



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

ELEKTROTEGNIEK N5

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Hierdie nasienriglyn bestaan uit 8 bladsye.

VRAAG 1

1.1 1.1.1 $V = 620 \text{ V}$, $P = 42 \text{ kW}$, $N = 1\,500 \text{ r/min}$, $\eta = 0,8$ pu
 $R_a = 0,2 \, \Omega$, $I_f = 2 \, \Omega$, $I_a R_b = 2,5 \text{ V}$

$$P_{in} = \frac{P_{out}}{\eta} = \frac{42000}{0,8} = 52,5 \text{ kW} \checkmark$$

$$P_{in} = V \times I_L$$

$$I_L = \frac{P_{in}}{V} = \frac{52500}{620} = 84,68 \text{ A} \checkmark \quad (2)$$

1.1.2 $I_a = I_L - I_f = 84,68 - 2 = 82,68 \text{ A} \checkmark$

$$E = V - (I_a R_a + I_a R_b)$$

$$E = 620 - [(82,68 \times 0,2) + (2,5)] = 600,96 \text{ V} \checkmark$$

$$E I_a = \frac{2\pi N T}{60}$$

$$T = \frac{60 \times E I_a}{2\pi N} = \frac{60 \times 600,96 \times 82,68}{2\pi \times 1500} \checkmark = 316,48 \text{ Nm} \checkmark \quad (3)$$

1.2 1.2.1 $E = 525 - (150 \times 0,4) = 465 \text{ V} \checkmark$
 $C = 2p = 2 \times 3 = 6$
 $465 = 2 \times \frac{780}{6} \times N \times \frac{3}{60} \times 0,05 \checkmark$
 $N = \frac{465}{0,65} = 715,36 \text{ r/min} \checkmark$

1.2.2 $P = V \times I = 465 \times 150 = 69\,750 \text{ W}$

$$P = \frac{2\pi N T}{60} = 69\,750 \checkmark$$

$$T = \frac{69750}{74,88} = 931,49 \text{ Nm} \checkmark$$

OF

$$T = 0,318 \frac{I_a}{C} Z p \phi$$

$$= 0,318 \times \frac{150}{6} \times 780 \times 0,05 \checkmark \checkmark$$

$$= 930,15 \text{ Nm} \checkmark$$

(2 × 3) (6)

- 1.3
- Om die hoë aansitstroom te beperk.
 - Moet slegs vir aansitdoeleindes aan die ankerkring bekendgestel word.
 - Dit bevat ook beskermende kenmerke om die motor te beskerm teen die skadelike gevolge van oorlading en kortsluitings.
 - Dit verander die ohmiese weerstand in die anker- en opwekkingskring.

(4)

- 1.4
- Toenemende borselkontakweerstand.
 - Skuif die borsels.
 - Gebruik hulppole.
 - Gebruik kompenserende wikkelings.

(4)
[20]

VRAAG 2

2.1

$$P = VI \cos \phi$$

$$1600 = 15 \times 220 \cos \phi$$

$$\cos \phi = 0,485 \text{ naloop } \checkmark$$

$$P = I^2 \times R$$

$$R = \frac{P}{I^2} = \frac{1600}{15^2} = 7,11 \, \Omega \checkmark$$

$$\cos \phi = \frac{R}{Z}$$

$$Z_1 = \frac{R}{\cos \phi} = \frac{7,11}{0,485} = 14,66 \, \Omega \checkmark$$

OR

$$Z_1 = \frac{V}{I} = \frac{220 \angle 0^\circ}{15 \angle -60,99^\circ} = 7,11 + j 12,8$$

Parallel

$$I_1 = 15 \angle -60,99^\circ = 7,27 - j 13,1$$

$$I_t = 40 \angle -31,79^\circ = 34 - j 21,1 \checkmark$$

$$I_2 = I_t - I_1 = (34 - j 21,1) - (7,27 - j 13,1) = 26,73 - j 8 = 27,901 \angle -16,662^\circ \text{ A } \checkmark$$

$$Z_2 = \frac{V}{I_2} = \frac{220 \angle 0^\circ}{27,901 \angle -16,662^\circ} \checkmark = 7,885 \angle 16,662^\circ \, \Omega = 7,554 + j 2,261 \checkmark$$

Serie

$$Z_t = Z_1 + Z_2 = 7,11 + j 12,8 + 7,554 + j 2,261 = 14,664 + j 15,061$$

$$= 21,021 \angle 45,765^\circ \text{ A } \checkmark$$

$$I = \frac{V}{Z_t} = \frac{220 \angle 0^\circ}{21,021 \angle 45,765^\circ} \checkmark = 10,465 \angle -45,765^\circ \text{ A}$$

$$\cos \phi = \cos 45,765 = 0,698 \text{ naloop } \checkmark$$

$$I = 10,465 \text{ A } \checkmark$$

(12)

$$2.2 \quad 2.2.1 \quad 2\pi fL = \frac{1}{2\pi fC} \text{ en}$$

$$C = \frac{1}{(2 \times 3,14 \times 50)(2 \times 3,14 \times 50) \times 0,8} \checkmark = 12,68 \mu F \checkmark \quad (2)$$

$$2.2.2 \quad I = \frac{V}{R} = \frac{200}{9,5} = 21,05 A \checkmark$$

$$V_L = 2 \times 3,142 \times 50 \times 0,8 \times 21,05 \checkmark = 5\,290,442 V \checkmark$$

$$V_C = V_L = 5\,290,442 V \checkmark \quad (4)$$

- 2.3
- Die totale impedansie van die stroombaan is sy weerstand ($X_L = XC, Z = R$).✓
 - Die impedansie (Z) sal op sy minimum wees.
 - Die stroom wat uit die toevoer (I) getrek word, sal op sy maksimum wees. ($I = \frac{V}{Z} = \frac{V}{R}$)
 - Die kring sal teen arbeidsfaktor van een werk, sodat die stroom in fase met die spanning sal wees. ($\cos \phi = 1$). (Enige 2 × 1) (2)
- [20]**

VRAAG 3

- 3.1 Moet hê:
- Dieselfde spanningsverhouding (dieselfde windingsverhouding).
 - Dieselfde persentasie impedansie en dieselfde $\frac{X}{R}$ -verhouding.
 - Dieselfde polariteit.
 - Dieselfde fasevolgorde. (Enige 2 × 1) (2)

$$3.2 \quad \frac{V_1}{V_2} = \frac{250}{500} = \frac{N_1}{N_2} \quad (6)$$

$$I_1 = \frac{S}{V_1} = \frac{15000}{3500} = 4,286 A \checkmark$$

$$R_e = R_1 + R_2 \left(\frac{N_1}{N_2}\right)^2 = 7,5 + 0,5(5)^2 = 20 \Omega \checkmark$$

$$X_e = X_1 + X_2 \left(\frac{N_1}{N_2}\right)^2 = 15 + 0,65(5)^2 = 31,25 \Omega \checkmark$$

$$Z_e = \sqrt{(R_e)^2 + (X_e)^2} = \sqrt{(20)^2 + (31,25)^2} = 37,1 \Omega$$

OF

$$Z_e = R_e + j X_e = 20 + j 31,25 = 37,1 \angle 57,38^\circ \Omega$$

$$\text{Reg} = \frac{I_1 [R_e \cos \phi + X_e \sin \phi]}{V_1} = \frac{4,286 [20 \times 0,8 + 31,25 \times 0,6]}{3500} = 0,043 \text{ pu} \checkmark \checkmark$$

$$V_{2FL} = V_{2NL} - \text{puReg} \times V_{2NL} = 700 - (700 \times 0,043) = 669,9 V \checkmark$$

3.3 TRA

$$Z_A = \frac{2150}{1500} (0,03 + j 0,09) \checkmark = 1,433(3 + j 9) = 4,299 + j 12,897 \\ = 13,59 \angle 71,57^\circ \Omega \checkmark$$

TR B

$$Z_B = 0,024 + j 0,08 = 2,4 + j 8 = 8,35 \angle 73,3^\circ \Omega \checkmark$$

$$Z_A + Z_B = 4,299 + j 12,897 + 2,4 + j 8 \checkmark = 6,699 + j 20,897 = 21,95 \angle 72,23^\circ \Omega \checkmark$$

Die las $S_T = 1\,200\text{ kW}$ at $\cos\phi = 0,85$ naloop $\checkmark$

$$S_T = \frac{1200}{0,85} = 1411,76 \angle 31,79^\circ$$

$$S_A = S_T \times \frac{Z_B}{Z_A + Z_B} = 1411,76 \angle 31,79^\circ \times \frac{8,35 \angle 73,3^\circ}{21,95 \angle 72,23^\circ} \checkmark = 537,05 \angle -30,72^\circ \checkmark$$

$$P_f = \cos 30,72^\circ 0,86 \text{ naloop } \checkmark$$

$$S_B = S_T \times \frac{Z_A}{Z_A + Z_B} = 1411,76 \angle 31,79^\circ \times \frac{13,59 \angle 71,57^\circ}{21,95 \angle 72,23^\circ} \checkmark = 874,07 \angle -32,45^\circ \checkmark$$

$$P_f = \cos 32,45^\circ 0,844 \text{ naloop } \checkmark$$

(12)

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VRAAG 4

$$4.1 \quad \text{Lusweerstand} = \frac{\rho l}{a} \frac{17,8 \times 56 \times 10 \exp 5}{0,9 \times 0,9 \times \pi \times 10 \exp 6} = 3,74 \Omega \checkmark \checkmark \checkmark$$

$$\text{Lusinduktansie} = 56 [0,05 \ 0,2 \ln (\frac{d}{r})] \text{ mH} \checkmark = 56 [0,05 \ 0,2 \ln (\frac{80}{0,9} \checkmark)] \text{ mH} \\ = 53,06 \text{ mH} \checkmark$$

$$\text{Totale kapasitansie} = \frac{28}{36 \ln (\frac{d-r}{r})} = \frac{28}{36 \ln (\frac{80-09}{09})} \checkmark \checkmark = 0,174 \mu\text{F}$$

(8)

$$4.2 \quad P_{in} = \frac{18500}{0,85} = 21\,764,7 \text{ W} \checkmark$$

$$P_1 + P_2 = 21\,764,7 \dots\dots\dots(1) \checkmark$$

$$\tan \phi = \frac{\sqrt{3}(P_2 - P_1)}{21\,764,7}$$

$$P_2 - P_1 = \frac{21\,764,7 \times \sqrt{(1 - \cos \phi \times \cos \phi)}}{\sqrt{3} \times 0,7} \checkmark = \frac{21\,764,7 \times \sqrt{(1 - 0,7 \times 0,7)}}{\sqrt{3} \times 0,7} \checkmark = 12\,819,8 \text{ W} \checkmark \dots\dots\dots(2)$$

$$(1) + (2) = 2 \times P_2 = 34\,584,6 \text{ W} \checkmark$$

$$P_2 = 17\,292,3 \text{ W} \checkmark$$

Vervang P2 in vergelyking 1

$$P_1 = 21\,764,7 - 17\,292,3 = 4\,472,5 \text{ W} \checkmark$$

OF

$$P_{in} = \frac{18500}{0,85} = 21\,764,7 \text{ W} \checkmark$$

$$IL = \frac{21\,764,7}{\sqrt{3} \times 380 \times 0,7} = 47,24 \text{ A} \checkmark$$

$$W_1 = VLIL \cos(\phi + 30) = 380 \times 47,24 \cos(45,573 + 30) \checkmark \checkmark = 4\,472,475 \text{ W} \checkmark$$

$$W_2 = VLIL \cos(\phi - 30) = 380 \times 47,24 \cos(45,573 - 30) \checkmark \checkmark = 17\,292,197 \text{ W} \checkmark \quad (8)$$

$$4.3 \quad 4.3.1 \quad WT = 700 + 360 = 1\,060 \text{ KW} \quad (1)$$

$$4.3.2 \quad \tan \phi = \frac{\sqrt{3}(W_2 - W_1)}{W_1 + W_2} = \frac{\sqrt{3}(700 - 360)}{1060} = 0,556 \checkmark$$

$$\phi = 29,074^\circ \checkmark$$

$$\text{Pf} = \cos(29,074) = 0,87 \checkmark$$

(3)

[20]

VRAAG 5

5.1 Die verskil tussen die sinchrone spoed (N_s) en die werklike spoed (N) van die rotor staan bekend as glip ('slip') $\checkmark \checkmark$

Vir 'n induksiemotor om wringkrag te ontwikkel, moet EMK en stroom $\checkmark$ in die rotor geïnduseer word. Dit sal slegs plaasvind wanneer daar 'n relatiewe spoedverskil' tussen die roterende magnetiese veld en die rotor is. $\checkmark$

(2 × 2)

(4)

5.2

5.2.1

$$f_1 = \frac{N_1 \times p}{60}$$

$$50 = \frac{N_1 \times 4}{60}$$

$$N_1 = 750 \text{ r/min} \checkmark$$

$$\begin{aligned} N_2 &= N_1 - s N_1 \\ &= 750 - 0,05(750) \\ &= 712,5 \text{ r/min} \checkmark \end{aligned}$$

OF

$$0,05 = 12,5 - NR/12,5 \quad NR = 11,875 \text{ r/s} \checkmark \checkmark \quad (2)$$

5.2.2

$$\text{Bruto P} = \frac{2 \times \pi \times N_2 \times T}{60}$$

$$28290 = \frac{2 \times \pi \times 712,5 \times T}{60} \checkmark$$

$$T = 379,16 \text{ Nm} \checkmark$$

$$\text{Rotorinset} = \frac{2 \times \pi \times N_1 \times T}{60} = \frac{2 \times \pi \times 750 \times 379,35}{60} = 29\,779,16 \text{ W} \checkmark$$

$$\text{Rotorkoperverlies} = s \times \text{rotorinset} = 0,05 \times 29\,794 = 1\,488,958 \text{ W} \checkmark$$

OF

$$\begin{aligned} \text{RKV/BrutoP} &= \text{Glip} / 1 - \text{Glip} \quad \text{Bruto P} = 28\,000 + 290 \\ &= 28\,290 \text{ W} \checkmark \end{aligned}$$

$$\text{RKV}/28\,290 = 0,05/1 - 0,05 \checkmark \checkmark$$

$$\text{RKV} = 1\,488,947 \text{ W} \checkmark \quad (4)$$

5.3

5.3.1

$$X = 9,5 \, \Omega$$

$$E_A = 2\,950 \text{ V/p}$$

$$I_R = 65 \text{ A}$$

$$I_R = \frac{E_R}{2X} \checkmark$$

$$\begin{aligned} E_R &= I_R \times 2X = 65 \times (2 \times 9,5) \checkmark \\ &= 1\,235 \text{ V} \checkmark \end{aligned}$$

$$E_R = E_A + E_B$$

$$\begin{aligned} E_B &= E_A - E_R \checkmark = 2\,950 - 1\,235 \checkmark \\ &= 1\,715 \text{ V} \checkmark \end{aligned}$$

(6)

5.3.2 Aansluiterspanning = $E_A - \frac{1}{2} E_R = 2\,950 - \frac{1}{2} 1\,235 = 2\,332,5 \text{ V} \checkmark$
Aansluiterspanning (L) = $2\,332,5 \times \sqrt{3} = 4\,040,009 \text{ V} \checkmark$ (2)

5.4 Daar moet aan die volgende voorwaardes voldoen word:

- Hul EMK's moet dieselfde wees
 - Hul EMK's moet dieselfde frekwensie hê
 - Hul EMK's moet in fase wees
 - Hul EMK's moet dieselfde hoekverplasing hê
- (Enige 2 × 1) (2)

[20]

TOTAAL: 100