higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ARMATURE WINDING THEORY N2

1 December 2023

This marking guideline consists of 7 pages.

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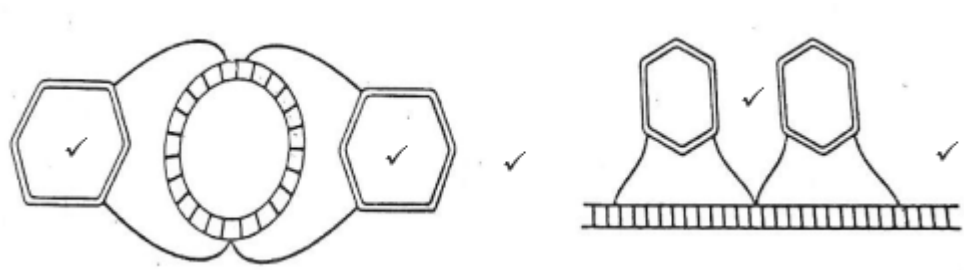
QUESTION 1

1.1
- Use interpole coils.
- Shift the brushes.
- Use compensation windings. (3)

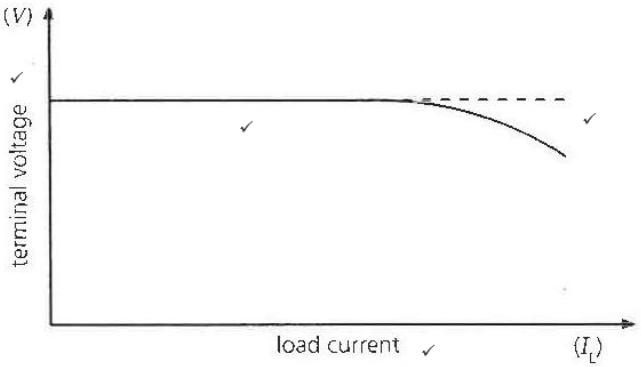
1.2



(5)

1.3
- Series
- Shunt
- Long shunt
- Short shunt (4)

1.4



(4)

1.5 1.5.1 $$\text{Coil span} = \frac{\text{Total number of slots} + 1}{\text{Total number of poles}}$$

$$= \frac{72 + 1}{6} \checkmark$$

$$= 12{,}167$$

$$= 12 \checkmark$$

1.5.2 $$\text{Commutator pitch} = \frac{\text{Number of segments} + 1}{\text{Pair of poles}}$$

$$= \frac{143 + 1}{3} \checkmark$$

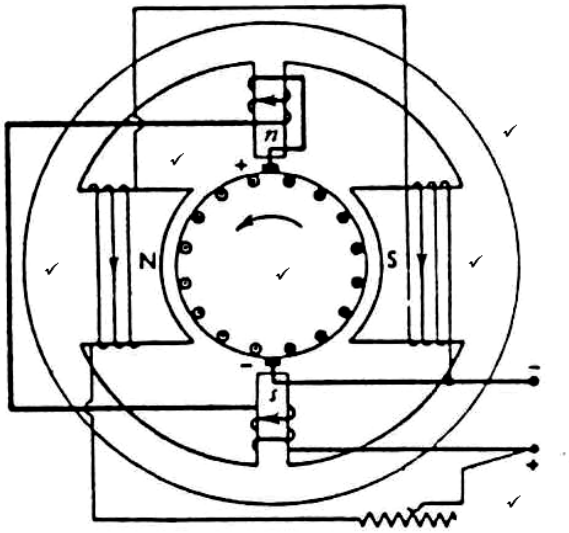
$$= 48 \checkmark$$

(2 × 2) (4)

[20]

QUESTION 2

2.1



(6)

2.2
- With slot linings cut and tucked over the coils in a slot
- Slot left open but subsequently covered with a strip insulator
- Slot closed with hammered wedges and the insulator cut flush (3)

2.3 2.3.1

$$Z = \frac{60EC}{2PN\emptyset}$$

$$Z = \frac{60 \times 450 \times 8}{2 \times 4 \times 200 \times 0{,}444}\checkmark$$

$$Z = 304{,}054 \text{ conductors}\checkmark$$

$$\therefore \text{Conductors per slot} = \frac{304{,}054}{76} = 4 \text{ conductors per slot}\checkmark\checkmark$$ (4)

2.3.2

$$T = \frac{2PI\emptyset}{C\pi}\checkmark$$

$$T = \frac{2 \times 3 \times 110 \times 0{,}444}{6 \times \pi}$$

$$T = 15{,}546 \text{ Nm}\checkmark\checkmark$$ (3)

2.4 2.4.1

$$E = V + IR$$
$$= 220 + (1{,}8 \times 10)\checkmark$$
$$= 238 \text{ V}\checkmark$$

2.4.2

$$E = V - IR$$
$$= 220 - (1{,}8 \times 10)\checkmark$$
$$= 202 \text{ V}\checkmark$$

(2 × 2) (4)

[20]

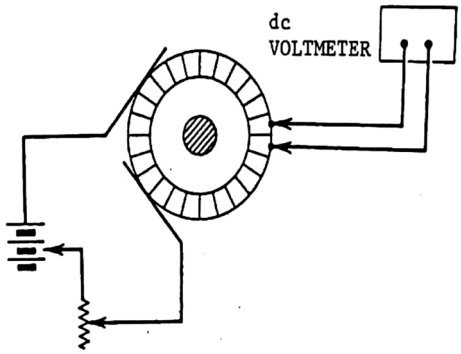
QUESTION 3

3.1
- It must be earth-free.
- The connections to the commutator must be correct.
- There must be no shorts between any turns in a coil.
- There must be no shorts on the coils.
- The joints to the commutator must be sound. (5)

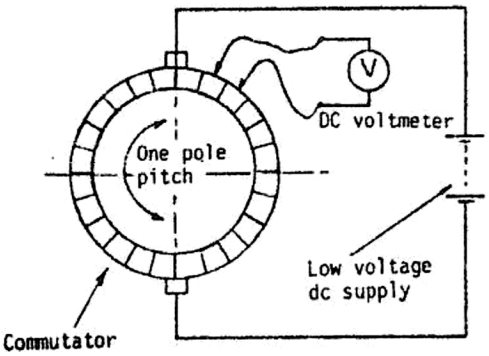
3.2
- Insulation resistance to earth
- Ductor test (low-voltage resistance test)
- Voltage drop test
- Growler test (4)

3.3
- Loose connections on the fields or armature circuit
- Dirty or clogged commutator
- Wrong brushes or wrong brush grade (3)

3.4

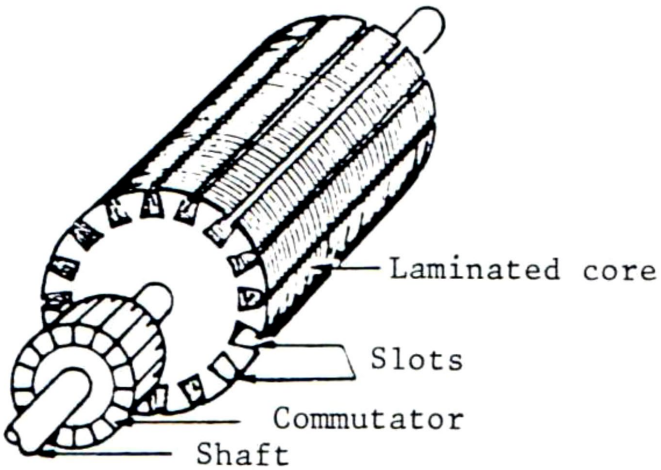


OR



(Full marks for any correct diagram) (5)

3.5



(Full marks for any correct diagram) (3)

[20]

QUESTION 4

4.1 4.1.1

$$X_L = 2\pi fL$$
$$X_L = 2\pi \times 50 \times 0{,}2 \checkmark$$
$$X_L = 62{,}832\ \Omega \checkmark$$

$$X_C = \frac{1}{2\pi fC}$$
$$= \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} \checkmark$$
$$= 31{,}831\ \Omega \checkmark$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$
$$Z = \sqrt{20^2 + (62{,}832 - 31{,}831)^2} \checkmark$$
$$Z = 36{,}893\ \Omega \checkmark \quad (6)$$

4.1.2

$$I_T = \frac{V_T}{Z}$$
$$= \frac{220}{36{,}893} \checkmark$$
$$= 5{,}963\ \text{A} \checkmark \quad (2)$$

4.1.3

$$V_L = I_T X_L$$
$$= 5{,}963 \times 62{,}832 \checkmark$$
$$= 374{,}667\ \text{V} \checkmark \quad (2)$$

4.1.4

$$V_C = I_T X_C$$
$$= 5{,}963 \times 31{,}831 \checkmark$$
$$= 189{,}808\ \text{V} \checkmark \quad (2)$$

4.1.5

$$\cos\theta = \frac{R}{Z} = \frac{20}{36{,}893} = 0{,}542 \checkmark$$

$$\theta = \cos^{-1} 0{,}542 = 57{,}173° \checkmark \quad \textbf{OR} \quad \theta = 57{,}180° \quad (2)$$

4.2
- Squirrel-cage rotor✓
- Wound rotor✓ (2)

4.3 The purpose is to disengage the starting winding and switch on the running winding✓ once the motor reaches 75% of its nominal speed.✓ (2)

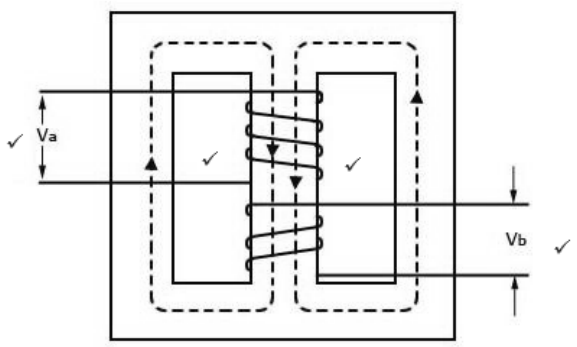
4.4
- Reversing the field current✓
- Reversing the armature current✓ (2)

[20]

QUESTION 5

5.1
- Star-star
- Star-delta
- Delta-delta
- Delta-star (4)

5.2



(4)

5.3
- Hysteresis losses
- Eddy current losses (2)

5.4 One should switch any two lines,✓✓ L1 and L2 or L1 and L3, and then the motor will change the direction of rotation. (2)

5.5 5.5.1 $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$N_2 = \frac{N_1 V_2}{V_1} = \frac{600 \times 16}{220}$✓

$= 43{,}636$

$= 44 \text{ turns}$✓

5.5.2 $\frac{V_1}{V_2} = \frac{I_2}{I_1}$

$I_1 = \frac{I_2 V_2}{V_1}$

$= \frac{5 \times 16}{220}$✓

$= 0{,}364 \text{ A}$✓

5.5.3 $S = VI = 220 \times 0{,}364 = 80{,}08 \text{ VA}$✓✓

OR

$S = VI = 16 \times 5 = 80 \text{ VA}$✓✓

5.5.4 $\frac{V_1}{V_2} = \frac{220}{16}$

$= 220:16$✓

$= 55:4$✓ **OR** $= 14:1$

(4 × 2) (8)
[20]

TOTAL: 100

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