higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N5

11 APRIL 2018

This marking guideline consists of 7 pages.

Copyright reserved

QUESTION 1

1.1
- Armature reaction is the effect of armature ampere turns upon the value and distribution of the magnetic flux entering and leaving the armature.
- Armature reaction is the distortion of the main magnetic flux due to the interaction between the two fields (main magnetic flux and flux set up by the armature conductors). (Any 1 × 2) (2)

1.2 At starting the back EMF is 0 volts, the armature resistance is very low and therefore an extremely high current will be drawn by the motor. For this reason the starting resistance is then required to limit this high current. (3)

1.3 $E_1 = V - I_{a1} R_a$
$= 400 - (55 \times 0,5)$
$= 372,5$ V✓

$N_2 = 0,7\ N_1$✓
$T_2 = 0,8\ T_1$
$\phi_2 = \phi_1$✓

$E/E_1 = \phi_2\ N_2/\phi 1\ N_1$
$E_2/372,5 = 0,7$✓
$E_2 = 260,75$ V✓

$T_2/T_1 = \phi_2\ I_{a2}/\phi 1\ I_{a1}$
$0,8 = I_{a2}/(55)$✓
$I_{a2} = (0,8 \times 55)$
$= 44$ A✓

$E_2 = V - I_{a2} (R_a + R_X)$
$260,75 = 400 - 44(0,5 + R_X)$✓
$0,5 + R_X = 3,165$✓
$R_X = (3,165 - 0,5)$
$R_X = 2,665\ \Omega$✓ (10)

1.4 $Eff = P_O/P_{IN}$
$P_{IN} = P_O/Eff$
$= 7,46/0,85$
$= 8,776$ kW✓

$P_{IN} = V/I_L$

$I_L = P_{IN}/V$
$= 8,776 \times 10^3/440$
$= 19,945$ A✓

$I_F = V/R_F$
$= 440/200$
$= 2,2$ A✓

$I_a = I_L - I_F$
$= 19,945 - 2,2$
$= 17,745$ A✓

$E_{MF} = V - I_a R_a$
$= 440 - (17,745 \times 0,8)$
$= 425,804$ A✓ (5)
[20]

QUESTION 2

2.1 2.1.1 $i_1 = (0 + 10,4)/2 = 5,2$ A√ (½) marks
$i_2 = (10,4 + 21,4)/2 = 15,9$ A√ (½)
$i_3 = (21,4 + 27)/2 = 24,2$ A√ (½)
$i_4 = (27 + 25)/2 = 26$ A√ (½)
$i_5 = (25 + 11,4)/2 = 18,2$ A√ (½)
$i_6 = (11,4 + 0)/2 = 5,7$ A√ (½)
$I_{AVE} = (i_1 + i_2 + \ldots.. + i_6)/6$
$= (5,2 + 15,9 + 24,2 + 26 + 18,2 + 5,7)/6$✓
$= 95,2/6$
$= 15,867$ A✓ (5)

2.1.2 $I_{RMS} = \sqrt{\ }(i_1^2 + i_2^2 + \ldots.. + i_6^2)/6$
$= \sqrt{\ }(5.2^2 + 15,9^2 + 24,2^2 + 26^2 + 18,2^2 + 5,7^2)/6$✓
$= \sqrt{1\,905,22/6}$✓
$= 17,819$ A✓ (3)

2.1.3 $K_F = I_{RMS} / I_{AVE}$
$= 17,819/15,867$
$= 1,123$✓ (1)

2.2 2.2.1 Magnitude = R = V/I
$= (0,707 \times 450)/(0,707 \times 45)$
$= 10\ \Omega$✓

Nature: It is a pure resistance because the current is in phase with the voltage.✓ (2)

2.2.2 $2\pi f = 628$
$f = 628/(2\pi)$
$= 99,95$ Hz✓
$T = 10$ ms✓ (2)

2.3 2.3.1 $V_C^2 = V_T^2 - V_L^2$
$V_C = \sqrt{(220^2 - 120^2)}$
$= 184,391$ V✓

$I_L = P_L/V_L$
$= 1\ 000/120$
$= 8,333$ A✓

$X_C = V_C/I_L$
$= 184,391/8,333$
$= 22,128\ \Omega$✓

$C = (2\ \pi\ f\ X_C)^{-1}$
$= (2 \times \pi \times 60 \times 22,128)^{-1}$✓
$= 119,874\ \mu f$✓ (5)

2.3.2 $\cos \Theta = V_L/V_T$
$= 120/220$✓

$\Theta = \cos^{-1}(120/220)$
$= 56,944^0$✓ (2)
[20]

QUESTION 3

3.1
- Voltage ratio must be equal
- Per unit impedance must be equal
- Same polarity
- Same phase sequence and zero displacement (Any 2 × 1) (2)

3.2 3.2.1 $I_1 = S/V_1$
$= 11\ 000/2\ 100$
$= 5{,}238$ A✓

$Z_{E1} = Z\ V_1/I_1$
$= 0{,}0633 \times 2\ 100 < 71{,}56/5{,}238$✓
$= 25{,}358 < 71{,}56$✓
$= 8{,}021 + j24{,}056$

$R_{E1} = 8{,}021\ \Omega$✓
$X_{E1} = 24{,}056\ \Omega$✓ (5)

3.2.2 $REG = Z_{E1}\ I_1\ COS\ (\Theta_E - \Theta_2)/V_1$
$= 25{,}358 \times 5{,}238 \times COS\ (71{,}56 - 36{,}87)/2\ 100$✓
$= 0{,}052$ p.u.✓

$REG \times V_2 = 0{,}052 \times 220$
$= 11{,}442$ V✓

$V_{TERM} = V_2 - REG \times V_2$
$= 220 - 11{,}442$✓
$= 208{,}558$ V✓ (5)

3.2.3 $V_{SC1} = I_1\ Z_{E1}$
$= 25{,}358 \times 5{,}238$✓
$= 132{,}825$ V✓ (2)

3.3 $Z_A + Z_B = 0{,}148 + j0{,}317 + 0{,}113 + j0{,}64 = 0{,}261 + j0{,}957$
$= 0{,}992 < 74{,}74\ \Omega$

$S_A = S_T\ (Z_B/Z_A + Z_B) = 4\ 000\ (0{,}65 < 80/0{,}992 < 74{,}74)$✓
$= 2619{,}019 < 5{,}26$ kVA✓

$Cos\ \Theta = Cos\ 5{,}26$
$= 0{,}996$ LAGGING✓

$S_B = S_T\ (Z_A/Z_A + Z_B)$
$= 4\ 000\ (0{,}35 < 65/0{,}992 < 74{,}74)$✓
$= 1412{,}335 < -9{,}73$ KVA✓

$Cos\ \Theta = COS\ 9{,}73$
$= 0{,}986$✓ (6)
[20]

QUESTION 4

4.1 $L = 0,05 + 0,2 \ln d_e/r$✓
$= 10$✓ $[0,05 + 0,2 \ln (0,7/0,005)]$ mH/km✓
$= 10(0,05 + 0,2 \ln 140)$✓
$= 10,383$ mH✓

$C = [18 \ln (d - r/r)]^{-1}$✓
$= 10$✓$/[36 \ln (70$✓$ - 0,5)/0,5]$✓
$= 10/[(36 \times 4,241)/0,5]$
$= 0,131$ µf✓ (10)

4.2 4.2.1 $P_T = W_1 + W_2$
$= 2,85 + 1,9$✓
$= 4,75$ kW✓ (2)

4.2.2 $\text{Tan } \Theta = \sqrt{3}\ (W_1 - W_2)/W_1 + W_2$
$= \sqrt{3}\ (2,87 - 1,9)/4,75$✓
$= 0,346$✓

$\Theta = 19,1$✓
$\text{Cos } \Theta = \text{Cos } 19,11$
$= 0,945$✓ (4)

4.2.3 $I_L = P_T/\sqrt{3}\ V_L \text{ Cos } \Theta$
$= 4,75 \times 10^3/(\sqrt{3} \times 400 \times 0,945$✓
$= 4\ 750/654,72$
$= 7,255$ A✓ (2)

4.3 $L = 0,05 + 0,2 \ln d_e/r$
$= 80[0,05 + 0,2 \ln (4/0,025)]$✓
$= 80(0,05 + 1,015)$
$= 85,203$ mH✓ (2)
[20]

QUESTION 5

5.1
- Measurement
- Calculation (2)

5.2 No.✓ It lacks a rotating magnetic flux.✓ (2)

5.3 $E_P = 2\ K_F\ K_d\ K_P\ \phi\ f\ Z_P$

$E_P = 15\ 000/1{,}73 = 8\ 670{,}520$ V

$Z_P = 8\ 670{,}520/(2 \times 1{,}11 \times 0{,}96 \times 1 \times 0{,}15 \times 50)$✓
= 541,8 conductors/PH✓
f = Np/60
p = 60 f/N
= 60 × 50/300✓
= 10 pole pairs
= 20 poles ✓

Slots/phase = 3 × 20 slots/phase
= 60 slots/phase✓

Z/S = conductors/slot
= 541,8/60
= 9,03 conductors/slots✓ (6)

5.4 5.4.1 $E_R = 2\ Z_S\ I_{CIRC}$
= 2 × 6,5 × 61,53✓
= 799,89 V✓

$E_R = E_A - E_B$
$E_B = E_R - E_A$
= 3 600 – 799,89✓
= 2 800,11 V✓ (4)

5.4.2 $V_P = (E_A + E_B)/2$
= (3 600 + 2 800)/2✓
= 3 200,055 V✓

$V_L = \sqrt{3}\ V_P$
= $\sqrt{3}$ × 3 200,055
= 5 542,66 V✓ (3)

5.5 f = Np/60
N = 60 f/p
= 60 × 50/3
= 1 000 r/min✓

$S = N_S - N_R/N_S$
$N_R = N_S - (S \times N_S)$
= 1 000 – (0,05 × 1 000)✓
= 1 000 – 50
= 950 r/min✓ (3)
[20]

TOTAL: 100

Copyright reserved