



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

6 December 2023

This marking guideline consists of 9 pages.

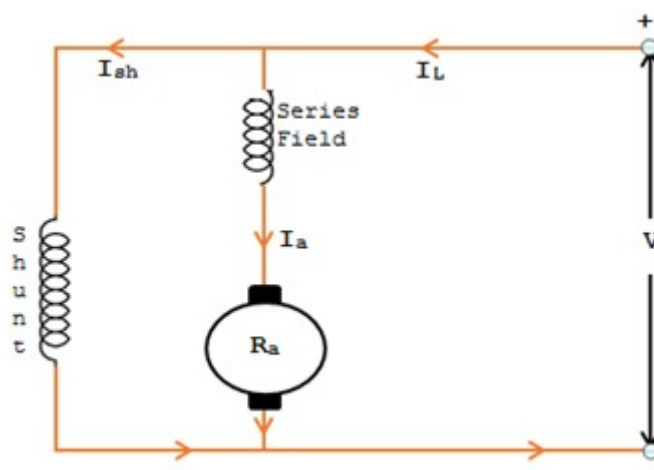
QUESTION 1

- 1.1 D
 1.2 C
 1.3 A
 1.4 B
 1.5 C
 1.6 D
 1.7 A
 1.8 B
 1.9 A
 1.10 D

(10 × 1) [10]

QUESTION 2

2.1



(1 mark each for armature, series field and shunt field) (3)

2.2 A generator is said to be undercompounded if the full-load terminal voltage ✓
 is less than the no-load terminal voltage. ✓ (2)

2.3

- Battery chargers
- Excitation for AC generators

(2)

2.4 $I_L = 40 \text{ A}$
 $V = 200 \text{ V}$
 $R_{se} = 0,25 \Omega$
 $R_a = 0,3 \Omega$

$I_L = I_a = I_{se} = 40 \text{ A}$

$E = V + I_a R_a + I_{se} R_{se}$
 $= 200 + (40)(0,3) \checkmark + (40)(0,25) \checkmark$
 $= 222 \text{ V} \checkmark$

(3)
[10]

QUESTION 3

3.1 The system in the coil of an electric motor that opposes the current flowing through the coil when the armature rotates. (3)

3.2 $p = 3$
 $N = 1\,500 \text{ r/min}$
 $E = 230 \text{ V}$
 $c = 2 \times 3 = 6$
 $Z = 700 \text{ conductors}$

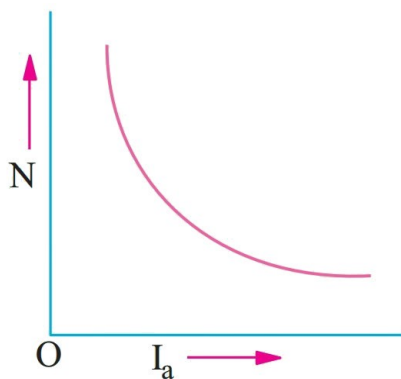
$$E = \frac{2 \phi N p Z}{60 c}$$

$$\phi = \frac{60 E c}{2 N p Z}$$

$$\phi = \frac{(60)(230)(6)}{(2)(1500)(3)(700)}$$

$\phi = 0,013 \text{ Wb} \vee 13,143 \text{ mWb}$ (4)

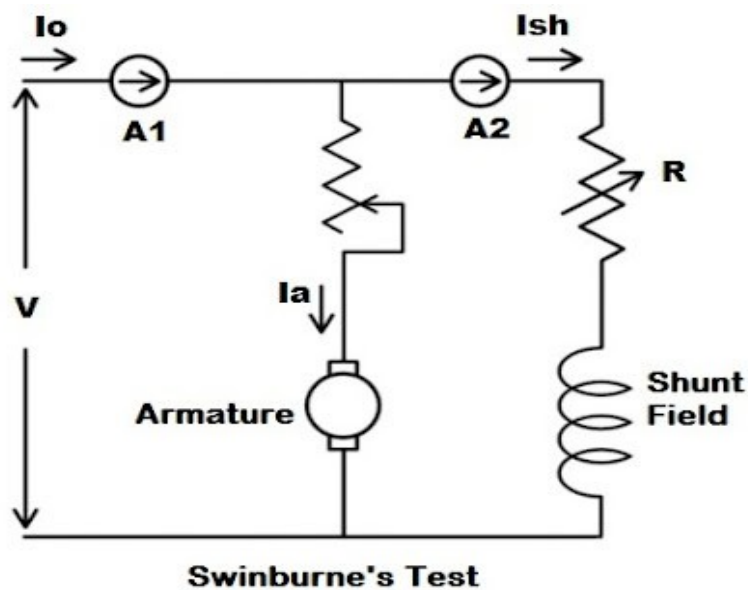
3.3



(1 mark each for the speed (N), armature current (I_a) and correct curve shape) (3)
[10]

QUESTION 4

4.1



(1 mark each for the armature, shunt field, ammeter 1 and 2 and 1 mark for correct sketch) (5)

4.2

- Eddy current loss
- Hysteresis loss

(Any 1 × 1) (1)

4.3

$$P = 25 \text{ kW}$$

$$V = 220 \text{ V}$$

$$I_2 = 35 \text{ A}$$

$$I_1 = \frac{P}{V} = \frac{25 \times 10^3}{220} = 113,636 \text{ A}$$

$$\eta = \sqrt{\frac{I_1}{I_1 + I_2}} \times 100$$

$$\eta = \sqrt{\frac{113,636}{113,636 + 35}} \times 100$$

$$\eta = 87,437 \%$$

(4)
[10]

QUESTION 5

5.1 Form factor is the ratio of the rms value✓ to the average value✓ of the waveform. (2)

5.2 $E_{\max} = 220 \text{ V}$, $F = 50 \text{ Hz}$

$$\begin{aligned} 5.2.1 \quad E_{\text{rms}} &= 0,707 \times E_{\max} \\ &= 0,707 \times 220 \checkmark \\ &= 155,54 \text{ V} \checkmark \end{aligned} \quad (2)$$

$$\begin{aligned} 5.2.2 \quad E_{\text{ave}} &= 0,637 \times E_{\max} \\ &= 0,637 \times 220 \checkmark \\ &= 140,14 \text{ V} \checkmark \end{aligned} \quad (2)$$

$$5.2.3 \quad e = 220 \sin 2\pi ft$$

$$180 = 220 \sin [(2\pi)(50) t \times (57,3)] \checkmark$$

$$[(2\pi)(50) t \times (57,3)] = \sin^{-1} 0,818 \checkmark$$

$$t = \frac{54,885}{(2\pi)(50)(57,3)}$$

$$= 0,003 \text{ sec OR } 3,049 \text{ ms} \checkmark \quad (4)$$

[10]**QUESTION 6**

$L = 20 \text{ mH}$, $R = 9 \Omega$, $V = 100 \text{ V}$, $F = 50 \text{ Hz}$

$$\begin{aligned} 6.1 \quad X_L &= 2\pi fL \\ &= 2\pi \times 50 \times 0,02 \\ &= 6,283 \Omega \checkmark \end{aligned} \quad (1)$$

$$\begin{aligned} 6.2 \quad Z &= \sqrt{R^2 + X_L^2} \\ &= \sqrt{9^2 + (6,283)^2} \checkmark \\ &= 10,976 \Omega \end{aligned} \quad (2)$$

$$\begin{aligned} 6.3 \quad I_T &= \frac{V}{Z} \\ &= \frac{100}{10,976} \\ &= 9,111 \text{ A} \end{aligned} \quad (2)$$

$$\begin{aligned}
 6.4 \quad V_R &= IR \\
 &= 9,111 \times 9 \checkmark \\
 &= 81,999 \text{ V} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 V_L &= IX_L \\
 &= 9,111 \times 6,283 \checkmark \\
 &= 57,244 \text{ V} \checkmark
 \end{aligned}$$

(2 + 2) (4)

$$6.5 \quad \cos \phi = \frac{R}{Z}$$

$$= \frac{9}{10,976}$$

$$= 0,82$$

(1)
[10]**QUESTION 7**

$$V_L = 400 \text{ V}, I_L = 30 \text{ A}, \cos \theta = 0,9 \text{ lagging}$$

$$\begin{aligned}
 7.1 \quad P_{in} &= \sqrt{3} V_L I_L \cos \theta \\
 &= \sqrt{3} (400)(30)(0,9) \checkmark \\
 &= 18\,706,149 \text{ W OR } 18,706 \text{ kW} \checkmark
 \end{aligned}$$

$$7.2 \quad kVA = \frac{\sqrt{3} V_L I_L}{1000}$$

$$= \frac{\sqrt{3} \times 400 \times 30}{1000}$$

$$= 20,785 \text{ kVA}$$

$$7.3 \quad I_{ph} = \frac{30}{\sqrt{3}} = 17,321 \text{ A}$$

$$\begin{aligned}
 7.4 \quad \cos \theta &= 0,9 \\
 \theta &= \cos^{-1} 0,9 \\
 &= 25,842^\circ
 \end{aligned}$$

$$\begin{aligned}
 7.5 \quad Q &= \sqrt{3} V_L I_L \sin \theta \\
 &= \sqrt{3} (400)(30)(\sin 25,842^\circ) \checkmark \\
 &= 9\,059,823 \text{ Var OR } 9,06 \text{ kVar} \checkmark
 \end{aligned}$$

(5 × 2) [10]

QUESTION 8

- 8.1 • Air cooling
 • Oil cooling (Any ONE) (1)

8.2 $V_1 = 12 \text{ kV}$, $V_2 = 230 \text{ V}$, $N_1 = 3\,800$ turns, single-phase transformer

8.2.1 $Turns ratio = \frac{V_1}{V_2} : \frac{V_2}{V_2} = \frac{12\,000}{230} : \frac{230}{230} = 52:1$ (3)

8.2.2 $N_2 = V_2 \frac{N_1}{V_1} = 230 \left(\frac{3\,800}{12\,000} \right) = 72,83 \text{ turns} \vee 73 \text{ turns} \checkmark$ (2)

8.2.3 $I_2 = 1\,100 \text{ A}$

$$I_1 = V_2 \frac{I_2}{V_1} = 230 \left(\frac{1\,100}{12\,000} \right) = 21,083 \text{ A} \checkmark$$

OR

$$I_1 = I_2 \frac{N_2}{N_1} = 1\,100 \left(\frac{72,83}{3\,800} \right) = 21,083 \text{ A} \checkmark$$
 (2)

8.2.4 $S = V_1 I_1$ **OR** $S = V_2 I_2$
 $= (12\,000)(21,083) \checkmark$ $= (230)(1\,100) \checkmark$
 $= 252,996 \text{ kVA} \checkmark$ $= 253 \text{ kVA} \checkmark$ (2)

[10]

QUESTION 9

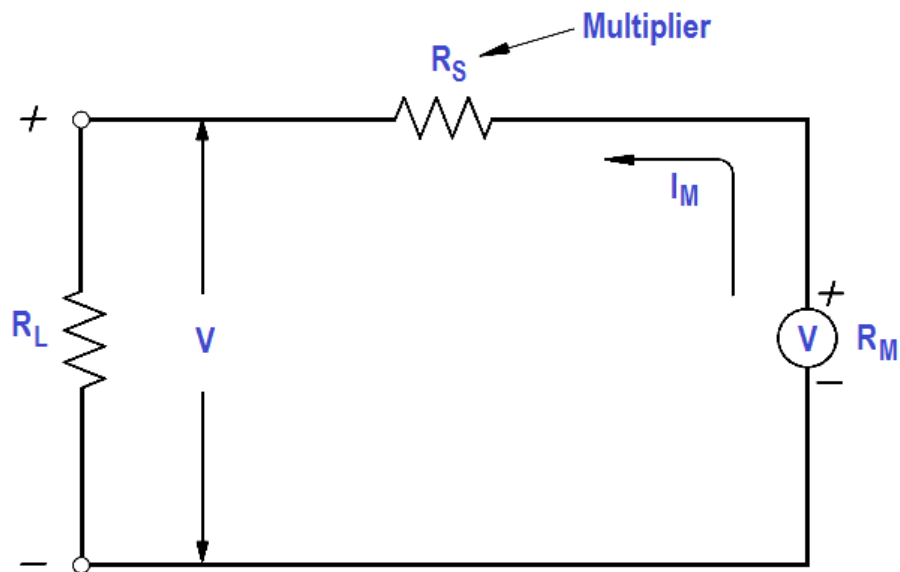
- 9.1 **Advantages**
 • Reasonably cheap
 • Robust construction
 • Can be used on both AC and DC supplies (Any TWO)

Disadvantages

- Nonlinear (uneven) scales
 • Accuracy influenced by stray magnetic fields and temperature changes
 • Reasonably difficult to calibrate (Any TWO)
(2 + 2) (4)

9.2 $R_m = 10 \Omega$, $I_m = 12 \text{ mA}$

9.2.1



(1 mark each for the meter and multiplier resistor and 1 mark for correct sketch)

(3)

9.2.2

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

$$= \frac{300}{12 \times 10^{-3}} - 10$$

$$= 24990 \Omega \vee 24,99 \text{ k}\Omega$$

(3)

[10]

QUESTION 10

- 10.1
- Motor speed control
 - Relay control
 - Regulated power supplies
 - Battery chargers
 - Time-delay circuits
 - Static switches
 - Phase control
 - Heater control

(Any 4 × 1)

(4)

10.2 $n = 3$

Number of possibilities = 2^n

$$= 2^3 \checkmark$$

$$= 8 \text{ possibilities} \checkmark$$

(2)

10.3 10.3.1 $110,11_2 = (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2})$
 $= 6,75_{10}$ ✓

10.3.2

	125 × 2
0	250 × 2
0	500 × 2
1	000

√√

$0,125_{10} = 0,001_2$ ✓

(2 × 2) (4)
[10]

TOTAL: 100