higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

ELEKTROTEGNIEK N5

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Hierdie nasienriglyn bestaan uit 9 bladsye.

Kopiereg voorbehou

VRAAG 1

1.1
- Vaste pole in die veldwikkeling
- Geen roterende magnetiese vloed nie
- Groot massa weens die swaarbewikkelde anker
- EMK ∝ Spoed ∝ Vloed (E ∝ N ∝ Φ) (Enige 2 × 1) (2)

1.2 'n Seriemotor kan nie sonder enige meganiese las✓ aangesluit word nie want teen nullas is die veldvloed te klein om die opbou van die nodige teen-EMK toe te laat en dit veroorsaak dat die motor tot eindigheid sal versnel en uiteindelik uitbrand.✓ (2)

1.3 Die kommutasievlak is die area waarin die kommutasiepole invloed het. (1)

1.4 $E_1 = V - I_aR_a$
$= 250 – (50)(0, 2)$
$= 250 – 10$
V✓✓

1.4.1 $E = kN\Phi$
$E_2/E_2 = N_2/N_1$
$E_2/240 = \frac{800}{1000}$✓✓
$E_2 = 192$ V✓✓

$E_2 = V - I_a(R_a + x)$
$192 = 250 – 50(0, 2 + x)$ ✓✓
$192 = 250 – 10 – 50x$
X 0, 96 Ω✓✓ (5)

1.4.2 Wanneer $T_2/T_1 = 0, 5$
$T \propto I_a$ ……omtakmotor
$T_2/T_1 = I_{a2}/I_{a1} = 0, 5$✓
$I_{a2} = 0, 5 \text{ x } I_{a1} = 0, 5 \times 50 = 25$ A✓
$E_2 = V - I_aR_a$
V✓
$E_2/E_2 = N_2/N_1$

$N_2/1000 = \frac{245}{240}$✓
$N_2 = 1021$ r/min✓ (5)

1.5 P = 450 kW
V = 380 V
$I = P/V = \frac{450\,000}{380} = 1184$ A
P = 3 (6 pole)
C = 2p (lusgekoppelde wikkeling)
= 2(3) = 6
Z = 180
$\theta = 0°$

Hulppool At/p = 1, 3 anker At/p
Kruis At/p = $\frac{IZ}{2c2p}$ [1 - $\frac{4\theta}{360°}$]
= $\frac{(1184)(180)}{2(6)2(3)}$ [1 - $\frac{4(0°)}{360°}$] ✓
= 2961 [1 – 0]
= 2961 At/p✓

Ontmag At/p = $\frac{IZ}{2c2p}$ [$\frac{4\theta}{360°}$]
= 0 At/p, want θ = 0°
Anker A/p = 2961 + 0 = 2961 At/p✓
Vir hulppole:
At/p = 1, 3 × 2961= 3849✓
$I_a = \frac{At/p}{t/p}$
1184 = $\frac{3849}{t/p}$
t/p = 3, 25✓ (5)
[20]

VRAAG 2

2.1 V_t = 84, 86 $\sin(1000t + 45°)$
i_t = 14, 14 $\sin(1000t - 45°)$
Aard: Suiwer reaktansie omdat die stroom teen 90° tot die spanning naloop✓
Grootte:
$X_L = \frac{V}{I} = \frac{0,707\ x\ 84,86}{0,707\ x\ 14,14}$ = 6 Ω✓
$2\pi f$ = 1000
f = $\frac{1000}{2\pi}$ = 159 Hz✓
X_L = 2 πfL✓
6 = 2 π(159)L
L = 0, 006H = 6 mH✓ (5)

2.2 Z_1 = 2 – j1 = 2, 236$\angle 26,6°$ Ω
Z_2 = 3 + j5 = 5, 83$\angle 59°$ Ω
Z_3 = 1 + j2 = 2, 236$\angle 63,4°$ Ω

2.2.1 Verwys na FIGUUR 1 in Addendum A (aangeheg). (Nothing attached) (2)

2.2.2 $Z_1 + Z_2 = 5 + j4 = 6,4\angle 38,7°\ \Omega$✓✓

$Z_p = (Z_1 \times Z_2)/(Z_1 + Z_2) = \frac{13,04\angle 85,6°}{6,4\angle 38,7°}$ ✓ = 2, 04∠46, 9° Ω✓✓✓

$V_p = V_1 = I_1Z_1 = 10(2, 236)$ ✓= 22, 36 V✓✓✓

$I_2 = (V_p/Z_2) = \frac{22,36}{5,83}$ = 3, 835 A✓✓

$I_3 = I_1 + I_2 = 10 + 3, 835 = 13, 835$ A

$V_3 = I_3 \times Z_3 = 13,835(2, 236) = 30, 93$ V✓✓✓✓

$V_T = V_P + V_3 = 22, 36 + 30, 93 = 53$ V✓✓

$Z_4 = 3 + j4 = 5\angle 53,13°\ \Omega$✓✓

$I_4 = \frac{V}{Z} = \frac{53}{5}$ = 10, 6 A✓✓

$I_T = I_1 + I_2 + I_4$

= 10 + 3, 835 + 10, 6✓✓

1 A✓✓ (13)

[20]

VRAAG 3

3.1 $V_L = 415$ V

$V_L = \sqrt{3}\ V_P$

$V_P = V_L/\sqrt{3} = \frac{415}{\sqrt{3}}$ = 239, 6 V✓✓

$I_P = I_L$

$X_L = 2\pi$ f L = 2π (50)(0, 02) = 6, 283 Ω✓✓

$X_C = \frac{1}{2\pi fC} = \frac{10\ 00000}{2\pi(50)(31,8)}$ = 100, 1 Ω✓✓

$Z_1 = R + jX_L = 10 + j6, 283 = 11, 81\angle 32,81°\ \Omega$

$Z_2 = R - jX_C = 0 - j100, 1 = 100, 1\angle -90°\ \Omega$

$Z_1 + Z_2 = 10 - j93, 817 = 94, 348\angle -83,9°\ \Omega$

$Z_T = (Z_1 \times Z_2)/(Z_1 + Z_2) = \frac{1182,18\angle -57,9°}{94,35\angle -83,9°}$ =12, 53∠26° Ω✓✓

$I_P = V_P/Z_P = \frac{239,6}{12,53}$ = 19, 122 A✓✓

$I_L = I_P$ = 19, 122 A ……(Sterverbind) (5)

3.2 Enkelfasige transformatorlasdeling

33 kV / 3, 3 kV

Twee transformators: 500 kVA en 1000 kVA

S_T =1200 kVA

cos Ø = 0,8 lag

Ø = 36, 87°

$Z_1 = \frac{1000}{500}(1, 5 + j6) = 3 + j12 = 12, 37\angle 76°\ \Omega$✓✓

$Z_2 = 1 + j6, 2 = 6, 28\angle 80,8°\ \Omega$

$Z_1 + Z_2 = 4 + j18,2 = 18, 63\angle 77,6°\ \Omega$✓✓

$S_1 = S_T \times (Z_2/(Z_1 + Z_2)) = \frac{1200\angle -36,87° x 6,28\angle 80,8°}{18,63\angle 77,6°}$ ✓✓

= 404∠ − 34° kVA✓✓

= 404 kVA met arbeidsfaktor van 0,82 naloop✓✓

$S_2 = S_T \times (Z_1/(Z_1 + Z_2)) = \frac{1200\angle -36,87° x 12,37\angle 76°}{18,63\angle 77,6°}$✓✓

= 796∠ − 39° kVA

= 796 kVA met arbeidsfaktor = 0,77 naloop✓✓ (7)

3.3 30 kVA transformator: 6000/230 V
$R_1 = 12\ \Omega$
$R_2 = 0,018\ \Omega$
$X_e = 26\ \Omega$
$\cos \emptyset = 0,8$ naloop
$R_e = R_1 + R_2(N1/N_2)^2 = 12 + 0,018(\frac{6000}{220})$ ✓✓
$0,9\ \Omega$✓✓

$I_{FL} = \frac{P}{V} = \frac{30\,000}{6000} = 5$ A ✓✓

Regulering $= I_1(R_e\cos \emptyset + X_e\sin \emptyset)/V_1$
$= 5[(24,25)(0,8) + (26)(0,6)]/6000$✓✓
$= 0,02917$ per eenheid
$= 2,917\ \%$✓✓ (5)

3.4
- Dieselfde spanningsverhouding
- Dieselfde per eenheid of persentasie-impedansie
- Dieselfde polariteit
- Dieselfde fasesekwens en geen relatiewe faseverplasing nie

(Enige 3 × 1) (3)
[20]

VRAAG 4

4.1 $P_T = P_2 + P_1 = 820 + (-480) = 340$ W✓
$\tan \emptyset = \sqrt{3}(P_2 - P_1)/(P_2 + P_1) = \frac{\sqrt{3}\,(1300)}{340} = 6,623$✓
$\emptyset = 81,41°$
$\cos \emptyset = 0,1493$

Vir driefase:
$P_T = \sqrt{3}\,V_L I_L \cos \emptyset$
$340 = \sqrt{3}(120)I_L(0,1493)$✓
$I_L = 10,956$ A
$I_P = I_L/\sqrt{3} = \frac{10,956}{\sqrt{3}} = 6,326$ A✓
$Z_p = V_p/I_p = \frac{120}{6,326} = 18,97\ \Omega$✓ (5)

4.2 P = 20 kW ……Lewering van die motor
Rendement = 90% = 0,9
$\cos \emptyset = 0,45$ and $\emptyset = 63,25°$✓✓
$P_{in} = \frac{20}{0,9} = 22,222$ kW
$\therefore P_1 + P_2 = 22222$ W✓
$\tan \emptyset = \tan 63,25° = 1,9845$
$\tan \emptyset = \sqrt{3}(P_2 - P_1)/(P_1 + P_2)$
$1,9845 = \sqrt{3}(P_2 - P_1)/(22222)$
$(P_2 - P_1) = 25461$ W✓✓

Vergelyking 1 + Vergelyking 2:
$2P_2 = 47683$
$P_2 = 23842$ W
Vervang P_2 in Vergelyking 1
$P_1 + 23842 = 22222$
$P_1 = -1620$ W
$W_1 = P_1 = -1620$ W✓✓
$W_2 = P_2 = 23842$ W✓✓ (5)

4.3 Transmissielyn (driefasig)
S = 2500 kVA
V_R = 11 kV
$\cos \emptyset = 0, 8$
$I_L = \frac{S}{\sqrt{3}V} = \frac{2500}{\sqrt{3}(11)} = 131, 2159$ A✓
Volt-drop = $IR\cos \emptyset + IX\sin \emptyset$
= $I[R\cos \emptyset + X\sin \emptyset]$ ✓
= 131, 22[(3)(0, 8) +(6)(0, 6)]
= 787 V (fasewaarde)✓
= 1363 V (lynwaarde)✓

$V_s = V_R$ + Spanningsval
= 11 kV + 1, 363 kV =12, 363 kV✓

OF

$V_s = V_R\angle 36.87° + IR\angle 0° + IX\angle 90°$

$V_s = \frac{11000}{\sqrt{3}}\angle 36.87° + (131.22x3)\angle 0° + (131.22x6)\angle 90°$✓

= $6350.853\angle 36.87° + (393.647 + j0) +(0 + j\ 787.295)$✓

= (5080.676 + j3810.521) +(393.647+j787.295)✓

= 5474.322 + j4597.816 = $7148.994\angle 40.026°$✓

$V_{sLine)} = (\sqrt{3}x7148.994) = 12382.421$ V = 12.382 kV

Regulering = 0.1256 = 12.56%✓✓

4.3.1 Regulering = $(V_S – V_R)/V_R = \frac{1,363}{11}$ =0, 1239 pu✓✓✓✓
= 12,39% (7)

4.3.2 Verliese = $3I^2R$ (W gekanselleer)
= $3(131, 2159)^2(3)$✓
= 154, 959 kW
= $\frac{154,959}{0,8}$ = 193, 7 kVA✓
Rendement = $\frac{Output}{Input} = \frac{Output}{Output+Losses} = \frac{2500}{(2500+193,7)}$ = 0, 928 pu
= 92, 8 %✓ (3)
[20]

VRAAG 5

5.1 Wanneer die las aan die alternator wissel sal die aansluiterspanning ook wissel weens die verandering in die arbeidsfaktor✓ en die interne spanningsval in die masjien as gevolg van impedansie.✓ (2)

5.2
- Die EMK's moet gelyk wees
- Die EMK's moet dieselfde frekwensie hê
- Die EMK's moet in fase wees
- Opeenvolgende EMK's (in veelfasige masjiene) moet oor dieselfde hoekverplasing beskik, d.i. 120° vir driefasige masjiene (Enige 3 × 1) (3)

5.3 Sleepring-induksiemotor, sterverbind

$E_o = \frac{55}{\sqrt{3}}$ = 31, 754 V
R_o = 0, 7 Ω
X_o = 5 Ω
Rotor = 0, 7 + j5
R_{st} = 4 Ω
X_{st} = 3 Ω
Starter = 4 + j3

5.3.1 By aansluit (stilstaande)

$Z_o = \sqrt{[(0, 7 + 4)^2 + (5 + 3)^2]}$
= 9, 278 Ω✓

$I_o = E_o/Z_o = \frac{31,754}{9,278}$ = 3, 423 A✓✓ (3)

5.3.2 Met s = 5 % = 0,005

$E_2 = sE_o$ = (0, 05)(31, 75) = 1, 5877
$Z_2 = \sqrt{[(R_2)^2 + (sX_o)^2]}$
$= \sqrt{[(0, 7)^2 + (0, 05x5)^2]}$
0, 9 Ω✓
$I_2 = E_2/Z_2 = \frac{1,5877}{0,7433}$ = 2, 136 A✓ (2)

5.4 Alternator (driefasig)

E_L = 15 kV

$E_o = \frac{15000}{\sqrt{3}}$ = 8660 V per fase✓

Φ =0, 15 Wb

K_p = 1

3 gleuwe per pool per fase

N = 250

K_d = 0, 96

$E_o = 2,22 k_d k_p \Phi f Z/_{phase}$

$8660 = 2,22(0,96)(1)(0,15)(50)Z/_{phase}$✓

$Z/_{phase}$ = 541, 81 en

Z_T = 3(541, 81)

= 1625✓

$f = \frac{np}{60}$

$50 = \frac{250\ x\ p}{60}$

p = 12 (poolpare)

p = 24 pole

$3 = \frac{slots}{poles\ x\ phases} = \frac{slots}{24\ x3}$

Gleuwe = 3x24x3 = 216

Geleiers per gleuf = $\frac{Zt}{slots} = \frac{1625}{216}$ =7, 523 aanvaar 8✓ (5)

5.5 Alternators in parallel (driefasig sterverbind)

X_s = 7, 5 Ω

5.5.1 $I_p = E_z/2X_s$

$64 = E_z/2(7,5)$✓✓

E_z = 960 V✓✓

$E_a = E_b - E_z$

= 3800 – 960 = 2840✓✓ (3)

5.5.2 $E_p = (E_b + E_a)/2$

= (3800 + 2840)/2✓✓

= 3320 V

$E_L = \sqrt{3}\ E_p$

$= \sqrt{3}$ (3320)

= 5750 V✓✓ (2)

[20]

TOTAAL: 100

Kopiereg voorbehou