higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

26 JULY 2019

This marking guideline consists of 7 pages.

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QUESTION 1

1.1 Nucleus
1.2 Positive
1.3 Opposite
1.4 Lenz's law
1.5 Directly proportional
1.6 Yoke
1.7 Downwards
1.8 Parallel
1.9 Series
1.10 Short-circuited

(10 × 1) **[10]**

QUESTION 2

2.1 It states that the algebraic sum of the voltage drop in any closed circuit is equal to the algebraic sum of the applied EMF. (2)

2.2
- The type of material used
- The heat treatment and mechanical handling to which the specimen has been subjected. (2)

2.3 2.3.1
- The TWO principal laws are Faraday's laws
- An EMF is induced in an electric circuit whenever there is a change in the magnetic flux linking with that circuit.
- The magnitude of the induced EMF is directly proportional to the rate of change of the flux linkages. (3)

2.3.2
- The third law is Lenz's Law
- The direction of an induced EMF is always such that it tends to set up a current opposing the motion or the change of flux responsible for inducing that EMF. (2)

2.4 GIVEN:

l = 30 cm
B = 0,15 Wb/m²
V = 5 m/s

2.4.1 $E = Blv$
$= 0,15x30x10^{-2}x5$ ✓
$= 0,225V$ ✓

2.4.2 $F = BlI$
$= 0,15x30x10^{-2}x400x10^{-3}$ ✓
$= 18mH = 0,018N$ ✓

(2 × 2) (4)

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2.5

$$R = \frac{\rho}{A}\ell$$

$$R.A = \rho\ell \checkmark$$

$$A = \frac{\rho}{R}\ell \checkmark$$

$$\frac{\pi d^2}{4} = \frac{\rho}{R}\ell \checkmark$$

$$d^2 = \frac{4\rho}{\pi R}\ell \checkmark$$

$$d = \sqrt{\frac{4\rho}{\pi R}}\ell \checkmark$$

(5)
[18]

QUESTION 3

3.1 3.1.1 By the movement of a conductor in a magnetic field

3.1.2 By the changing (increase/decrease) of current in a circuit

(2 × 1) (2)

3.2
- Carbon brushes
- Graphite brushes
- Electrographite brushes
- Copper-graphite brushes (4)

3.3 A separately-excited machine is one in which the DC supply to the field coils is completely separate from the connections to the armature. (1)

3.4
- Shunt-connected
- Series-connected
- Compound-connected (3)

3.5 GIVEN:

Aluminium (Al):	Copper (Cu):
Length (l) = 3 km	Length (l) = 3 km
Current (I) = ?	Current (I) = 50 A
Diameter (d) = 2 mm	Diameter (d) = ?
Resistivity (ρ) = 0,0028 μΩm	Resistivity (ρ) = 0,018 μΩm

Total current (I_T) = 200 A

3.5.1 $I_T = I_{Al} + I_{Cu}$

$200 = I_{Al} + 50$

$I_{Al} = 150A$ ✓

$R_{Al} = \frac{\rho}{A}\ell$

$= \frac{0,002x10^{-6}x3x10^{3}x4}{\pi x2^{2}x10^{-6}}$ ✓

$= 2,674\Omega$ ✓

$V_{Al} = IR = 150x2,674 = 401,1V$ ✓

$R_{Cu} = \frac{V}{I_{Cu}} = \frac{401,1}{50} = 8,022\Omega$ ✓

$d = \sqrt{\frac{4\rho}{\pi R_{Cu}}}\ell$

$= \sqrt{\frac{(4x0,018x10^{-6}x3x10^{3}}{\pi x8,022}}$ ✓

$= 2,928mm$ ✓ (7)

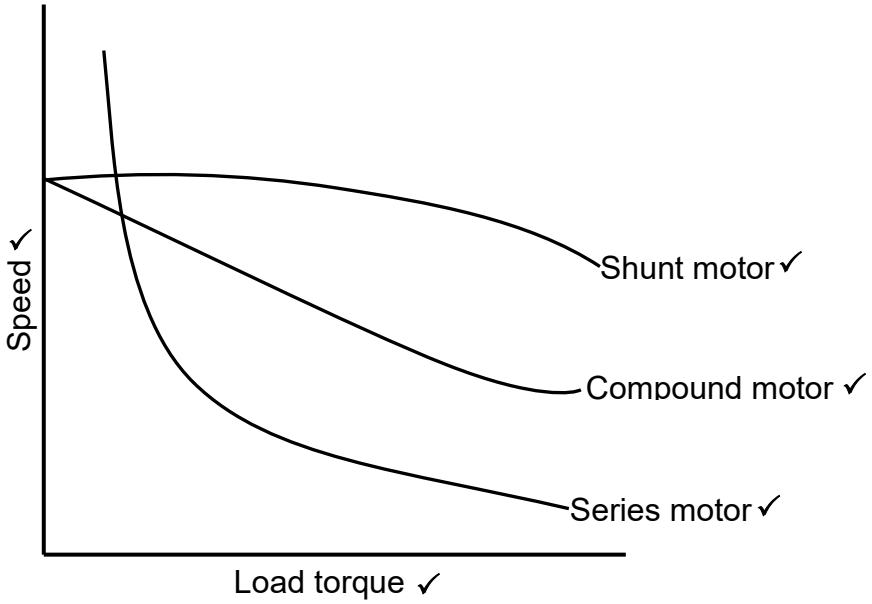
3.5.2 $V_T = V_{Al} = V_{Cu} = 401,1V$ (1)

[18]

QUESTION 4

4.1
- The iron core of the pole piece may have lost its residual magnetism.
- The field coils may be connected incorrectly.
- Brushes may be jammed in their holders.
- The brushes or the commutator may be dirty.
- There may be an open- or short-circuited field circuit.
- There may be loose brush connections.
- The speed of the armature may be too low.
- The resistance of the field circuit may be too high. (3)

4.2



(5)

4.3
- They are more efficient.
- They are self-starting.
- They are cheaper.
- They have a high starting torque.
- Their physical size is smaller. (Any other relevant answer) (5 × 2) (10)

[18]

QUESTION 5

5.1
- Their efficiency at full load is about 97%.
- They have no moving parts and their operation is silent.
- As they have no rotating parts or bearings, they require little care and maintenance. (3)

5.2
- The magnetic circuit
- The windings
- The oil tanks
- The protection device
- The cooling system (5)

5.3
- Refrigerators
- Automatic washing machines
- Compressors (3)

5.4 To reverse the direction of rotation, the connection to either the starting winding or the running winding must be reversed, but not both. (2)

5.5 GIVEN:

Rm = 10 Ω
Im = 25 mA = 0,025 A

5.5.1 As ammeter: I_T = 20 A

$$V_m = I_m x R_m$$
$$= 0,025x10$$
$$= 0,25V \checkmark$$

$$I_T = I_M + I_{SH}$$
$$20 = 0,025 + I_{SH}$$
$$I_{SH} = 19,975A \checkmark$$

$$R_{SH} = \frac{V_{SH}}{I_{SH}} = \frac{V_M}{I_{SH}}$$
$$= \frac{0,25}{19,975}$$
$$= 0,0125\Omega \checkmark$$

(3)

5.5.2 As voltmeter: V_T = 110 V

$$V_T = V_M + V_{Ser}$$
$$110 = 0,25 + V_{Ser}$$
$$V_{Ser} = 109,75V \checkmark$$

$$R_{Ser} = \frac{V_{Ser}}{I_{Ser}} = \frac{V_{Ser}}{I_M}$$
$$= \frac{109,75}{0,025}$$
$$= 4390\Omega \checkmark$$

(2)
[18]

QUESTION 6

6.1
- Long-shunt method
- Short-shunt method

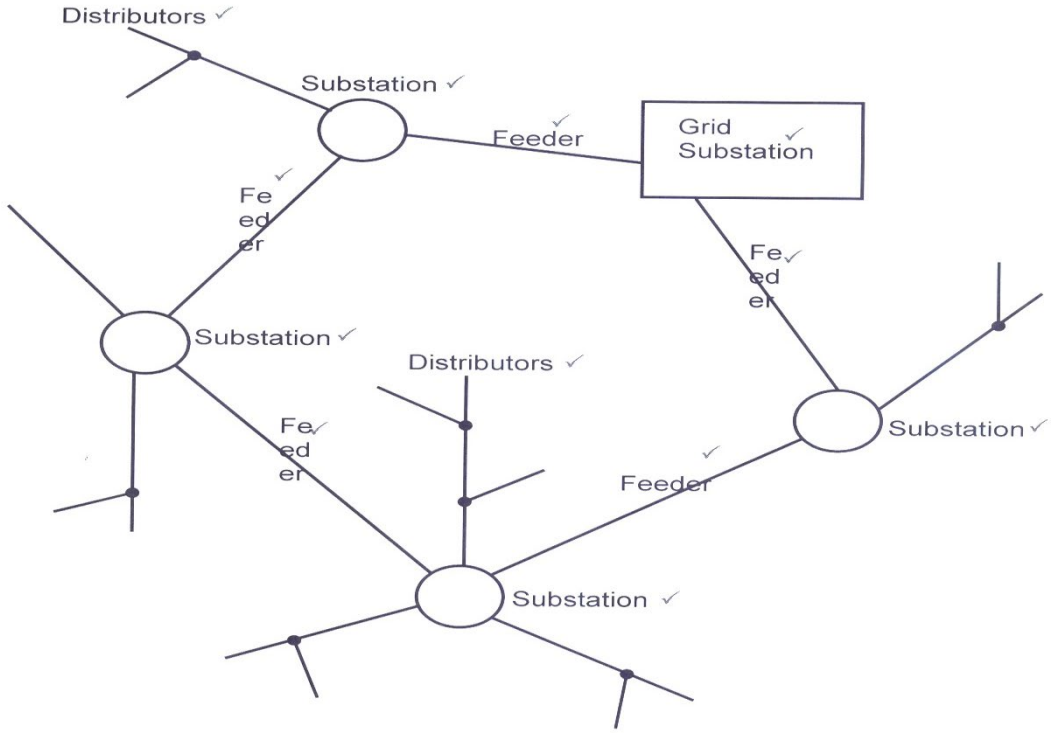
(2)

6.2 It supplies the huge water pressure required. (1)

6.3
- Voltmeter
- Ammeter
- Wattmeter

(3)

6.4



(12)
[18]

TOTAL: 100

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