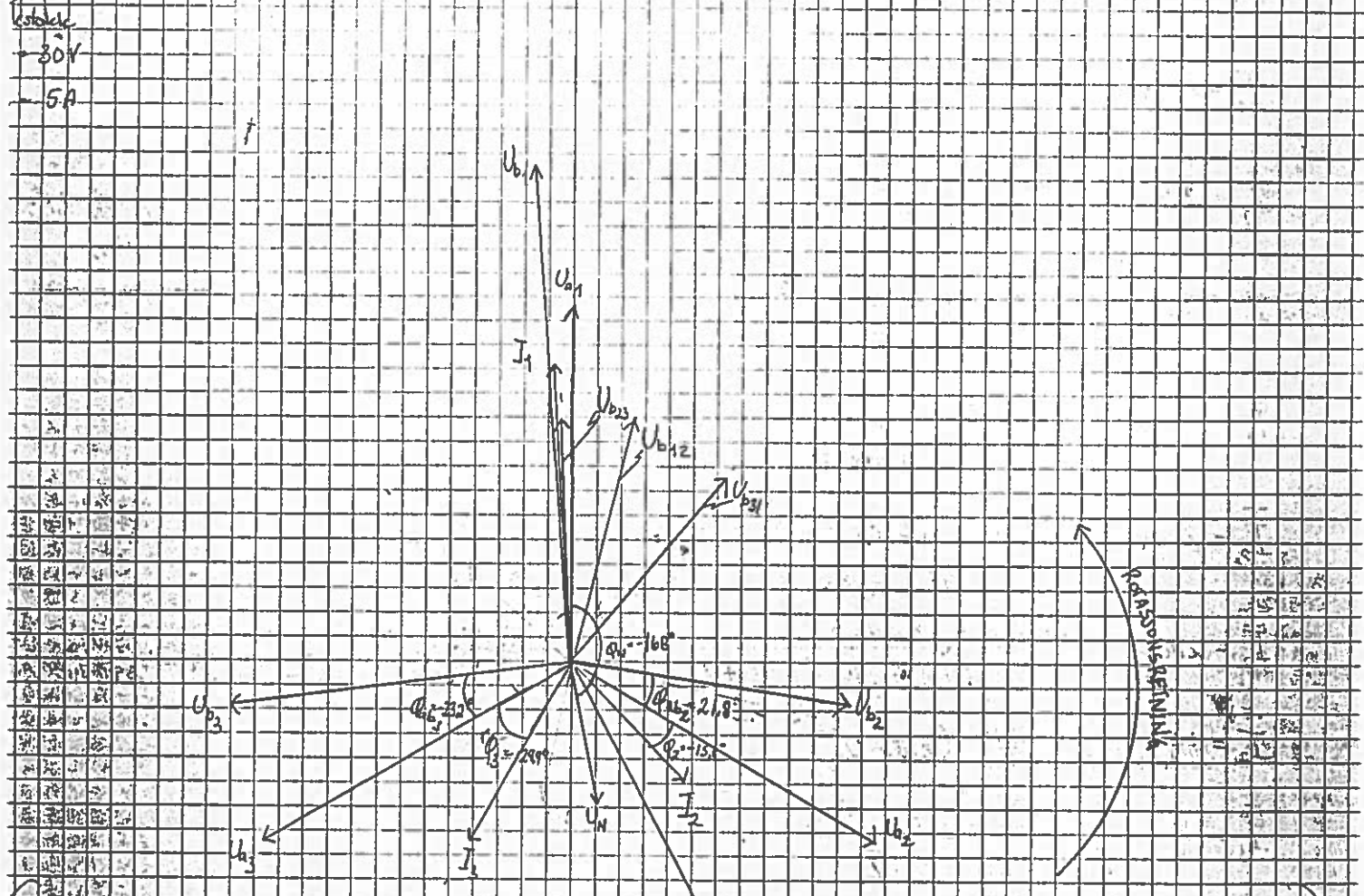
$$\vec{I}_3 = 20,99A \angle 29,9^\circ \text{ (foran } U_{a3})$$

$$\begin{aligned} \bar{U}_N &= \bar{U}_{a1} - \bar{I}_1 \cdot \bar{Z}_1 = 220V - 30,57A \angle 3,4^\circ \cdot (10\Omega + j0) = 220V - (30,52A + j1,81A) \cdot (10\Omega + j0) \\ &= 220V - (305,2V + j18,1V) = -85,2V - j18,1V = \underline{87,1V \angle -168^\circ} \text{ (etter } U_{a1}) \text{ (ifor } I_{a1} \text{ form } U_{a1})} \end{aligned}$$

$$\begin{aligned} \bar{U}_{b1} &= \bar{I}_1 \cdot \bar{Z}_1 = 30,57A \angle 3,4^\circ \cdot (10\Omega + j0) = (30,52A + j1,81A) \cdot 10\Omega = 305,2V + j18,1V = \underline{305,7V \angle 3,4^\circ} \\ &\text{(foran } U_{a1}) \\ &\text{(i fase med } \bar{I}_1) \end{aligned}$$

$$\begin{aligned} \bar{U}_{b2} &= \bar{I}_2 \cdot \bar{Z}_2 = 17,44A \angle -15,1^\circ \cdot (8\Omega + j6\Omega) = (6,84A - j4,54A) \cdot (8\Omega + j6\Omega) \\ &= 134,7V + j101,0V - j36,32V + 27,24V = 161,94V + j64,68V = \underline{174,4V \angle 21,8^\circ} \\ &\text{(foran } U_{a2}) \end{aligned}$$

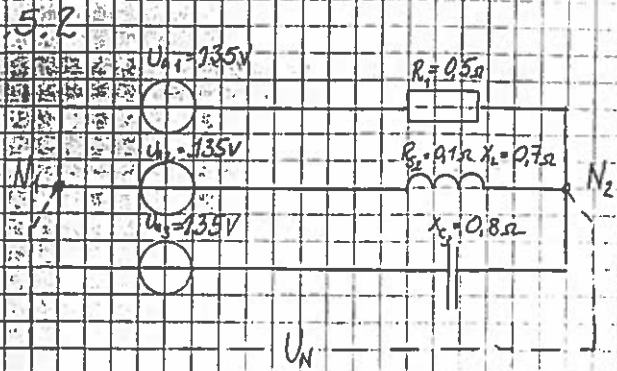
$$\begin{aligned} \bar{U}_{b3} &= \bar{I}_3 \cdot \bar{Z}_3 = 20,99A \angle 29,9^\circ \cdot (6\Omega - j8\Omega) = (18,20A + j10,46A) \cdot (6\Omega - j8\Omega) \\ &= 109,2V - j145,6V + j62,78V + 83,7V = 192,9V - j82,82V = \underline{209,9V \angle -23,2^\circ} \text{ (etter } U_{a3}) \end{aligned}$$



~~$$\bar{U}_{b12} = \bar{U}_{b1} - \bar{U}_{b2} = (305,2V + j18,1V) - (161,94V + j64,68V) = 143,26V - j46,58V = \underline{150,5V \angle -18,1^\circ} \text{ (etter } U_{b1})$$~~

~~$$\bar{U}_{b23} = \bar{U}_{b2} - \bar{U}_{b3} = (161,94V + j64,68V) - (192,9V - j82,82V) = -30,96V + j147,5V = \underline{150,7V \angle 101,9^\circ} \text{ (foran } U_{b2})$$~~

~~$$\bar{U}_{b31} = \bar{U}_{b3} - \bar{U}_{b1} = (192,9V - j82,82V) - (305,2V + j18,1V) = -112,3V - j100,9V = \underline{151,0V \angle -138,1^\circ} \text{ (etter } U_{b3})$$~~



- Find strømme i hver fase og faseforskyvningsvinklene
- Find fase-spændingene over belastningene og spændingen mellem stjernepunkterne samt vinklerne mellem en af fase-spændingene og U_N .
- Beregn hovedspændingene ved belastningene.
- Konstruer et vektordiagram for alle strømme og spændinger i kredsen.

$$\vec{I}_1 = \vec{U}_{a1} \cdot \frac{(1\frac{1}{2} - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_2 + (1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_3}{\vec{Z}_1(\vec{Z}_2 + \vec{Z}_3) + \vec{Z}_2 \cdot \vec{Z}_3}$$

$$\vec{I}_1 = 135V \cdot \frac{(1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot (0,1\Omega + j0,7\Omega) + (1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot (-j0,8\Omega)}{0,5\Omega(0,1\Omega + j0,7\Omega - j0,8\Omega) + (0,1\Omega + j0,7\Omega)(-j0,8\Omega)}$$

$$\vec{I}_1 = 135V \cdot \frac{0,15\Omega + j1,05\Omega - j0,0866\Omega + 0,606\Omega - j1,2\Omega + 0,693\Omega}{0,05\Omega^2 + j0,35\Omega^2 - j0,4\Omega^2 - j0,08\Omega^2 + 0,56\Omega^2} = 135V \cdot \frac{1,449\Omega - j0,237\Omega}{0,61\Omega^2 - j0,13\Omega^2} = 135V \cdot \frac{1,468\Omega \angle -9,29^\circ}{0,624\Omega^2 \angle -12^\circ}$$

$$\vec{I}_1 = 317,8A \angle 2,71^\circ \quad \phi_1 = \phi_1 - \phi_0 = -9,29^\circ - (-12,0^\circ) = 2,71^\circ$$

$$\vec{I}_2 = \vec{U}_{a2} \cdot \frac{(1\frac{1}{2} - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_3 + (1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_1}{\vec{Z}_2(\vec{Z}_3 + \vec{Z}_1) + \vec{Z}_3 \cdot \vec{Z}_1} = 135V \cdot \frac{(1\frac{1}{2} - j\frac{\sqrt{3}}{2}) \cdot (-j0,8\Omega) + (1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot 0,5\Omega}{(0,1\Omega + j0,7\Omega)(-j0,8\Omega + 0,5\Omega) + (-j0,8\Omega) \cdot 0,5\Omega}$$

$$\vec{I}_2 = 135V \cdot \frac{j1,2\Omega - 0,693\Omega + 0,75\Omega + j0,433\Omega}{j0,08\Omega^2 + 0,05\Omega^2 + 0,56\Omega^2 + j0,35\Omega^2 - j0,4\Omega^2} = 135V \cdot \frac{0,057\Omega - j0,767\Omega}{0,61\Omega^2 - j0,13\Omega^2} = 135V \cdot \frac{0,769\Omega \angle -85^\circ}{0,624\Omega^2 \angle -12^\circ}$$

$$\vec{I}_2 = 166,5A \angle -73^\circ$$

$$\vec{I}_3 = \vec{U}_{a3} \cdot \frac{(1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_1 + (1\frac{1}{2} - j\frac{\sqrt{3}}{2}) \cdot \vec{Z}_2}{\vec{Z}_3(\vec{Z}_1 + \vec{Z}_2) + \vec{Z}_1 \cdot \vec{Z}_2} = 135V \cdot \frac{(1\frac{1}{2} + j\frac{\sqrt{3}}{2}) \cdot 0,5\Omega + (1\frac{1}{2} - j\frac{\sqrt{3}}{2}) \cdot (0,1\Omega + j0,7\Omega)}{-j0,8\Omega(0,5\Omega + 0,1\Omega + j0,7\Omega) + 0,5\Omega \cdot (0,1\Omega + j0,7\Omega)}$$

$$\vec{I}_3 = 135V \cdot \frac{0,75\Omega + j0,433\Omega + 0,15\Omega + j1,05\Omega + j0,0866\Omega - 0,606\Omega}{0,61\Omega^2 - j0,13\Omega^2} = 135V \cdot \frac{0,294\Omega + j0,704\Omega}{0,61\Omega^2 - j0,13\Omega^2}$$

$$\vec{I}_3 = 135V \cdot \frac{0,763\Omega \angle 67,3^\circ}{0,624\Omega^2 \angle -12^\circ} = 165,0A \angle 79,3^\circ$$

$$U_N = U_{a1} - \vec{I}_1 \cdot \vec{Z}_1 = 135V - 317,8A \angle 2,71^\circ \cdot 0,5\Omega = 135V - (317,4A + j15,0A) \cdot 0,5\Omega = 135V - 158,7V + j7,5V$$

$$U_N = 237V + j7,5V = 249V \angle 162^\circ$$

$$U_{b1} = \vec{I}_1 \cdot \vec{Z}_1 = 317,8A \angle 2,71^\circ \cdot 0,5\Omega = (317,4A + j15,0A) \cdot 0,5\Omega = 158,7V + j7,5V = 158,9V \angle 2,71^\circ$$

$$U_{b2} = \vec{I}_2 \cdot \vec{Z}_2 = 166,5A \angle -73^\circ \cdot (0,1\Omega + j0,7\Omega) = (48,68A - j159,2A) \cdot (0,1\Omega + j0,7\Omega) = 4,868V + j34,1V - j15,9V + 111,4V =$$

$$\vec{U}_{b2} = 116,3V + j18,2V = 117,7V \angle 8,89^\circ$$

$$\vec{U}_{b3} = \vec{I}_3 \cdot \vec{Z}_3 = 165,0A \angle 79,3^\circ \cdot (-j0,8\Omega) = (30,6A + j162,1A) \cdot (-j0,8\Omega) = -24,48V + j129,7V = 131,9V \angle -10,7^\circ$$