higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNOLOGY N3

16 April 2020

This marking guideline consists of 8 pages.

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QUESTION 1

1.1 These parts of a DC machine are laminated in order to minimise✓ or reduce eddy current losses.✓ (2)

1.2 Ball bearings✓ and roller bearings✓ (2)

1.3 1.3.1 The field coils produce or generate✓ the main magnetic flux in a DC machine.✓ (2)

1.3.2
- Pole shoes are used to evenly distribute✓ the main magnetic flux✓ over the entire air gap.
- Pole shoes hold the field coils✓ securely in position.✓
- Pole shoes increase the efficiency✓ of the magnetic path.✓

(Any 1 × 2) (2)

1.4 1.4.1 Lap- wound

1.4.2 Differentially compounded

(2 × 1) (2)
[10]

QUESTION 2

2.1 When a coil of wire or a conductor is rotated inside a magnetic field,✓ magnetic field lines are cut and an EMF is induced✓ in the coil or in the conductor.

OR

An electromotive force is always induced in a coil✓ whenever the magnetic flux linking with the coil changes.✓ (2)

2.2
- Increase brush contact resistance
- Use interpoles
- Use compensating windings
- Shift the brushes (Any 2 × 1) (2)

2.3 2.3.1 $E = V + I_a R_a$
= 200 + (42,75)(0,15) ✓
= 206,413 V ✓ (2)

2.3.2 $I_{sh} = \frac{V}{R_{sh}} = \frac{200}{125} = 1{,}6\ A$ ✓

$I_L = I_a - I_{sh} = 42{,}75 - 1{,}6 = 41{,}15\ A$ ✓

$P_o = VI_L = (200)(41{,}15) = 8{,}23\ kW$ ✓

$\eta = \frac{P_o}{P_i} \times 100\% = \frac{8{,}23}{9{,}5} \times 100\% = 86{,}632\%$ ✓ (4)

[10]

QUESTION 3

3.1
- Armature reaction is the distortion of the main magnetic flux entering and leaving the armature✓ caused by the flux set up by the armature conductors when they carry current.✓
- Armature reaction is the effect of the armature ampere turns upon the value✓ and distribution of the magnetic flux entering and leaving the armature core.✓
- Armature reaction is the distortion of the main flux✓ as a result of current flowing in the armature conductors.✓ (Any 1 × 2) (2)

3.2 $P_i = \frac{P_o}{\eta} = \frac{15\,000}{0{,}85} = 17{,}647\ kW$ ✓

$P_i = VI_L \qquad I_L = \frac{17{,}647 \times 10^3}{400} = 44{,}118\ A$ ✓

$I_{sh} = \frac{V}{R_{sh}} = \frac{400}{275} = 1{,}455\ A$

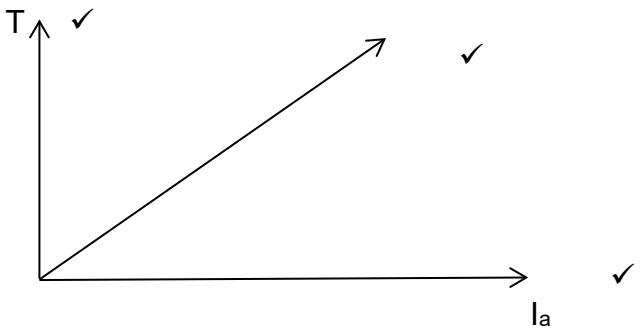
$I_a = I_L - I_{sh} = 44{,}118 - 1{,}455 = 42{,}663\ A$ ✓

Z = Number of slots × conductors/slot
= 100 × 4 = 400 conductors ✓

$T = \frac{0{,}318 I_a \emptyset p Z}{c}$

$\emptyset = \frac{(136)(6)}{(0{,}318)(42{,}663)(3)(400)} = 0{,}05\ Wb$ OR $50\ mWb$ ✓ (5)

3.3



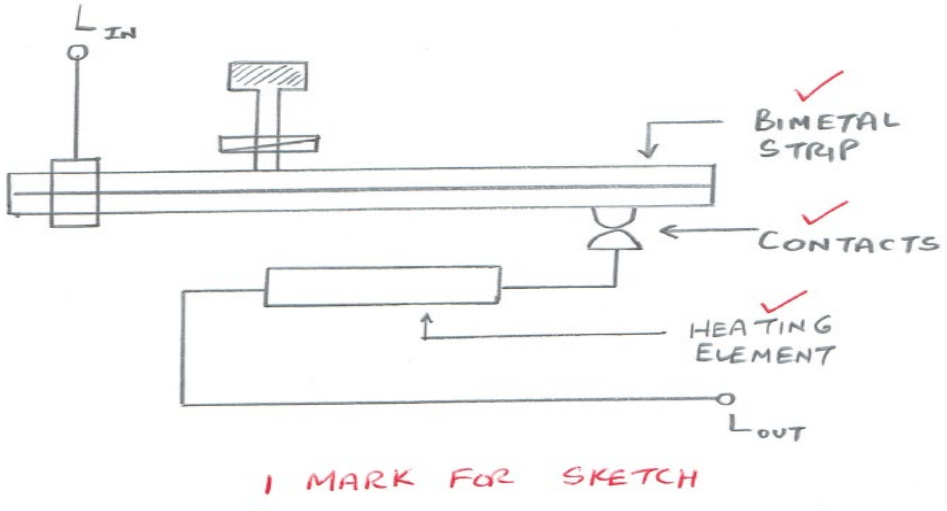
(3)

[10]

QUESTION 4

4.1
- Field poles
- Pole shoes
- Armature core (Any 2 × 1) (2)

4.2



(4)

4.3 $P_i = VI = (220)(17,5) = 3\,850\,W$ ✓

$P_o = \frac{2\pi Nr(W-S)}{60} = \frac{2\pi(875)(0,125)(310)}{60} = 3\,550,654\,W$ ✓✓

$\eta = \frac{P_o}{P_i} \times 100\,\% = \frac{3\,550,654}{3\,850} \times 100\% = 92,225\,\%$ ✓

OR

$$\eta = \frac{2\pi N(W-S)r}{60VI} \times 100\%$$

$$= \frac{2\pi \times 875 \times 310 \times 0,125}{60 \times 220 \times 17,5} \times 100\%$$ ✓✓✓

$$= 92,225\%$$ ✓

(4)
[10]

QUESTION 5

5.1 5.1.1 A cycle is one complete set of changes✓ which an alternating quantity undergoes.✓ (2)

5.1.2
- Frequency represents the number of cycles✓ completed in one second.✓
- Frequency is the total number of complete changes✓ in a given time.✓ (Any 1 × 2) (2)

5.2 5.2.1 $\omega = 2\pi f = 376{,}991$ ✓

$f = \frac{376{,}991}{2\pi} = 60\ Hz$ ✓ (2)

5.2.2 $I_{avg} = 0{,}637 I_m = 0{,}637(13{,}5)$✓ $= 8{,}6\ A$ ✓ (2)

5.2.3 $i = 13{,}5\ \sin(376{,}991 \times 0{,}75 \times 10^{-3} \times 57{,}3)$ ✓

$= 13{,}5(0{,}279)$

$= 3{,}767\ A$ ✓ (2)
[10]

QUESTION 6

6.1 $X_L = 2\pi f L = (2\pi)(50)(120 \times 10^{-3}) = 37{,}699\ \Omega$ ✓

$X_C = \frac{1}{2\pi f C} = \frac{1}{(2\pi)(50)(220\times10^{-6})} = 14{,}469\ \Omega$ ✓

$I_R = \frac{V_T}{R} = \frac{90}{40} = 2{,}25\ A$ ✓

$I_L = \frac{V_T}{X_L} = \frac{90}{37{,}699} = 2{,}387\ A$ ✓

$I_C = \frac{V_T}{X_C} = \frac{90}{14{,}469} = 6{,}22\ A$ ✓ (5)

6.2 $I_T = \sqrt{I_R^2 + (I_C - I_L)^2} = \sqrt{2{,}25^2 + (6{,}22 - 2{,}378)^2}$✓ $= 4{,}445\ A$ ✓ (2)

6.3 $\cos \emptyset = \frac{I_R}{I_T} = \frac{2{,}25}{4{,}445} = 0{,}506$ ✓ (1)

6.4 $\cos \emptyset = 0{,}506 \therefore \emptyset = 59{,}602°$ ✓

$Q = V_T I_T \sin \emptyset = (90)(4{,}445)\sin(59{,}602°) = 345{,}056\ VA_r$ ✓ (2)
[10]

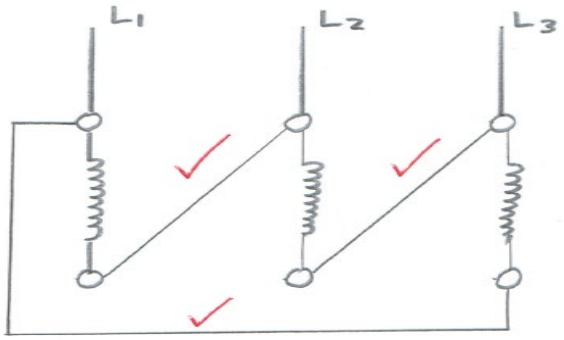
QUESTION 7

7.1

SYMBOL	QUANTITY	FORMULA	UNIT
P✓	True power	$VI\cos\emptyset$	W or kW✓
S✓	Apparent power	VI	VA or kVA✓
Q✓	Reactive power	$VI\sin\emptyset$	VAr or kVAr✓

(6)

7.2



(3)

7.3 $V_P = V_L = 525\,V$ ✓ (1)

[10]

QUESTION 8

8.1
- Eddy current losses
- Hysteresis losses

(2)

8.2 8.2.1 $V_{P1} = V_{L1} = 11\,000\,V$ ✓

$$\frac{V_{P1}}{V_{P2}} = \frac{N_1}{N_2}$$

$$V_{P2} = V_{P1}\left(\frac{N_2}{N_1}\right) = (11\,000)\left(\frac{200}{800}\right) ✓ = 2\,750\,V ✓$$

$$V_{L2} = \sqrt{3}\,(V_{P2})$$

$$\therefore V_{L2} = \sqrt{3}\,(2\,750) = 4\,763{,}14\,V ✓$$ (4)

8.2.2 $$V_{P1} = \frac{V_{L1}}{\sqrt{3}} = \frac{11\,000}{\sqrt{3}} = 6\,350{,}853\,V ✓$$

$$\frac{V_{P1}}{V_{P2}} = \frac{N_1}{N_2}$$

$$V_{P2} = V_{P1}\left(\frac{N_2}{N_1}\right) = (6\,350{,}853)\left(\frac{200}{800}\right) ✓ = 1\,587{,}713\,V ✓$$

$$V_{P2} = V_{L2}$$

$$\therefore V_{L2} = 1\,587{,}713\,V ✓$$

(4)

[10]

QUESTION 9

9.1 9.1.1

$$I_{sh} = I - I_m = 6{,}2 - 20 \times 10^{-3} = 6{,}18\ A \checkmark$$

$$R_{sh} = \frac{I_m R_m}{I_{sh}} = \frac{(20\times10^{-3})(85)}{6{,}18} \checkmark = 0{,}275\ \Omega \checkmark$$

OR

$$R_{sh} = \frac{I_m R_m}{I - I_m} = \frac{(20 \times 10^{-3})(85)}{6{,}2 - 20 \times 10^{-3}} \checkmark\checkmark = 0{,}275\ \Omega \checkmark \quad (3)$$

9.1.2

$$V = I_m(R_{se} + R_m)$$

$$R_{se} = \frac{V}{I_m} - R_m = \frac{150}{20\times10^{-3}} - 85 \checkmark\checkmark = 7\,415\ \Omega \checkmark \quad (3)$$

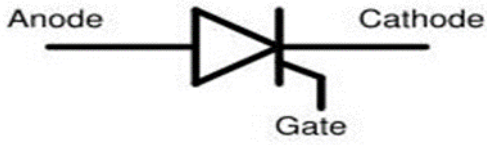
9.2 9.2.1 Current Transformer= 5A (1)

9.2.2 Potential Transformer= 110V (1)

9.3 Deflecting mechanism
Controlling mechanism
Damping mechanism (Any 2 × 1) (2)
[10]

QUESTION 10

10.1



(1 mark for each correct labelling) (3 × 1) (3)
(1 mark for the correct sketch) (1)

10.2 $2^n = 16$

$2^n = 2^4$ ✓

$\therefore n = 4$ ✓ (2)

10.3

2	15	
2	7	rem 1
2	3	rem 1
2	1	rem 1
	0	rem 1

	8 125 × 2
1	6 250 × 2
1	2 500 × 2
0	5 000 × 2
1	0

$15{,}8125_{10} = 1111{,}1101_2$ ✓✓✓✓ (Award ½ mark for each place value) (4)
[10]

TOTAL: 100

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