



# higher education & training

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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

## **NASIENRIGLYN**

### **NASIONALE SERTIFIKAAT**

### **ELEKTROTEGNIIEK N6**

**12 Augustus 2025**

**Hierdie nasienriglyn bestaan uit 10 bladsye.**

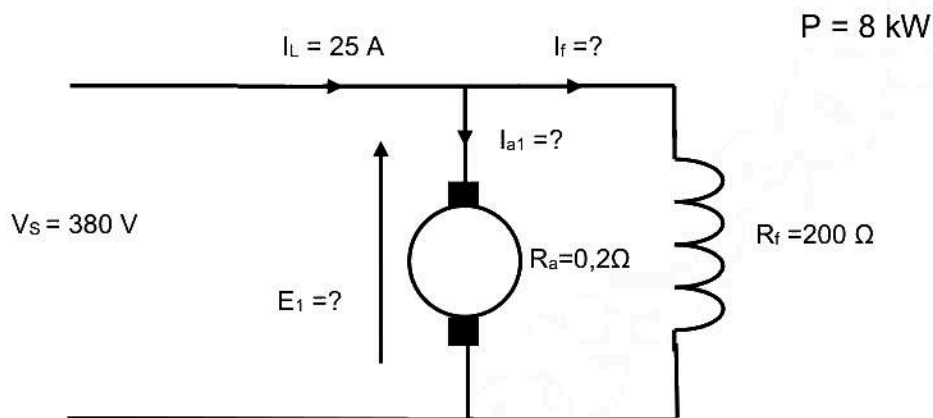
**VRAAG 1: GS-MASJIENE**

1.1 1.1.1 Die spoed kan verminder word deur die veldstroom te verhoog as die pole onversadig is. ✓

1.1.2 Die spoed kan vermeerder word deur die ankerspanning te verhoog, maar nie in 'n direkte verhouding nie. ✓

(2 × 2) (4)

1.2 Gegee: 'n Sjuntmotor



1.2.1  $I_{SH} = V/R_{SH} = 380/200 = 1,9 \text{ A} \checkmark$   
 $I_A = I_L - I_{SH} = 25 - 1,9 = 23,1 \text{ A} \checkmark$   
 $P_{in} = V \cdot I_L = 380 \times 25 = 9,5 \text{ kW} \checkmark$

$\text{Ankerkoperverlies} = (I_a)^2 \cdot R_a = (23,1)^2 \times 0,2 = 106,722 \text{ W} \checkmark$

$\text{Veldkoperverlies} = (I_{sh})^2 \cdot R_{sh} \quad \text{OF} \quad \text{Veldkoperverlies} = I_{sh} \cdot V$   
 $= (1,9)^2 \times 200 \quad \quad \quad = 1,9 \times 380$   
 $= 722 \text{ W} \checkmark \quad \quad \quad = 722 \text{ W} \checkmark$

$\text{Totale koperverlies} = \text{Ankerverlies} + \text{Veldkoperverlies}$   
 $= 106,722 + 722$   
 $= 828,722 \text{ W} \checkmark$

$\text{Totale verliese} = P_{in} - P_{out} = 9,5 - 8$   
 $= 1,5 \text{ kW} \checkmark$

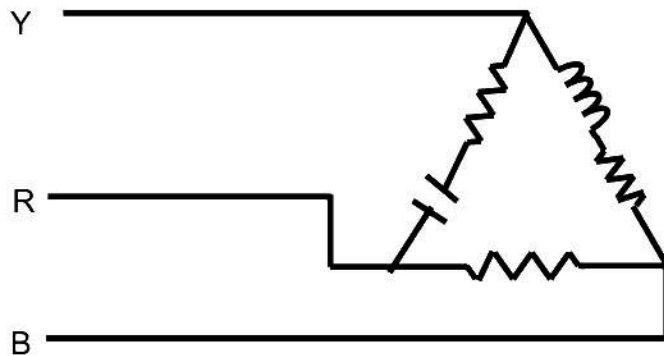
$\text{Yster - en wrywingsverlies}$   
 $= \text{Totale verliese} - \text{Totale koperverliese by}$   
 $= 1\,500 - 828,722$   
 $= 671,278 \text{ W} \checkmark \quad (9)$

1.2.2  $\eta = \frac{P_{out}}{P_{in}} \times 100\% = \frac{8}{9,5} \times 100\% \checkmark$   
 $= 84,211\% \checkmark \quad (2)$

**VRAAG 2: WS-TEORIE**

2.1  $(V_L) = (V_{ph})$  in Delta✓ en  $(V_L) = (\sqrt{3}V_{ph})$  in Ster.✓ (2)

2.2 Gegee: 'n Ongebalanseerde, driefasige, deltaverbinde las



$$\begin{aligned} I_{RY} &= 27 + j0 \text{ ampère} \\ I_{YB} &= 29 - j15 \text{ ampère} \\ I_{BR} &= 33 + j20 \text{ ampère} \\ V_L &= 415 \text{ V} \end{aligned}$$

2.2.1  $I_{RY} = 27 + j0 = 27 \angle 0^\circ \checkmark$

$$I_{YB} = 29 - j15 = 32,65 \angle -27,35^\circ \text{ A} \checkmark$$

$$I_{BR} = 33 + j20 = 38,588 \angle 31,218^\circ \text{ A} \checkmark$$

$$P_{RY} = VI \cos \theta = 415 \times 27 \times \cos 0^\circ = 11,205 \text{ kW} \checkmark$$

$$P_{YB} = VI \cos \theta = 415 \times 32,65 \times \cos 27,35^\circ = 12,035 \text{ kW} \checkmark$$

$$P_{BR} = VI \cos \theta = 415 \times 38,588 \times \cos 31,218^\circ = 13,695 \text{ kW} \checkmark$$

(6)

2.2.2  $I_R = I_{RY} - I_{BR} = 27 + j0 - (33 + j20) = -6 - j20 \checkmark$   
 $= 20,881 \angle -106,699^\circ \text{ A} \checkmark$

$$I_Y = I_{YB} - I_{RY} = 29 - j15 - (27 + j0) = 2 - j15 \checkmark$$

$$= 15,133 \angle -82,405^\circ \text{ A} \checkmark$$

$$I_B = I_{BR} - I_{YB} = 33 + j20 - (29 - j15) = 4 + j35 \checkmark$$

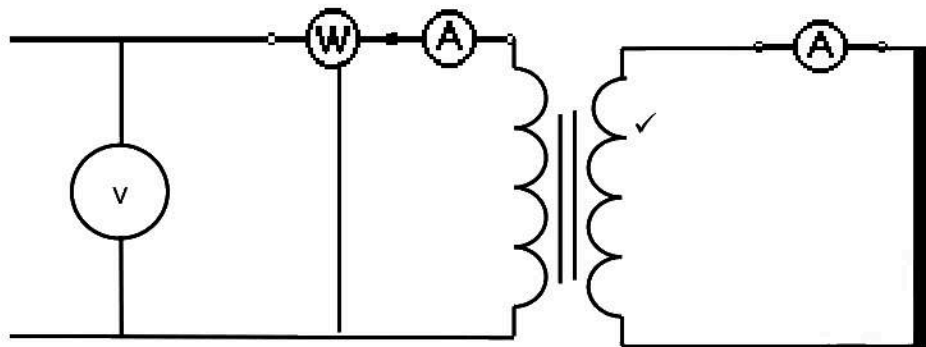
$$= 35,228 \angle 83,480^\circ \text{ A} \checkmark$$

(6)

**[14]**

### VRAAG 3: TRANSFORMATORS

3.1



Die sekondêre wikkeling word deur 'n ammeter kortgesluit. ✓

'n Lae spanning word op die primêre wikkeling toegepas en aangepas om in al twee wikkings 'n vollasstroom te sirkuleer. ✓

Die wattmeter gee 'n lesing van die vollaskoperverlies. ✓

(4)

3.2

3.2.1

| Metode 1                                                                                                                                                                            | Metode 2                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| $R_{e1} = R_1 + R_2(V_1/V_2)^2$ $= 0,6 + 0,0101(6\,600/400)^2$ $= 3,35 \, \Omega \checkmark$                                                                                        | $R_{e2} = R_2 + R_1(V_2/V_1)^2$ $= 0,0101 + 0,6(400/6\,600)^2$ $= 0,0123 \, \Omega \checkmark$ |
| $I_1 = S/V_1 = 300\,000/6\,600$ $= 45,455 \, A \checkmark$                                                                                                                          | $I_2 = S/V_2 = 300\,000/400$ $= 750 \, A \checkmark$                                           |
| $P_{sc} = (I_1)^2 R_{e1} = (45,455)^2 \times 3,35$ $= 6,921 \, kW \checkmark$                                                                                                       | $P_{sc} = (I_2)^2 R_{e2} = (750)^2 \times 0,0123$ $= 6,919 \, kW \checkmark$                   |
| $\eta = \frac{S \cdot \cos \theta}{S \cdot \cos \theta + P_i + P_{sc}} \times 100\% = \frac{300 \times 0,8}{(300 \times 0,8) + 3,2 + 6,921} \checkmark$ $= 95,954 \, \% \checkmark$ |                                                                                                |

(5)

3.2.2

$$\eta = \frac{kS \cos \theta}{kS \cos \theta + P_i + k^2 P_{sc}} \times 100\%$$

$$= \frac{0,5 \times 300 \times 0,8}{(0,5 \times 300 \times 0,8) + 3,2 + (0,5^2 \times 6,921)} \times 100\% \checkmark$$

$$= 96,054 \, \% \checkmark$$

(2)

3.2.3 Vir  $\eta_{\text{maks}}$ :  $k = \sqrt{P_i/P_{sc}} = \sqrt{3,2/6,921} = 0,68\checkmark$

Metode 1

$$\begin{aligned}\eta_{\text{maks}} &= \frac{kS \cos \theta}{kS \cos \theta + P_i + k^2 P_{sc}} \times 100 \% \\ &= \frac{0,68 \times 300 \times 0,8}{(0,68 \times 300 \times 0,8) + 3,2 + (0,68^2 \times 6,921)} \times 100 \% \checkmark \\ &= 96,226 \% \checkmark\end{aligned}$$

Metode 2

$$\begin{aligned}\eta_{\text{maks}} &= \frac{kS \cos \theta}{kS \cos \theta + 2P_i} \times 100 \% \\ &= \frac{0,68 \times 300 \times 0,8}{(0,68 \times 300 \times 0,8) + (2 \times 6,921)} \times 100 \% \checkmark \\ &= 92,182 \% \checkmark\end{aligned}$$

(3)

3.2.4  $S = kS = 0,68 \times 300 = 204 \text{ kW} \checkmark$

(1)

[15]

#### VRAAG 4: WS-MASJIENE

4.1 Dit is die verhouding  $\checkmark$  van die werklike emk  $\checkmark$  wat verkry sou word indien al die geleiers in slegs een gleuf gekonsentreer was.  $\checkmark$

(3)

4.2  $E_P = \frac{3 \ 300}{\sqrt{3}} = 1 \ 905,256 \text{ V} \checkmark$

$$f = \frac{Np}{60} \quad p = \frac{(60)(50)}{1 \ 500} = 2 \quad \therefore 4 \text{ pole} \checkmark$$

Totaal gleuwe = (4) (4 pole)(3 fases) = 48  $\checkmark$

Spoelspan =  $\frac{5}{6} \times 180 = 150^\circ \checkmark$

$\varphi = 180^\circ - 150^\circ = 30^\circ \checkmark$

$k_p = \cos \frac{\varphi}{2} = \cos \frac{30^\circ}{2} = 0,966 \checkmark$

$\gamma = \frac{180^\circ}{4 \times 3} = 15^\circ \checkmark$

$$k_d = \frac{\sin \frac{\eta\gamma}{2}}{\eta \sin \frac{\gamma}{2}} = \frac{\sin \frac{(4)(15^\circ)}{2}}{4 \sin \frac{15^\circ}{2}} = 0,958 \checkmark$$

$$E_p = 2f\phi Z_p k_f k_p k_d$$

$$Z_p = \frac{1\,905,256}{(2)(50)(60 \times 10^{-3})(1,11)(0,966)(0,958)} \checkmark = 309,127 \checkmark$$

$$Z_T = 309,127 \times 3 = 927,38 \checkmark$$

$$\therefore \text{Geleiers per gleuf} = \frac{927,38}{48} = 19,32 \quad \text{sê } 20 \checkmark$$

(12)  
[15]

### VRAAG 5: WS-MASJIENE

5.1  $V_p = \frac{415}{\sqrt{3}} = 239,600 \text{ V} \checkmark$

$$E_p = \frac{600}{\sqrt{3}} = 346,410 \text{ V}$$

$$Z_s = (2 + j 4,8) = 5,2 \angle 67,38^\circ \checkmark$$

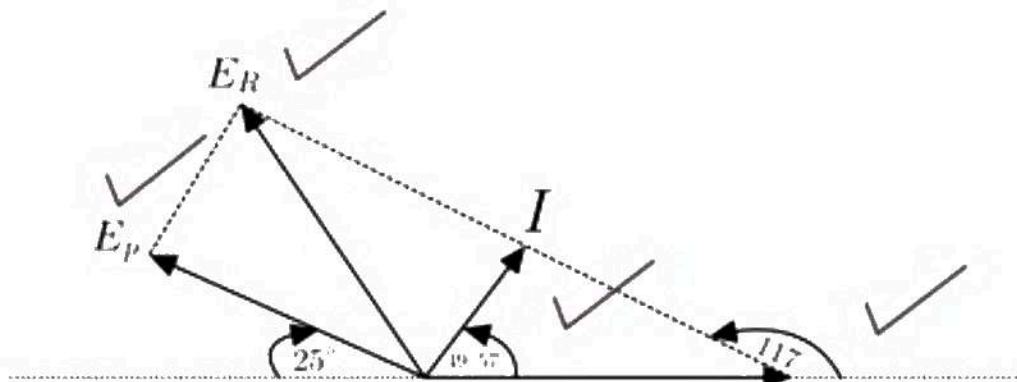
$$\begin{aligned} E_R &= 239,600 \angle 0^\circ \checkmark + 346,410 \angle 155^\circ \checkmark \\ &= (239,600 + j 0) + (-313,954 + j 146,399) \\ &= -74,354 + j 146,399 \\ &= 164,199 \angle 116,952^\circ \checkmark \end{aligned}$$

$$I = \frac{E_R}{Z} = \frac{164,199 \angle 116,952^\circ}{5,2 \angle 67,38^\circ} \checkmark = 31,577 \angle 49,572^\circ \text{ A} \checkmark \quad (7)$$

5.2  $P_i = \sqrt{3} V_L I_L \cos \phi = (\sqrt{3})(415)(31,577) \cos(49,572^\circ) \checkmark = 14,719 \text{ kW} \checkmark$

$$P_o = P_i \times \eta = (14,719)(0,9) = 13,247 \text{ kW} \checkmark \quad (3)$$

5.3

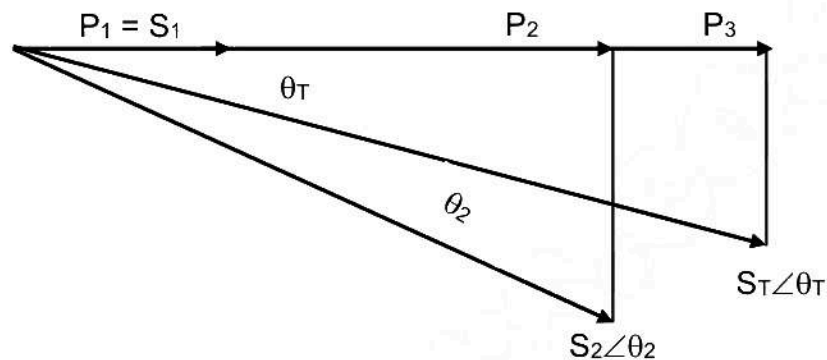


(4)

# VRAAG 6: ONTWIKKELING EN VOORSIENING VAN WS-KRAG

- 6.1
- Die verbruiker betaal 'n laer tarief.
  - Die rendement van sy/haar installasie is hoër.
- (2)

- 6.2
- Gegee:  $V_L = 600 \text{ V}$   $P_2 = 34 \text{ kW}$  teen 0,8 arbeidsfaktor naloop  
 $f = 50 \text{ Hz}$   $\eta = 86\%$   
 $P_1 = 2,5 \text{ kW}$  teen arbeidsfaktor een

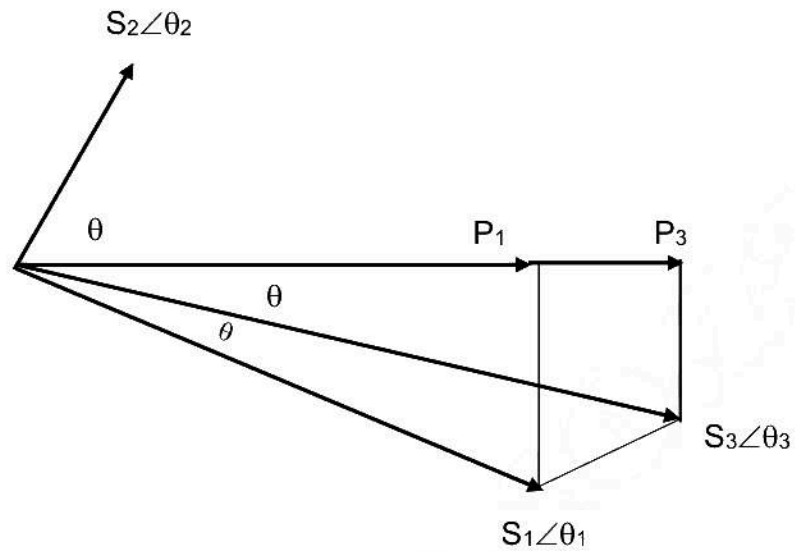


- 6.2.1
- $\cos \theta_1 = 1(\text{een})$   $\cos \theta_2 = 0,8 \text{ (naloop)}$   
 $\therefore \theta_2 = \cos^{-1} 0,8 = -36,87^\circ$   
 $S_1 =$   $S_2 = P_{in2} / \cos \theta_2 = 39,535 / 0,8$   
 $P_1 / \cos \theta_1 = 2,5 / 1 = 2,5 \text{ kVA} \checkmark$   $= 49,419 \text{ kW} \checkmark$   
 $\eta = P_{out2} / P_{in2}$   $S_T = S_1 + S_2$   
 $\therefore P_{in2} = P_{out2} / \eta = 34\,000 / 0,86$   $= 2,5 \angle 0^\circ + 49,419 \angle -36,87$   
 $= 39,535 \text{ kW} \checkmark$   $= 42,035 - j29,651$   
 $\therefore S_T = 51,44 \text{ kW} \checkmark$   $= 51,44 \angle -35,199^\circ \text{ kW} \checkmark$
- (5)

- 6.2.2
- Arbeitsfaktor =  $\cos \theta_T$   
 $= \cos (35,199)$   
 $= 0,817 \text{ naloop} \checkmark$
- (1)

6.2.3

Metode 1



Laat  $S_1$  = totale kVA van die las, geneem uit VRAAG 6.2

$$S_1 = 51,44 \angle -35,199^\circ \text{ kW} = 42,034 - j 29,651$$

$$S_3 = \sqrt{3} V_L I_L = \sqrt{3} \times 600 \times 55 = 57,158 \text{ kW} \checkmark$$

$$P_3 = \sqrt{3} V_L I_L \cos \theta$$

$$\therefore \cos \theta_3 = \frac{42,034 \times 10^3}{\sqrt{3} \times 600 \times 55} = 0,735 \text{ naloop} \checkmark$$

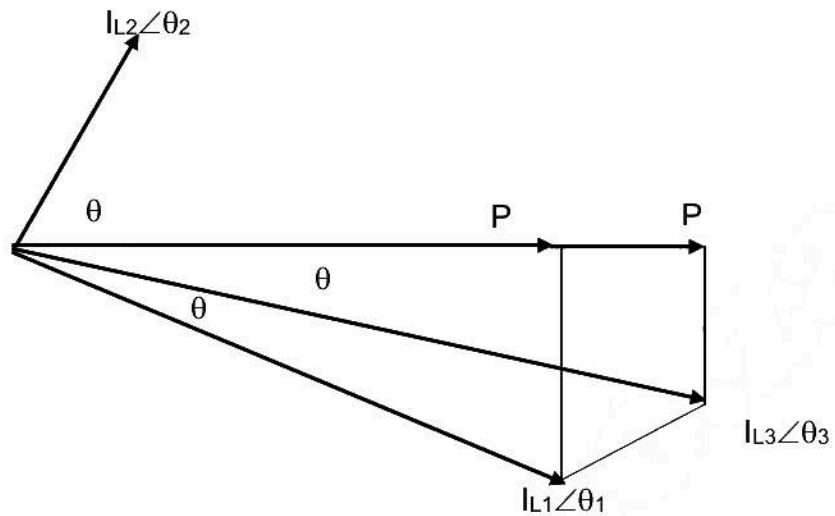
$$\therefore \theta_3 = \cos^{-1}(0,735) = 42,693^\circ \checkmark$$

$$\begin{aligned} S_2 &= S_3 - S_1 = 57,158 \angle -42,693^\circ - 51,44 \angle -35,199^\circ \checkmark \\ &= 0,023 - j9,106 \\ &= 9,106 \angle 89,855^\circ \text{ kVA} \checkmark \end{aligned}$$

$$S = \sqrt{3} V_L I_L$$

$$I_L = \frac{S}{\sqrt{3} V_L} = \frac{9,106 \times 10^3}{\sqrt{3} \times 600} = 8,762 \text{ A} \checkmark$$

### Metode 2



Laat  $S_1$  = totale kVA van die las, geneem uit VRAAG 6.2

$$S_1 = 51,44 \angle -35,199^\circ \text{ kW} = 42,034 - j 29,651 \checkmark$$

$$S_1 = \sqrt{3} V_L I_{L1}$$

$$I_{L1} = \frac{S_1}{\sqrt{3} V_L} = \frac{51,44 \times 10^3}{\sqrt{3} \times 600} = 49,498 \text{ A}$$

$$= 49,498 \angle -35,199^\circ \text{ A} \checkmark$$

$$I_{L3} = 55 \text{ A,} \quad \text{gegees}$$

$$P_3 = P_1 = 42,034 \text{ kW} \checkmark$$

$$P_3 = \sqrt{3} V_L I_L \cos \theta$$

$$\therefore \cos \theta_3 = \frac{42,034 \times 10^3}{\sqrt{3} \times 600 \times 55} = 0,735 \text{ naloop}$$

$$\therefore \theta_3 = \cos^{-1}(0,735) = 42,693^\circ \checkmark$$

$$I_{L3} = 55 \angle -42,693^\circ \text{ A}$$

$$I_{L2} = I_{L3} - I_{L1} = 55 \angle -42,693^\circ - 49,498 \angle -35,199^\circ$$

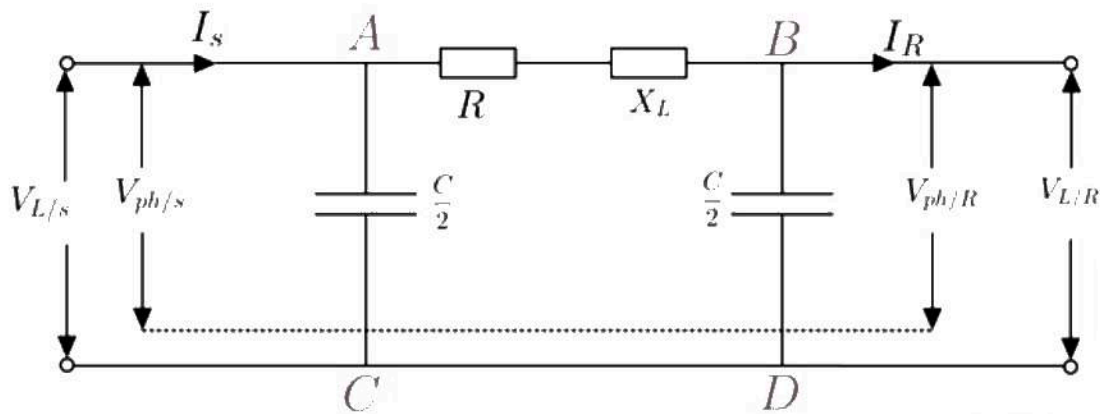
$$= 40,425 - j35,294 - 40,448 + j28,532 \checkmark$$

$$= -0,023 - j8,762$$

$$= 8,762 \angle -90,195^\circ \text{ A} \checkmark$$

(6)

6.3



$$X_C = \frac{1}{2\pi f C} = \frac{1}{2 \times \pi \times 50 \times 1,5 \times 10^{-6}} = 2\,122,066\,\Omega \checkmark$$

$$V_{ph/s} = V_{L/s} / \sqrt{3} = 132\,000 / \sqrt{3} = 76\,210,236 \angle 0^\circ \text{ V} \checkmark$$

$$Z_{AB} = 16 + j36 = 39,395 \angle 66,038^\circ \Omega \checkmark$$

$$Z_C = 0 - j \frac{2\,122,066}{2} = 1061,033 \angle -90^\circ \Omega \checkmark$$

$$I_{AC} = V_{AC} / Z_{AC} = 76\,210,236 \angle 0^\circ / 1\,061,033 \angle -90^\circ = 71,826 \angle 90^\circ \text{ A} \checkmark$$

$$I_{AB} = I_S - I_{AC} = 205 \angle -36,87^\circ - 71,826 \angle 90^\circ \\ = 254,663 \angle -49,91^\circ \text{ A} \checkmark$$

$$V_{AB} = I_{AB} \cdot Z_{AB} = 254,663 \angle -49,91^\circ \times 39,395 \angle 66,038^\circ = 10\,032,449 \angle 16,128^\circ \text{ V} \checkmark$$

$$V_{BD} = V_{AC} - V_{AB} = 76\,210,236 \angle 0^\circ - 10\,032,449 \angle 16,128^\circ \\ = 66\,630,699 \angle -2,397^\circ \text{ V} \checkmark$$

$$V_R = \sqrt{3} \cdot V_{PH/R} = \sqrt{3} \times 66\,630,699 = 115,408 \text{ kV} \checkmark$$

$$I_{BD} = V_{BD} / Z_{BD} = 66\,630,699 \angle -2,397^\circ / 1\,061,033 \angle -90^\circ = 62,798 \angle 87,603^\circ \text{ A} \checkmark$$

$$I_S = I_{AB} - I_{BD} = 254,663 \angle -49,91^\circ - 62,798 \angle 87,603^\circ \\ = 303,946 \angle -57,932^\circ \text{ A} \checkmark$$

(13)

[27]

**TOTAAL: 100**