



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

28 March 2023

This marking guideline consists of 7 pages.

SECTION A**QUESTION 1: MATERIAL, COMPONENTS AND INTERPRETATION OF DRAWINGS**

1.1	1.1.1	True		
	1.1.2	True		
	1.1.3	True		
	1.1.4	False		
	1.1.5	False		
	1.1.6	True		
	1.1.7	True		
	1.1.8	False		
	1.1.9	True		
	1.1.10	False		
			(10 × 1)	(10)
1.2	1.2.1	E		
	1.2.2	J		
	1.2.3	A		
	1.2.4	F		
	1.2.5	K		
	1.2.6	B		
	1.2.7	G		
	1.2.8	C		
	1.2.9	H		
	1.2.10	D		
			(10 × 1)	(10)
				[20]
TOTAL SECTION A:				20

SECTION B**QUESTION 2: PRINCIPLES OF ELECTRICITY**

2.1	• They have a high melting point. • They will reduce current flowing drastically to the instrument.	(2)
2.2	A positive temperature coefficient of resistance means the higher the temperature, the higher the resistance of material.✓✓ A negative temperature coefficient of resistance means the higher the temperature, the lower the resistance of a material.✓✓	(2 + 2) (4)
2.3	The sum of the currents flowing towards a junction is equal to the sum of the currents flowing away from that junction.	(2)

2.4 Given:

$$N = 500 \text{ turns}$$

$$A = 0,2 \text{ mm}^2$$

$$l = 120 \text{ mm}$$

$$L = 0,3 \text{ H}$$

2.4.1 $R = ?$

$$\rho = 0,025 \text{ } \mu\Omega\text{m}$$

$$l = 120 \text{ mm} \times 500 = 60 \text{ m} \checkmark$$

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

$$= \rho \frac{(0,025 \times 60)}{0,2}$$

$$= 7,5 \text{ } \Omega \checkmark$$

(3)

2.4.2 $E = ?$

$$I = 7 \text{ A}$$

$$t = 0,5/2 = 0,25 \text{ s} \checkmark$$

$$E = L (\Delta I / \Delta t)$$

$$= 0,3 (7/0,25)$$

$$= 8,4 \text{ V} \checkmark$$

(2)

2.5 To find the resistance of the load:

$$P = I^2 R_L$$

$$48 = 3^2 \times R_L \checkmark$$

$$R_L = 5,333 \text{ } \Omega \checkmark$$

$$P = I^2 R_L$$

$$27 = 3^2 \times R_L \checkmark$$

$$R_L = 3 \text{ } \Omega \checkmark$$

To find the volt drop:

$$V_L = IR = 3 \times 5,333 = 16 \text{ V} \checkmark$$

$$V_p = V_T - V_L = 48 - 16 = 32 \text{ V} \checkmark$$

$$V_L = IR = 3 \times 3 = 9 \text{ V} \checkmark$$

$$V_p = V_T - V_L = 48 - 9 = 39 \text{ V} \checkmark$$

To find the currents:

$$I_{40} = V_p / R = 32/40 = 0,8 \text{ A} \checkmark \quad I_{40} = V_p / R = 39/40 = 0,975 \text{ A} \checkmark$$

$$I_x = I_L - I_{40} = 3 - 0,8 = 2,2 \text{ A} \checkmark \quad I_x = I_L - I_{40} = 3 - 0,975 = 2,025 \text{ A} \checkmark$$

$$R_x = V/I$$

$$= V_p / I_x$$

$$= 32/2,2$$

$$= 14,545 \text{ } \Omega \checkmark$$

The value of the unknown resistor is 14,545 Ω .

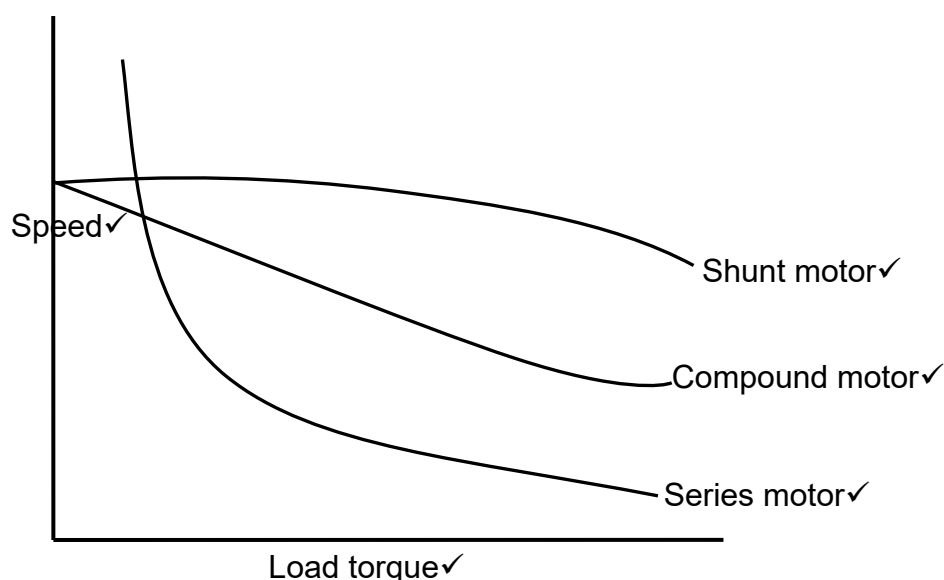
$$\begin{aligned} R_x &= V/I \\ &= V_p/I_x \\ &= 39/2,025 \\ &= 19,259 \Omega \checkmark \end{aligned}$$

(7)
[20]

QUESTION 3: DIRECT-CURRENT MACHINES

- 3.1
- Carbon brushes
 - Graphite brushes
 - Electrographite brushes
 - Copper-graphite brushes
- (Any 3 × 1) (3)
- 3.2 A separately excited machine is one in which the DC supply to the field coils is completely separate from the connections to the armature. (2)
- 3.3
- Shunt connected
 - Series connected
 - Compound connected
- (3)
- 3.4
- The iron core of the pole piece might have lost its residual magnetism.
 - The field coils might have been connected incorrectly.
 - The brushes might have jammed in their holders.
 - The brushes or commutator might be dirty.
 - There might be an open or short-circuited field circuit.
 - There might be loose brush connections.
 - The speed of the armature might be too low.
 - The resistance of the field circuit might be too high.
- (Any 2 × 1) (2)

3.5



(5)

- 3.6 3.6.1 Separately excited generator
 3.6.2 Self-excited generator
 3.6.3 Shunt generator
 3.6.4 Series generator
 3.6.5 Compound generator

(5 × 1) (5)
[20]

QUESTION 4: ALTERNATING-CURRENT THEORY

4.1 Given:

$$V_{\max} = 325 \text{ V}$$

$$V_{\text{rms}} = 0,707 \times 325 = 229,775 \text{ V} \checkmark$$

$$V_{\text{ave}} = 0,637 \times 325 = 207,025 \text{ V} \checkmark \quad (2)$$

4.2 Given:

$$R = 25 \, \Omega$$

$$L = 54 \text{ mH}$$

$$C = 322 \, \mu\text{F}$$

$$V = 230 \text{ V}$$

$$f = 50 \text{ Hz}$$

$$4.2.1 \quad X_L = 2\pi fL = 2\pi(50)(54 \times 10^{-3}) = 16,965 \, \Omega \checkmark \checkmark$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 322 \times 10^{-6}} = 9,885 \, \Omega \quad (4)$$

$$4.2.2 \quad Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(25)^2 + (16,965 - 9,885)^2} = 25,983 \, \Omega$$

$$I = V/Z = 230/25,983 = 8,852 \text{ A} \checkmark \checkmark$$

$$V_R = IR = 8,852 \times 25 = 221,3 \text{ V} \checkmark$$

$$V_L = IX_L = 8,852 \times 16,965 = 150,174 \text{ V} \checkmark$$

$$V_{\text{coil}} = \sqrt{(V_R)^2 + (V_L)^2} = \sqrt{(221,3)^2 + (150,174)^2} = 267,443 \quad (8)$$

$$4.2.3 \quad V_C = I_C X_C \\
= 8,852 \times 9,885 \\
= 87,502 \text{ V} \checkmark$$

(1)
[15]

QUESTION 5: ALTERNATING-CURRENT MACHINES

- 5.1
- Used for the protection of transformers from the faults occurring inside the transformer
 - Serves as a protection device and activates an alarm (Any 1 × 2) (2)
- 5.2
- It provides a high starting torque.
 - It causes a split phase to ensure self-starting.
 - It is used in the creation of phase angle difference to enable rotation. (Any 1 × 1) (1)
- 5.3
- They extract moisture from the air. (2)
- 5.4
- Ring feeders
 - Radial feeders (2)
- 5.5
- Radial feeder (1)
- 5.6
- Star connection
 - Delta connection (2)
- 5.7
- Cheaper
 - Less maintenance
 - Less wear (brushes and commutator)
 - Control circuits more reliable
 - Supply (AC) always available
 - Smaller and lighter
 - Maintenance less than for DC motors (Any 3 × 1) (3)
- 5.8
- Pollution: leads to land pollution
 - Danger: very dangerous to the community/animals/stock
 - Transport: saves on transport
 - Sources: minimises the cost charged by coal suppliers/mines (Any 2 × 1) (2)

[15]

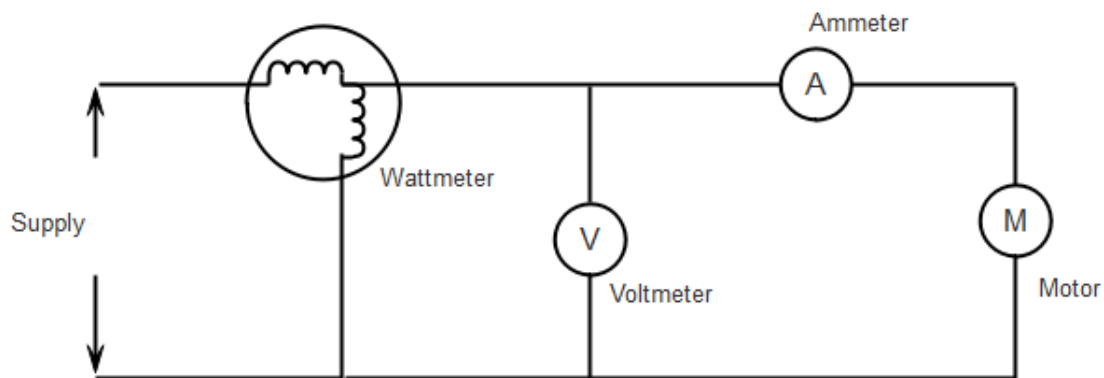
QUESTION 6: MEASURING INSTRUMENTS

Given:

$$I = 12 \text{ A} \quad \cos \theta = ?$$

$$V = 240 \text{ V} \quad R = ?$$

$$P = 1550 \text{ W} \quad X_L = ?$$



(3 for correct labels/symbols)

$$P = VI \cos \theta$$

$$1\,550 = (240)(12) \cos \theta \checkmark$$

$$\cos \theta = 0,538 \checkmark$$

To find R (this must be done from P and not from the I and V):

$$P = I^2 R$$

$$1\,550 = 12^2 R$$

$$R = 10,764 \, \Omega \checkmark$$

$$V_R = IR = 12 \times 10,764 = 129,168 \text{ V} \checkmark$$

$$(V_T)^2 = (V_R)^2 + (V_L)^2$$

$$(240)^2 = (129,168)^2 + (V_L)^2 \checkmark$$

$$V_L = 202,276 \text{ V} \checkmark$$

$$V_L = I X_L$$

$$202,276 = 12 X_L$$

$$X_L = 16,856 \, \Omega \checkmark$$

[10]

TOTAL SECTION B: 80
GRAND TOTAL: 100