



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

21 November 2023

This marking guideline consists of 9 pages.

QUESTION 1

- 1.1
- | | |
|--------|---|
| 1.1.1 | E |
| 1.1.2 | H |
| 1.1.3 | B |
| 1.1.4 | K |
| 1.1.5 | A |
| 1.1.6 | J |
| 1.1.7 | D |
| 1.1.8 | F |
| 1.1.9 | G |
| 1.1.10 | C |

(10 × 1) (10)

1.2 Given:

Aluminium	Copper
$\rho = 0,028 \times 10^{-6} \Omega m$	$\rho = 0,017 \times 10^{-6} \Omega m$
$d = 1 mm$	$d = ?$
$l = 7,5 m$	$l = 6 m$
$I = 3 A$	$I = 2 A$
$I_T = 5 A$	

$$R_{al} = \frac{(\rho l)_{al}}{A_{al}} = \frac{0,028 \times 10^{-6} \times 7,5}{\left[\frac{\pi (1 \times 10^{-3})^2}{4} \right]} = 0,267 \Omega \quad \checkmark \checkmark$$

$$V_p = I_{al} \times R_{al} = 3 \times 0,267 = 0,801 V \quad \checkmark \checkmark$$

$$R_{cu} = \frac{V_p}{I_{cu}} = \frac{0,801}{2} = 0,4005 \Omega \quad \checkmark \checkmark$$

$$A_{cu} = \frac{(\rho l)_{cu}}{R_{cu}} = \frac{0,017 \times 10^{-6} \times 6}{0,4005} = 2,547 \times 10^{-7} m^2 \quad \checkmark \checkmark$$

$$d = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{(4 \times 2,547 \times 10^{-7})}{\pi}} = 0,000569 m \quad \checkmark \checkmark$$

(10)

1.3 For loop ABEFA:

$$\sum V = 0$$

$$(15 - 12) - [I_1 + 0,2(I_1 - I_2)] = 0$$

$$3 - [I_1 + 0,2I_1 - 0,2I_2] = 0$$

$$3 - 1,2I_1 + 0,2I_2 = 0$$

$$1,2I_1 - 0,2I_2 = 3 \dots\dots\dots(1) \checkmark\checkmark$$

For loop AC DFA:

$$\sum V = 0$$

$$(15 - 9) - (I_1 + 0,2I_2) = 0$$

$$6 - (I_1 + 0,2I_2) = 0$$

$$I_1 + 0,2I_2 = 6 \dots\dots\dots(2) \checkmark\checkmark$$

Equation 1 + Equation 2:

$$1,2I_1 - 0,2I_2 = 3$$

$$I_1 + 0,2I_2 = 6$$

$$2,2I_1 = 9$$

$$I_1 = 4,090 A \quad \checkmark\checkmark$$

Substitute I_1 in Equation 2:

$$I_1 + 0,2I_2 = 6$$

$$4,09 + 0,2I_2 = 6$$

$$0,2I_2 = 1,91$$

$$I_2 = 9,55 A \quad \checkmark\checkmark$$

$$I_1 - I_2 = 4,090 - 9,55 = -5,46 A \quad \checkmark\checkmark$$

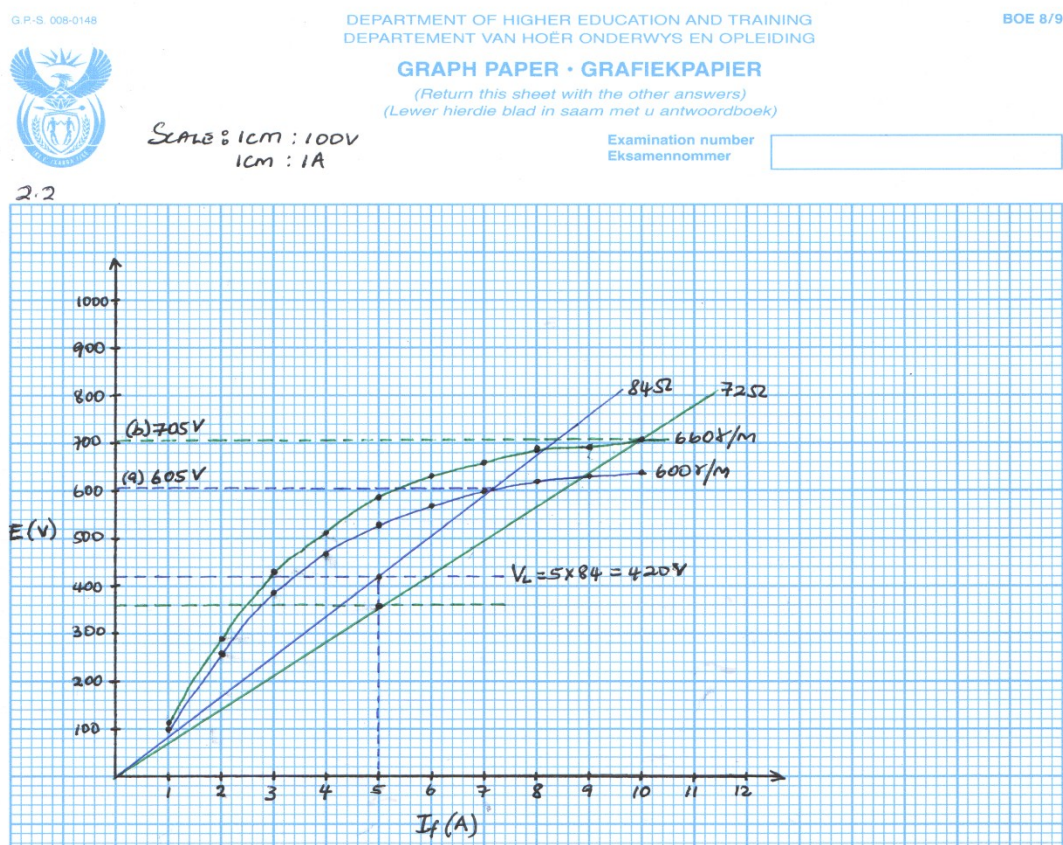
(10)
[30]

QUESTION 2

- 2.1 A – Interpole
B – Pole core
C – Shaft
D – Field windings
E – Commutator
F – Armature conductors
G – Pole shoe
H – Frame/Yoke

(8)

2.2



- 2.2.1 Voltage is $\pm 605\text{ V}$
Cartesian plane✓✓
Plotting curve✓
Straight line✓
Reading voltage from point of intersection✓✓

(6)

2.2.2

I (A)	1	2	3	4	5	6	7	8	9	10
E ₂ (V)	110	286	429	517	583	627	660	682	693	704

- $\therefore$ Voltage is $\pm 705\text{ V}$
E₂ values✓✓
Plotting curve✓
Straight line✓
Reading voltage from point of intersection✓✓

(6)

[20]

QUESTION 3

3.1 Given:

$$n = \frac{3000}{60} \text{ r.p.s}$$

$$V_{\max} = 25\sqrt{2}V$$

$$V = 20V$$

$$3.1.1 \quad f = \frac{N}{60} = \frac{3000}{60} = 50\text{Hz} \quad \checkmark \quad (1)$$

$$3.1.2 \quad \begin{aligned} V &= V_m \sin \omega t \\ &= 25\sqrt{2} \sin(2\pi \times 50 \times 0,004 \times 57,3) \quad \checkmark \\ &= 33,6V \quad \checkmark \end{aligned} \quad (2)$$

$$3.1.3 \quad \begin{aligned} V &= V_m \sin \omega t \\ 20 &= 25\sqrt{2} \sin(2\pi \times 50 \times 57,3t) \quad \checkmark \\ \frac{20}{25\sqrt{2}} &= \sin 18001t \quad \checkmark \\ 0,566 &= \sin 18001t \\ 18001t &= \sin^{-1} 0,566 \quad \checkmark \\ t &= \frac{\sin^{-1} 0,566}{18001} \quad \checkmark \\ t &= 0,0019\text{sec} \quad \checkmark \\ t &= 1,9\text{msec} \end{aligned} \quad (5)$$

3.2 Diagram representing AC and voltage of the same frequency as vectors or phasors with the phase angle between them (2)

3.3 Given:

$$R = 20 \Omega$$

$$L = 51 \text{ mH}$$

$$C = 318 \mu\text{F}$$

$$V = 220V$$

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

$$3.3.1 \quad \begin{aligned} X_L &= 2\pi fL = 2\pi(50)(51) = 16,022 \Omega \quad \checkmark \\ X_C &= 1/2\pi fC = 1/2\pi(50)(318 \times 10^{-6}) = 10 \Omega \quad \checkmark \end{aligned} \quad (2)$$

$$3.3.2 \quad Z^2 = R^2 + (X_L - X_C)^2 = (20)^2 + (6)^2 = 20,88 \, \Omega \checkmark \checkmark$$

$$I = V/Z = 220/20,88 = 10,536 \, A \checkmark$$

$$V_R = IR = 10,536 \times 20 = 210,72 \, V \checkmark$$

$$V_L = IX_L = 10,536 \times 16 = 168,58 \, V \checkmark$$

$$V_{\text{coil}} = (V_R)^2 + (V_L)^2 = (211)^2 + (169)^2 = 270 \, V \checkmark \checkmark \quad (7)$$

$$3.3.3 \quad V_C = I_C X_C$$

$$= 10,536 \times 10$$

$$= 105,536 \, V \checkmark$$

(1)
[20]

QUESTION 4

4.1 Data:

$$I_o = 2,5 \, A$$

$$\cos \phi_o = 0,3 \text{ lagging}$$

$$4.1.1 \quad \cos \phi_o = 0,3$$

$$\therefore \phi_o = 72,542^\circ \checkmark \quad (1)$$

$$4.1.2 \quad I_m = I_o \sin \phi_o = (2,5) \sin 72,542^\circ = 2,385 \, A \checkmark \checkmark \quad (2)$$

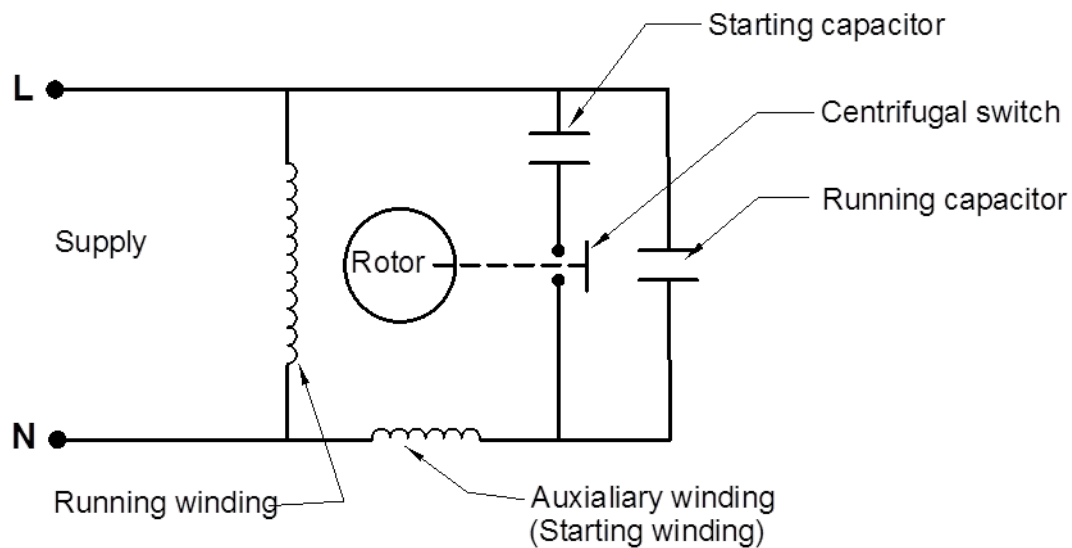
$$4.1.3 \quad I_c = I_o \cos \phi_o = (2,5) \cos 72,542^\circ = 0,75 \, A \checkmark \checkmark \quad (2)$$

- 4.2 A – Transformer tank
B – Breather
C – Conservator/Expansion tank
D – Buchholz relay
E – Cooling fins/Radiator tubes

(5)
[10]

QUESTION 5

5.1



(Any 5 × 1) (5)

5.2

- Very expensive
- Less efficient
- Bigger in size
- More maintenance required
- Have complicated design
- Self-starting
- Limited starting and operating torque

(Any 2 × 1) (2)

5.3

In order to reverse the direction of rotation, reverse the connection to either the starting winding✓ or the running winding,✓ but not both.✓

(3)
[10]

QUESTION 6

- 6.1
- Solar power station
 - Gas turbine power station
 - Wind turbine power station
- (3)

- 6.2
- It reduces the size (diameter) of the conductors required.
 - They can span much greater distances between pylons.
- (2)

- 6.3 Wattmeter
- (1)

- 6.4 Given:
 $R_m = 30 \, \Omega$
 $I_m = 50 \, \text{mA} = 0,05 \, \text{A}$
 $V_m = I_m R_m = (0,05)(30) = 0,15 \, \text{V}$

6.4.1 Where $I_T = 5 \, \text{A}$:

$$I_T = I_m + I_s$$

$$5 = 0,05 + I_s$$

$$I_s = 4,95 \, \text{A} \checkmark$$

$$R_s = V_s / I_s = V_m / I_s$$

$$= 0,15 / 4,95$$

$$= 0,030 \, \Omega \text{ or } 30,3 \, \text{m}\Omega \checkmark$$

6.4.2 Where $V_T = 50 \, \text{V}$:

$$V_T = V_m + V_{ser}$$

$$50 = 0,15 + V_{ser}$$

$$V_{ser} = 49,85 \, \text{V} \checkmark$$

$$R_{ser} = \frac{V_{ser}}{I_{ser}} = \frac{V_{ser}}{I_m}$$

$$= 49,85 / 0,05$$

$$= 997 \, \Omega \checkmark$$

(2 × 2) (4)
[10]

TOTAL: 100