higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

ELEKTROTEGNIEK N5

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VRAAG 1

1.1 Ankerreaksie is die vervorming van die poolvloed weens ankervloed. (1)

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Ankerreaksie is die vervorming van die hoofveld weens die interaksie tussen die twee velde (die hoofveldvloed en die vloed om die ankergeleiers).

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Ankerreaksie is die vervorming van die hoof- magnetiese veld wat by die anker in- en uitgaan wat deur die magnetiese veld van die anker veroorsaak word.

1.2 1.2.1 Ontmagnetiserende ampèrewindings per pool:

$= \frac{IZ}{4cp} \times \frac{4\theta}{360}$

$= \frac{120 \times 960}{4 \times 2 \times 3} \times \frac{4 \times 4}{360}$✓

$= 4\,800 \times 0{,}0444$

$= 213{,}12$ At✓

Dwarsmagnetiserende ampèrewindings per pool:

$= (\frac{IZ}{4cp}) - (\frac{IZ}{4cp} \times \frac{4\theta}{360})$

$= \frac{IZ}{4cp}(1 - \frac{4\theta}{360})$

$= \frac{120 \times 960}{4 \times 2 \times 3}(1 - \frac{4 \times 4}{360})$✓

$= 4\,800\ (1 - 0{,}0444)$

$= 4\,586{,}88$ At✓ (4)

1.2.2 $I_f = \frac{ontmag\ At}{hoeveelheid\ windings} = \frac{213{,}12}{1\,100}$✓ $= 0{,}194$ A✓ (2)

1.3 $I_L = \frac{Pgen}{V} = \frac{8\,000}{300} = 26{,}667$ A✓

$I_a = I_L + I_{sh} = 26{,}667 + \frac{V}{Rsh} = 26{,}667 + \frac{300}{300} = 26{,}667 + 1$

$= 27{,}667$ A✓

$E_{gen} = V + I_aR_a = 300 + (27{,}667 \times 0{,}6) = 300 + 16{,}6002$

$= 316{,}6002$ V✓

$P_{gen} = E_{gen} \times I_a = 316{,}6002 \times 27{,}667$

$= 8\,759{,}378$ W✓

$P_{inset} = P_{gen} + \text{verliese} = 8\,759{,}378 + 500$

$= 9\,259{,}378$ W✓

$P_{inset} = \frac{2\pi NT}{60}$

$T = \frac{P \times 60}{2\pi N} = \frac{9\,259{,}378 \times 60}{2x\pi \times 1\,300}$

$= 68{,}016$ Nm✓ (6)

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P_{in}= P_o + verliese
= 8 000 + 500
= 8 500 W✓

$I_L = \frac{Pin}{V} = \frac{8\,500}{300}$ =28,333 A✓

$R_{sh} = \frac{V}{Rsh} = \frac{300}{300}$ = 1 A

$I_a = I_L + I_{sh}$ = 28,333 + 1 = 29,333 A✓

$E = V + I_aR_a$ = 300 + (29,333 × 0,6) = 317,6 V✓

$T = \frac{EIa}{2\pi N} = \frac{317,6 \times 29,333}{2\pi \times 21,667}$ = 68,042 Nm✓✓

1.4
- Ankerreaksie
- Kommutasie
- Veranderinge in ankerstroom (Enige 2 × 1) (2)

1.5 $E = V - I_aR_a$ = 550 – 100(0,4)
= 550 – 40 ✓
= 510 V✓

En
$E = \frac{2p\Phi NZ}{60c}$ dus

$N = \frac{E60c}{2p\Phi Z}$ ✓= $\frac{510 \times 60 \times 2}{2 \times 4 \times 0,07 \times 900} = \frac{61\,200}{504}$ ✓ = 121,43 r/min✓ (5)

[20]

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VRAAG 2

2.1 2.1.1 $X_C = \frac{1}{2\pi fC}$

$= \frac{1}{2 \times 3{,}142 \times 50 \times 300 \times 10^{-6}} = 10{,}609\ \Omega$✓

$Z_A = R_A - jX_C = 15 - j10{,}609 = 18{,}373\angle -35{,}27°\ \Omega$✓

$I_A = \frac{VA}{ZA} = \frac{230\angle 0°}{18{,}373\angle -35{,}27°}$✓ $= 12{,}52\angle 35{,}27°\ A$✓

$I_B = I_T - I_A = 13\angle 0° - 12{,}52\angle 35{,}27°$
$= (13 + j0) - (10{,}22 + j7{,}229)$✓
$= 2{,}78 - j7{,}229$
$= 7{,}745\angle -68{,}97°\ A$✓ (6)

2.1.2 Arbeidsfaktor = cos 68,97°✓
= 0,359 nalopend✓ (2)

2.1.3 $Z_B = \frac{V}{IB} = \frac{230\angle 0°}{7{,}745\angle -68{,}97°\ A} = 29{,}697\angle 68{,}97°\ \Omega$✓✓ (2)

2.1.4 $Z_B = R - jX = 10{,}657 + j27{,}7129$✓
$= 27{,}719\ \Omega$ ✓ (2)

2.1.5 ∴ R = 10,657 Ω (1)

2.2 $Z = \frac{L}{CR} = \frac{0{,}6 \times 10^{-3}}{0{,}0003 \times 10^{-6} \times 20} = 100\ 000\ \Omega = 100\ k\Omega$✓✓ (2)

2.3
- Gebruik van kapasitorbanke parallel met die toevoer
- Gebruik van sinchrone motors in plaas van induksiemotors
- Gebruik van faseverskuiwers (3)

2.4
- Die impedansie is op die maksimum.
- Die resultante stroom wat van die toevoer getrek word (I), is op die minimum.
- Die resultante stroom (I) sal gelykfasig met die spanning wees (arbeidsfaktor van een).

(Enige 2 × 1) (2)
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VRAAG 3

3.1 Nuttige vloed is die vloed wat twee wikkelings verbind en waarvan die baan deur die ysterkern beweeg, terwyl lekvloed die magnetiese vloed is wat deur die primêre wikkeling voortgebring word wat nóg aan die sekondêre wikkeling verbind nóg 'n baan deur die ysterkern het, maar in stede daarvan deur die wikkelingisolasie vloei. (2)

3.2 Weerstand verwys na sekondêr:

$R''_e = R_2(\frac{V_2}{V_1})^2$

$= 0,6 + 9\left(\frac{600}{3\,300}\right)^2$
$= 0,6 + 0,2975$
$= 0,898\ \Omega$✓

Reaktansie verwys na sekondêr:

$X_e'' = X_2 + X_1\ (\frac{V_2}{V_1})^2$

$= 0,9 + 16\left(\frac{600}{3\,300}\right)^2$

$= 0,9 + 0,529$

$= 1,429\ \Omega$✓

$I_{2FL} = \frac{S}{V_2}$

$= \frac{15 \times 10^3}{600}$✓

$= 25$ A✓

$\bar{z}_e'' = R_e'' + jX_e''$

$= 0,898 + j1,429$✓

$= 1,688\angle 57,85°\ \Omega$✓

$V_2 = V_2 - L_2 \cos(\emptyset_e - \emptyset_2)$

$= 600 - 25 \times 1,688\cos(57,85° - 36,87°)$✓

$= 600-39,40$

$= 560,6$ V✓

(8)

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Reg = $\frac{I_{2(Re\cos\emptyset + Xe\sin\emptyset)}}{V_2}$

$= \frac{25(0{,}898 \times 0{,}8 + 1{,}429 \times 0{,}6)}{600}$

= 0,0657 pu

$V_2 = 600 - (600 \times 0{,}0657)$

= 560,58 V

3.3 Neem die 1 400 kVA-transformator as die basis:

$R'_a = \frac{T_a}{T_b}(R_a)$

$= \frac{1\,400}{1\,000}$(2%)

= 2,8%✓

$X'_a = \frac{T_a}{T_b}(X_a)$

$= \frac{1\,400}{1\,000}$(6%)

= 8,4%✓

$\bar{Z}_{serie} = \bar{Z}_a + \bar{Z}_b$

= (2,8 + j8,4) + (3 + j7)

= (5,8 + j15,4)

= 16,46∠69,36° %✓

$\bar{S}_a = \bar{S}_t(\frac{\overline{Z_B}}{\overline{Z_A}+\overline{Z_B}})$

$= 2\,000\angle -31,79^0(\frac{3 + j7}{16{,}46\angle 69{,}36^0})$

$= 2\,000\angle -31,79^0(\frac{7{,}616\angle 66{,}80^0}{16{,}46\angle 69{,}36^0})$✓

$= (\frac{1\,5232\angle 35{,}01^0}{16{,}46\angle 69{,}36^0})$

$= 925\angle -34,35^0$ kVA (onder die 1 000 kVA-aanslag)✓

$\bar{S}_b = \bar{S}_r(\frac{\overline{Z_a}}{\overline{Z_A}+\overline{Z_B}})$

$= 2\,000\angle -31,79^0(\frac{2{,}8 + j8{,}4}{16{,}46\angle 69{,}36^0})$

$= 2\,000\angle -31,79^0(\frac{8{,}85\angle 71{,}57^0}{16{,}46\angle 69{,}36^0})$ ✓

$= (\frac{17\,700\angle 39{,}78^0}{16{,}46\angle 69{,}36^0})$✓

$= 1\,075{,}33\angle -29,58^0$ kVA (onder die 1 400 kVA-aanslag)✓ (8)

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$Za = (0,02 + j0,06)\frac{1\,400}{1\,000}$
$= 0,028 + j0,084$
$= 0,089 \angle 71,57° \Omega$

$Zb = 0,03 + j0,07$
$= 0,076\angle 66,801° \Omega$

$Za + Zb = 0,058 + j0,154$
$= 0,165\angle 69,362° \Omega$

$S_1 = S_T\angle\emptyset \times \frac{Zb}{Za+Zb}$
$= 2\,000\angle -31,79 \times \frac{0,076\angle 66,801}{0,165\angle 69,362}$
$= 922\angle -34.351° \, kVA$
$Pf = \cos\emptyset$
$= \cos 34,351$
$= 0,826$ nalopend

$S_2 = S_T\angle\emptyset \times \frac{Za}{Za+Zb}$
$= 2\,000\angle -31,79 \times \frac{0,089\angle 671,57}{0,165\angle 69,362}$
$= 1078\angle -29.582° \, kVA$
$Pf = \cos\emptyset$
$= \cos 29,582$
$= 0,869$ nalopend

3.4
- Histereseverlies is eweredig aan WS-frekwensie (f) en magnetiesevloeddigtheid (B). Histereseverlies ∝ B.f.
- Werwelstroomverlies is eweredig aan die kwadraat van die vloeddigtheid, die kwadraat van die frekwensie en die kwadraat van die dikte van laagvorming. Werwelstroomverlies ∝ $B^2.f^2.t^2$; hoe hoër die frekwensie dus is, hoe hoër die ysterkernverliese.

(2)
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VRAAG 4

4.1 Dit is die verhouding tussen die spanning (EMK) wat geïnduseer word deur verspreiding van die geleiers in verskillende gleuwe en die spanning wat geïnduseer sou word as al die geleiers in een gleuf gekonsentreer was. (2)

4.2 $E_{wgk} = 2{,}22\Phi fZk_pk_d$

$Z = \frac{Ewgk}{2{,}22\Phi fkpkd} = \frac{Ewgk}{2{,}22 \times 0{,}04 \times 50 \times 1 \times 0{,}96} = \frac{19\,053}{4{,}2624} = 4\,470\ \Omega$✓✓

$P = \frac{fx60}{N}$ = drie pare = ses pole✓✓

Geleiers per pool = $\frac{4\,470}{6} = 745$✓

Geleiers per pool per fase = $\frac{745}{3} = 248{,}33$, sê 249✓✓

Geleiers per gleuf per pool per fase = $\frac{249}{3} = 83$✓ (8)

4.3 $N_s = \frac{f \times 60}{p} = \frac{50 \times 60}{2} = 1\,500$ r/min ✓ ✓

$N_R = N_s – (sxN_s)$
$= 1\,500 - (0{,}04 \times 1\,500)$
$= 1\,400$ r/min ✓✓ (4)

4.4.1 Statoruitset = statorinset x η

$= 430 \times 0{,}88$

$= 378{,}4$ kW✓✓

4.4.2 P_{dev} = statorinset – stator-koperverliese – rotorverliese

$= 430 – (12\% \times 430) – 13$

$= 365{,}4$ kW✓✓

4.4.3 Rotorinset = $\frac{2\pi N_S T}{60}$

$T = \frac{rotorinset \times 60}{2\pi N_S}$

$= \frac{365{,}4 \times 10^3 \times 60}{2 \times 3{,}142 \times 1\,000}$✓

$= 3\,488{,}86$ Nm✓

(3 × 2) (6)
[20]

VRAAG 5

5.1 $a = \frac{\pi d2}{4} = \frac{3,142 \times (19 \times 10^{-3})2}{4} = 283,57 \times 10^{-6}\ m^2$✓

$R = \frac{\rho l}{a} = \frac{0,0173 \times 10^{-6} \times 15\,000}{283,57 \times 10^{-6}} = 0,915\ \Omega$ per geleier✓✓

$R_t = 0,915 \times 2 = 1,83\ \Omega$ vir die roete✓

$L = 0,1 + 0,4\ln(\frac{de}{r})$ mH/km
$= 0,1 + 0,4\ln(\frac{1\,000}{9,5}) \times l$✓
$= 1,9626 \times 15$
$= 29,44$ mH✓

$C = \frac{1}{36\ Lin\ \frac{d-r}{r}}$ µf/km

$= (\frac{1}{36\ Lin\ (\frac{1-0,0095}{0,0095})}) \times 15$

$= 0,089$ µf✓✓ (8)

5.2 $P_{in} = \frac{Po}{\eta} = \frac{70}{0,9} = 77,8$ kW✓✓

$\cos\phi = 0,85$
$\phi = \cos^{-1}(0,85)$✓
$= 31,79°$✓

$P_{in} = W_1 + W_2 = 77,8$ kW …… (1)✓

$\tan \emptyset = \sqrt{3}(\frac{W1 - W2}{W1 + W2})$✓

$\tan 31,79 = \sqrt{3}(\frac{W1 - W2}{77,8})$✓

$0,6198 = \sqrt{3}(\frac{W1 - W2}{77,8})$✓
$\frac{0,6198}{\sqrt{3}} = (\frac{W1 - W2}{77,8})$✓

$27,84 = W1 - W2$ ..... (2)
$2W_2 = 77,8 - 27,84$✓
$W_2 = 24,98$ kW✓
En
$W_1 = 77,8 - 24,98$
$W_1 = 52,82$ kW✓

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$P_{in} = \frac{Po}{\eta}$
$= \frac{70}{0,98}$
= 77,778 kW

$I_L = \frac{Pin}{\sqrt{3}VL\cos\emptyset}$
$= \frac{77,77810^3}{\sqrt{3}\times 500 \times 0,85}$
= 105,659

$\cos\emptyset = 0,85$
$\emptyset = \cos^{-1} 0,85$
= 31,79°✓

$W_1 = VLIL\cos(30 + \emptyset)$
$= 500 \times 105,659\ \cos(30 + 31,79°)$
= 24,973 kW
$W_2 = VLIL\cos(30 - \emptyset)$
$= 500 \times 105,659\ \cos(30 - 31,79°)$
= 52,804 kW

`(12)
[20]

TOTAAL: 100

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