



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

13 July 2022

This marking guideline consists of 7 pages.

QUESTION 1

- 1.1 D
1.2 J
1.3 G
1.4 L
1.5 B
1.6 F
1.7 A
1.8 H
1.9 I
1.10 C

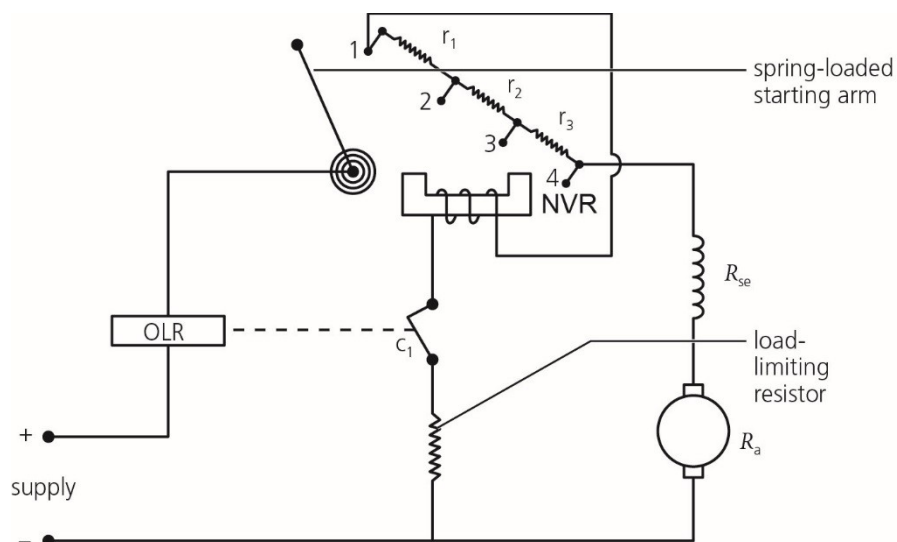
(10 × 1) **[10]****QUESTION 2**

- 2.1 A generator is used to convert mechanical energy ✓ into electrical energy. ✓ (2)
- 2.2 Commutation is the reversal of current ✓ through a coil occurring at the instant when the segments ✓ to which the coil is connected are short-circuited by the brushes. ✓ (3)
- 2.3 2.3.1
$$I_{Sh} = \frac{V}{R_{Sh}} = \frac{300}{185} = 1,622 \text{ A} \checkmark$$

$$I_a = I_L + I_{Sh} = 63 + 1,622 = 64,622 \text{ A} \checkmark$$
 (2)
- 2.3.2
$$E = V + I_a R_a = 300 + (64,622)(0,21) = 313,571 \text{ V} \checkmark$$
 (2)
- 2.3.3
$$P = V I_L = (300)(63) = 18,9 \text{ kW} \checkmark$$
 (1)
- [10]**

QUESTION 3

- 3.1 (6)



(5 for labels + 1 for correct sketch)

$$3.2 \quad E = V + I_a R_a + I_a R_{se}$$

$$\hookrightarrow 400 + (45)(0,2) + (45)(0,25) \checkmark$$

$$\hookrightarrow 420,25 \text{ V}$$

$$N = \frac{60 Ec}{2 \phi p Z} = \frac{60 (420,25)(8)}{(2)(25 \times 10^{-3})(4)(688)} = 1465,988 \text{ r/min}$$

(4)
[10]**QUESTION 4**

- 4.1
- Armature winding
 - Series field winding
 - Interpole winding
 - Compensating winding
 - Brush contact resistance loss
- (Any 3 × 1) (3)

4.2 Hopkinson back-to-back test ✓ (1)

4.3 4.3.1

$$I_L = \frac{P_o}{V} = \frac{7000}{250} = 28 \text{ A} \checkmark$$

$$I_{sh} = \frac{V}{R_{sh}} = \frac{250}{100} = 2,5 \text{ A} \checkmark$$

$$I_a = I_L + I_{sh} = 28 + 2,5 = 30,5 \text{ A} \checkmark \quad (3)$$

4.3.2 Armature copper loss = $I_a^2 R_a = (30,5)^2 (0,25) = 232,563 \text{ W} \checkmark \quad (2)$

4.3.3 Shunt field copper loss = $V I_{sh} = (250)(2,5) = 625 \text{ W} \checkmark \quad (1)$

[10]

QUESTION 5

- 5.1 5.1.1 The average value of a sinusoidal wave represents the average value of all mid-ordinates taken over half a cycle of the wave. ✓✓

OR

The average value of an alternating voltage or current is the average of the instantaneous values over a half cycle.

- 5.1.2 A cycle represents one complete set of changes of the wave. ✓✓

- 5.1.3 Instantaneous values are smaller values of emf or current occurring at specific instants. ✓✓

(3 × 2) (6)

5.2 5.2.1

$$I_{avg} = \frac{i_1 + i_2 + i_3 + i_4 + i_5 + i_6}{6}$$

↳ $\frac{7,5+13,2+18,7+25+11,3+2,6}{6}$ ✓

↳ 13,05 A ✓

5.2.2

$$I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + i_4^2 + i_5^2 + i_6^2}{6}}$$

$$= \sqrt{\frac{(7,5)^2 + (13,2)^2 + (18,7)^2 + (25)^2 + (11,3)^2 + (2,6)^2}{6}} \checkmark$$

$$= 14,942 \text{ A} \checkmark$$

(2 × 2) (4)
[10]**QUESTION 6**

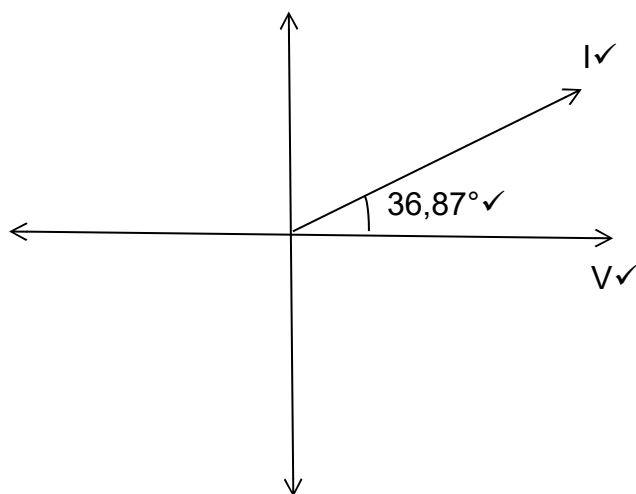
6.1 6.1.1 $\cos \phi = 0,8$
 $\phi = 36,87^\circ \checkmark$ (1)

6.1.2 $I = \frac{P}{V \cos \phi} = \frac{2,5 \times 10^3}{(240)(0,8)} = 13,021 \text{ A} \checkmark$ (2)

6.1.3 $Q = VI \sin \phi = (240)(13,021)(\sin 36,87^\circ) = 1,875 \text{ kVA} \checkmark$ (2)

6.1.4 $Z = \frac{V}{I} = \frac{240}{13,021} = 18,432 \Omega \checkmark$ (2)

6.2

(3)
[10]**QUESTION 7**

7.1 $P_i = \frac{P_o}{\eta} = \frac{15}{0,87} = 17,241 \text{ kW} \checkmark$ (1)

7.2 $V_p = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230,94 \text{ V} \checkmark$ (2)

7.3 $V_p = V_L = 400 \text{ V} \checkmark$ (1)

7.4

$$I_p = \frac{P_i}{3V_p \cos \phi} = \frac{17,241 \times 10^3}{(3)(400)(0,9)} = 15,964 \text{ A} \checkmark$$

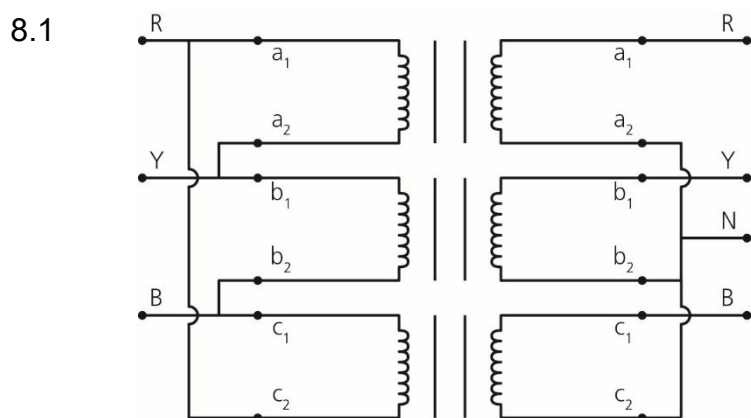
(2)

$$7.5 \quad I_L = \sqrt{3} I_p = \sqrt{3} (15,964) = 27,65 \text{ A} \checkmark \quad (2)$$

$$7.6 \quad S = \sqrt{3} V_L I_L = \sqrt{3} (400) (27,65) = 19,156 \text{ kVA} \checkmark$$

OR

$$S = \frac{P_i}{\cos \phi} = \frac{17,241}{0,9} = 19,157 \text{ kVA}$$

(2)
[10]**QUESTION 8**

(3 for connections on the primary side + 1 for bridge piece on secondary side) (4)

$$8.2 \quad 8.2.1 \quad V_{p1} = V_{L1} = 2\,200 \text{ V} \checkmark$$

$$\frac{V_{p1}}{V_{p2}} = \frac{2\,200}{240} = 9,167 \quad \therefore \text{Turns ratio} = 9,167 : 1 \checkmark$$

$$8.2.2 \quad I_{L1} = \frac{S}{\sqrt{3} V_{L1}} = \frac{90 \times 10^3}{\sqrt{3} (2\,200)} = 23,619 \text{ A} \checkmark$$

$$8.2.3 \quad V_{L2} = \sqrt{3} (240) = 415,692 \text{ V} \checkmark$$

$$I_{L2} = \frac{90 \times 10^3}{\sqrt{3} (415,692)} = 125 \text{ A} \checkmark$$

OR

$$I_{p1} = \frac{I_{L1}}{\sqrt{3}} = \frac{23,619}{\sqrt{3}} = 13,636 \text{ A}$$

$$I_{p2} = I_{p1} \left(\frac{V_{p1}}{V_{p2}} \right) = (13,636) (9,167) = 125 \text{ A} = I_{L2}$$

(3 × 2) (6)

QUESTION 9

9.1 $P_T = P_1 + P_2 = 14 + (-6,8) = 7,2 \text{ kW} \checkmark$ (1)

9.2 9.2.1 To ensure the immediate discharge of any harmful energy to the ground $\checkmark$ (1)

- 9.2.2
- Switch off the supply (current through primary). $\checkmark$
 - Short circuit the secondary winding by means of the short-circuit switch provided by the manufacturer. $\checkmark$ (2)

9.3 9.3.1 $I_{sh} = I - I_m = 7,488 \text{ A} \checkmark$

$$R_{sh} = \frac{I_m R_m}{I_{sh}}$$

$$\hat{=} \frac{(12,5 \times 10^{-3})(95)}{7,488} \checkmark$$

$$\hat{=} 0,159 \Omega \checkmark$$
 (3)

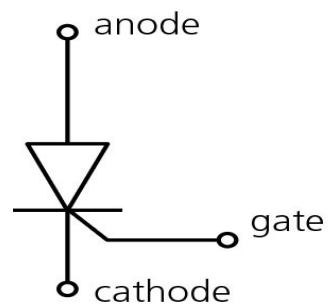
9.3.2 $R_{se} = \frac{V}{I_m} - R_m$

$$\hat{=} \frac{70}{12,5 \times 10^{-3}} - 95 \checkmark \checkmark$$

$$\hat{=} 5505 \Omega \checkmark$$
 (3)
[10]

QUESTION 10

10.1



(3 for labels + 1 for correct symbol) (4)

10.2 $Outputs = 2^n = 2^6 = 64$ ✓ (2)

10.3

2	19		↑
2	9	Rem 1	
2	4	Rem 1	
2	2	Rem 0	
2	1	Rem 0	
	0	Rem 1	

↓		125 × 2
	0	250 × 2
	0	500 × 2
	1	000

 $19,125_{10} = 10011,001_2$ ✓✓ (4)
[10]
TOTAL: 100