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 6 bladsye.

Kopiereg voorbehou

VRAAG 1

1.1
- Verhoog die borselkontakweerstand
- Beweeg die borsels vorentoe in 'n generator en agtertoe in 'n motor
- Verhoog die reluktansie
- Hulppole
- Kompenseerwikkelings (Enige 3 × 1) (3)

1.2 $\text{Amp-windings}_{ANKER} = ½ \times I_a/c \times Z/2p = ½ \times (648/8) \times (820/8)$✓
$= 4\ 151{,}25$ At(s)✓

$4\ 151{,}25/\text{Amp-windings}_{Hulppool} = 0{,}88$✓
$\text{Amp-windings}_{Hulppool} = 4\ 151{,}251/0{,}88 = 4\ 717{,}329$ At(s)✓

$\text{Windings}_{Hulppool} = 4\ 717{,}329/648 = 7{,}279$ windings
$= 7$ windings✓ (5)

1.3 $R_1 = V_S/I_{st} = 480/115 = 4{,}174\ \Omega$✓

$K = \sqrt[n]{R/r} = \sqrt[15]{\frac{4{,}174}{0{,}35}}$✓ $= 1{,}179$✓

$r\ 1 = R_1[(K - 1)/K] = 4{,}174[(1{,}179 - 1)$✓$/1{,}179] = 0{,}63\ \Omega$✓

$r\ 2 = 0{,}636/1{,}179 = 0{,}539\ \Omega$✓

$r\ 3 = 0{,}539/1{,}179 = 0{,}458\ \Omega$✓ (7)

1.4 $\text{Amp-winding}_{NL} = 2{,}5 \times 1\ 350 = 3\ 375$✓
$\text{Amp-winding}_{L} = 4{,}5 \times 1\ 350 = 6\ 075$✓

$I_L = 120 \times 10^3/440 = 272{,}727$ A✓

$\text{Amp-windings}_{SERIE} = 6\ 075 - 3\ 375 = 2\ 700$✓

$I_a = I_L + I_F = 272{,}727 + 2{,}5 = 275{,}227$ A

$\text{Windings}_{SERIE} = 2\ 700/275{,}227 = 9{,}8$✓

Sê: 10 windings (5)
[20]

VRAAG 2

2.1 2.1.1

$F_r = (2\pi \sqrt{LC})^{-1}$
$1,4 \times 10^6 = (2\pi \sqrt{0,000185 \times C})^{-1}$✓
$\sqrt{0,000185 \times C} = (2\pi \times 1,4 \times 10^6)^{-1}$
$C = 1,292 \times 10^{-14}/185 \times 10^{-6}$✓
$= 6,986 \times 10^{-11}$
$= 69,857$ pF✓
OF

$X_L = X_C = 2\pi \times 1,4 \times 10^6 \times 185 \times 10^{-6}$
$= 1\,627,345\ \Omega$✓
$1\,627,345 = (2\pi\ 1,4 \times 10^6 \times C)^{-1}$✓
$C = (2\pi \times 1,4 \times 10^6 \times 1\,627,345)^{-1}$
$= 6,986 \times 10^{-11}$✓
$= 69,857$ pF (3)

2.1.2 $Z_D = Z_P = L/CR = 185 \times 10^{-1}/69,857 \times 10^{-12} \times 8)$✓
$= 331\,033,397\ \Omega$✓
$= 331,033$ kΩ (2)

2.1.3 $Z_T = Z_P + Z_{SE} = 331\,033,397 + 6\,580 = 337\,613,397\ \Omega$✓

$I_T = V_T/Z_T = 440/337\,613,397 = 1,303 \times 10^{-3}$ A✓
$= 1,303$ mA

$V_P = I_T Z_P = 1,303 \times 10^{-1} \times 331\,033,397 = 431,425$ V✓

$Z_{SPOEL} = 8 + j1\,627,345 = 1\,627,365 < 89,72\ \Omega$
$I_{SPOEL} = V_P/Z_{SPOEL} = 431,425/1\,627,36 = 0,265$ A✓

$I_C = V_P/X_C = 431,425/1\,627,354 = 0,265$ A $= 265,108\ \mu$A✓ (5)

2.2 2.2.1 $X_{L1} = X_{C1} = (2\pi \times 0,95 \times 10^6 \times 287 \times 10^{-12})^{-1} = 583,734\ \Omega$✓
$L = X_{L1}/(2\pi f) = 583,734/(2\pi \times 0,95 \times 10^6)$✓
$= 97,794 \times 10^{-6}$ H $= 97,794\ \mu$H✓ (3)

2.2.2 $X_{C2} = (2\pi \times 0,95 \times 10^6 \times 271 \times 10^{-12})^{-1} = 618,197\ \Omega$✓
$X_C = X_{C2} - X_{C1} = 618,197 - 583,734 = 34,463\ \Omega$✓
$Z_2^2 = R^2 + (34,463)^2$✓
$I_2 = 0,74\ I_1 = 0,74\ V/Z_1$
$0,74\ V/Z_1 = V/Z_2$
$R^2 + (34,463)^2 = (1,351\ R)^2$✓
$R^2 + (34,463)^2 = 1,825\ R^2$
$0,825\ R^2 = (34,463)^2$✓
$R^2 = 1\,439,634$✓
$R = \sqrt{1\,439,634}$
$= 37,943\ \Omega$✓ (7)
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VRAAG 3

3.1 Ysterverliese sal toeneem met 'n toename in frekwensie. (2)

3.2 Wanneer die transformator 'n voorlooparbeidsfaktor het (1)

3.3 $I_1 = S/V_1 = 125 \times 10^3/2\,400\checkmark = 52{,}083\ A\checkmark$

$\%R = I_1 R_{E1}/V_1$
$3/100 = 52{,}083 \times R_{E1}\checkmark/2\,400$
$R_{E1} = 1{,}382\ \Omega\checkmark$

$\%X = I_1 X_{E1}/V_1$
$0{,}042 = 52{,}083\ X_{E1}\checkmark/2\,400$
$X_{E1} = 1{,}935\ \Omega\checkmark$

$Reg = I_1(R_{E1}\ Cos\Theta + X_{E1}\ Sin\Theta)/V_1$
$= 52{,}083[(1{,}382 \times 0{,}86) + (1{,}935 \times Sin30{,}68)]\checkmark/2\,400$
$= 52{,}083 \times 2{,}176/2\,400\checkmark$
$= 0{,}0472$ p.u.$\checkmark = 4{,}722\%$

$V_{2FL} = V_{2NL} - Reg \times V_{2NL} = 600 - (0{,}0472 \times 600)\checkmark$
$= 600 - 28{,}32 = 571{,}68\ V\checkmark$ (11)

3.4 3.4.1 $I_2 = S/V_2 = 13 \times 10^3/200\checkmark = 65\ A\checkmark$

$\%R = I_2 R_{E2}/V_2$
$0{,}02 = 65 \times R_{E2}/200\checkmark$
$R_{E2} = 400/6\,500 = 0{,}062\ \Omega\checkmark$ (4)

3.4.2 $\%X = I_2 X_{E2}/V_2$
$0{,}04 = 65\ X_{E2}/200\checkmark$
$X_{E2} = 800/6\,500 = 0{,}123\ \Omega\checkmark$ (2)

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VRAAG 4

4.1 $P_{IN} = P_O/\eta = 20 \times 10^3/0{,}88 = 22{,}727\ kW\checkmark$
$P_{IN} = \sqrt{3}\ V_L I_L\ Cos\Theta$
$V_L I_L = P_{IN}/(\sqrt{3}\ Cos\Theta) = 22{,}727 \times 10^3/(\sqrt{3} \times 0{,}89)\checkmark = 14\,743{,}191\ A\checkmark$

$\Theta = Cos^{-1}(0{,}89) = 27{,}13^\circ\checkmark$
$W_1 = V_L I_L Cos(30 - \Theta) = 14\,743{,}191 \times Cos(30 - 27{,}13)\checkmark$
$= 14\,724{,}699\ W = 14{,}725\ kW\checkmark$

$W_2 = V_L I_L Cos(30 + \Theta) = 14\,724{,}699 \times Cos(30 + 27{,}13)\checkmark$
$= 8\,001{,}642\ W = 8{,}002\ kW\checkmark$ (8)

4.2 4.2.1 $X_L = 2\pi \times 50 \times 465 \times 10^{-3} = 8\ \Omega$✓
$V_P = V_L/\sqrt{3} = 25 \times 10^3/\sqrt{3} = 14\,433{,}757$ V✓
$V_R = V_P(\text{Cos}\Theta + j\text{Sin}\Theta) = 14\,433{,}757\ (0{,}8 + j0{,}6)$✓
$= 11\,547{,}006 + j8\,660{,}254$✓

$I_P = 12 \times 10^6/(\sqrt{3} \times 25 \times 10^3 \times 0{,}8) = 346{,}41$ A✓
$V_d = I_P Z = 346{,}41(4 + j8)$
$= 1\,385{,}64 + j2\,771{,}28$✓

$V_S = V_R + V_d = 11\,547{,}006 + j8\,660{,}254 + 1\,385{,}64 + j2\,771{,}28$✓
$= 12\,932{,}646 + j11\,431{,}534$✓
$= 17\,260{,}745 < 41{,}47$ V✓ (9)

4.2.2 $\text{Reg} = (V_S - V_R)/V_R = (17\,260{,}745 - 14\,433{,}757)$✓$/14\,433{,}757$
$= 19{,}586\%$✓ (2)

4.3 $P_T = 820 + 300 = 1\,120$ W✓ (1)
[20]

VRAAG 5

5.1 'n Hoë spanning laat die arbeidsfaktor en die glip ('slip') albei afneem, maar verhoog die wringkrag. (2)

5.2 Daar is geen relatiewe spoedverskil tussen die draaiende magnetiese veld en die rotor nie.✓ Geen EMK sal in die rotor veroorsaak word nie✓ en daarom sal daar dus geen rotorstroom✓ en geen wringkrag✓ wees nie. (4)

5.3 5.3.1 $P = 60f/N_S = (60 \times 50)/1\,500$✓ $= 2$ (pare)
Pole $= 2 \times 2 = 4$ pole✓ (2)

5.3.2 $E_P = 500/\sqrt{3} = 288{,}675$ V✓
$Z_P = 10 \times 6 \times 4 = 240$ kond/ph✓
$\phi = E_P/(2{,}22\ K_d\ K_P\ Z_P\ f)$
$= 288{,}675/(2{,}22 \times 0{,}97 \times 240 \times 50)$✓
$= 0{,}0112$ Wb✓
$= 11{,}161$ MWb (4)

5.4 5.4.1 $N_S = 60f/p = (60 \times 50)/3 = 1\ 000$ r/min✓
$S = (N_S - N_R)/N_S$
$(0,06 \times 1\ 000) = 1\ 000 - N_R$
$N_R = 940$ r/min✓ (2)

5.4.2 $P_O = 2\pi N_R T/60$
$45\ 285 \times 60 = 2\pi \times 940 \times T$✓
$T = 460,042$ Nm✓

Rotoringang = $(2\pi \times 1\ 000 \times 460,042)$✓$/60$
= 48 175,486 W✓

Rotorkoperverlies = S × Rotoringang
= 0,06 × 48 175,486✓
= 2 890,529 W✓ (6)
[20]

TOTAAL: 100

Kopiereg voorbehou