



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY THEORY N3

14 August 2024

This marking guideline consists of 8 pages.

QUESTION 1

- 1.1 False
- 1.2 True
- 1.3 True
- 1.4 False
- 1.5 True
- 1.6 False
- 1.7 True
- 1.8 False
- 1.9 False
- 1.10 False

(10 × 1) [10]

QUESTION 2

- 2.1
 - Armature current (I_a)
 - Flux per pole (ϕ)

(2)

- 2.2 States that when a coil or conductor cuts or is cut by magnetic flux, an emf is induced in that coil or conductor.

OR

States that an emf or open circuit voltage is always induced in the coil whenever the magnetic flux linking with the coil changes.

(2)

- 2.3
 - Varying the value of the armature voltage.
 - Varying the value of the main magnetic flux.
 - Varying the effective number of armature conductors.
 - Series – parallel speed control.
 - Word – Leonard control system.

(Any 2 × 1) (2)

- 2.4

$$E = V - I_a R_a - I_a R_{se}$$

$$E = 250 - 45(0,1 + 0,25) \checkmark$$

$$= 234,25 \text{ V } \checkmark$$

$$k = \frac{E}{N\phi}$$

$$= \frac{234,25}{(1000)(25 \times 10^{-3})} \checkmark$$

$$= 9,37 \checkmark$$

(4)

[10]

QUESTION 3

- 3.1
 - The effective field flux is reduced due to armature reaction as the load increases.
 - The Voltage drop due to the armature circuit resistance.

- | | | | |
|-----|-------|---|-------------|
| 3.2 | 3.2.1 | Used as welding generator or carbon-arc searchlight. | |
| | 3.2.2 | Used as a voltage booster on DC transmission lines. | |
| | 3.2.3 | Used as the generator in the Ward-Leonard motor generator system. | |
| | | | (3 × 1) (3) |

$$\begin{aligned} 3.3.1 \quad E &= \frac{2p\phi ZN}{60c} \\ &= \frac{2(2)(30 \times 10^{-3})(500)(850)}{60(2)} \quad \checkmark \checkmark \\ &= 425 \text{ V } \checkmark \end{aligned} \quad (3)$$

$$\begin{aligned} 3.3.2 \quad E &= V + I_a R_a \\ I_a &= \frac{E - V}{R_a} \\ &= \frac{425 - 400}{0,25} \checkmark \\ &= 100 \text{ A } \checkmark \end{aligned}$$

QUESTION 4

$$4.1 \quad \begin{aligned} I_{sh} &= \frac{V}{R_{sh}} = \frac{300}{120} = 2,5 \text{ A} \checkmark \\ I_a &= I_L + I_{sh} = 56 + 2,5 \\ &= 58,5 \text{ A} \checkmark \end{aligned} \quad (2)$$

4.2 Armature winding copper loss = $I_a^2 R_a$
 $= (58,5)^2 (0,3)$
 $= 1026,675 \text{ W} \checkmark$

$$\begin{aligned} \text{Shunt field winding copper loss} &= I_{sh}^2 R_{sh} & \text{or} & & \text{Shunt field losses} &= IV \\ &= (2.5)^2 (120) & & & &= (300)(2.5) \\ &= 750 \text{ W} \checkmark & & & &= 750 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{Iron, Friction \& windage loss} &= VI_{a(o)} \\ &= (300)(2,2) \\ &= 660 \text{ W } \checkmark \end{aligned} \tag{3}$$

$$4.3 \quad P_o = VI_L = (300)(56) = 16800 \text{ W} = 16,8 \text{ kW} \quad (1)$$

$$\begin{aligned}
 4.4 \quad P_{in} &= P_o + \text{losses} = 16800 + (1026,675 + 750 + 660) \checkmark \\
 &= 19236,675 \text{ W} = 19,237 \text{ kW} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 4.5 \quad \text{Efficiency} &= \frac{P_o}{P_{in}} \times 100\% \\
 &= \frac{16800}{19236,675} \times 100\% \checkmark \\
 &= 87,333\% \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 \text{Efficiency} &= \frac{VI}{VI + (I_a^2 R_a + I_s V + I_{a(o)} V)} \times 100\% \\
 &= \frac{(300)(56)}{(300)(56) + (1026,675 + 750 + 660)} \times 100\% \checkmark \\
 &= 87,333\% \checkmark
 \end{aligned}$$

(2)
[10]

QUESTION 5

$$\begin{aligned}
 5.1 \quad e &= E_m \sin(2\pi ft) \\
 195 &= 325 \sin(2\pi \times 50 \times t \times 57,3^\circ) \checkmark \\
 \therefore \sin(2\pi \times 50 \times t \times 57,3^\circ) &= \frac{195}{325} = 0,6 \\
 t &= \frac{\sin^{-1}(0,6)}{(2\pi \times 50 \times 57,3^\circ)} \checkmark \\
 &= 0,002 \text{ sec} = 2,048 \text{ ms} \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 5.2 \quad e &= E_m \sin(2\pi ft) \\
 325 &= 325 \sin(2\pi \times 50 \times t \times 57,3^\circ) \checkmark \\
 \therefore \sin(2\pi \times 50 \times t \times 57,3^\circ) &= \frac{325}{325} = 1 \\
 t &= \frac{\sin^{-1}(1)}{(2\pi \times 50 \times 57,3^\circ)} \checkmark \\
 &= 0,005 \text{ sec} = 5 \text{ ms} \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 5.3 \quad E_{rms} &= 0,707 \times E_m \\
 &= 0,707(325) \\
 &= 229,775 \text{ V } \checkmark \\
 E_{ave} &= 0,637 \times E_m \\
 &= 0,637(325) \\
 &= 207,025 \text{ V } \checkmark \\
 \text{Form factor} &= \frac{E_{rms}}{E_{ave}} \\
 &= \frac{229,775}{207,025} = 1,11 \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 5.4 \quad \text{Crest factor} &= \frac{E_m}{E_{rms}} \\
 &= \frac{325}{229,775} = 1,414 \checkmark
 \end{aligned} \tag{1}$$

[10]

QUESTION 6

$$\begin{aligned}
 6.1 \quad X_L &= 2\pi fL \\
 &= 2\pi(50)(60 \times 10^{-3}) = 18,85 \, \Omega \checkmark \\
 X_C &= \frac{1}{2\pi fC} \\
 &= \frac{1}{2\pi(50)(115 \times 10^{-6})} = 27,679 \, \Omega \checkmark \\
 I_R &= \frac{V_T}{R} = \frac{130}{50} = 2,6 \text{ A } \checkmark \\
 I_L &= \frac{V_T}{X_L} = \frac{130}{18,85} = 6,897 \text{ A } \checkmark \\
 I_C &= \frac{V_T}{X_C} = \frac{130}{27,679} = 4,697 \text{ A } \checkmark
 \end{aligned} \tag{5}$$

$$\begin{aligned}
 6.2 \quad I_T &= \sqrt{I_R^2 + (I_L - I_C)^2} \\
 &= \sqrt{(2,6)^2 + (6,897 - 4,697)^2} \checkmark \\
 &= 3,406 \text{ A } \checkmark
 \end{aligned} \tag{2}$$

$$6.3 \quad Z_T = \frac{V_T}{I_T} = \frac{130}{3,406} = 38,168 \Omega \checkmark \quad (1)$$

$$6.4 \quad \cos \phi = \frac{I_R}{I_T} = \frac{2,6}{3,406} \checkmark \\ = 0,763 \checkmark \quad (2) \\ [10]$$

QUESTION 7

- 7.1
- Unity power factor
 - Lagging power factor
 - Leading power factor
- (3)

$$7.2 \quad 7.2.1 \quad P = \sqrt{3} V_L I_L \cos \theta \\ = \sqrt{3} (440)(21)(0,65) \checkmark \\ = 10402,697 \text{ W} = 10,403 \text{ kW} \checkmark \quad (2)$$

$$7.2.2 \quad V_P = \frac{V_L}{\sqrt{3}} = \frac{440}{\sqrt{3}} \checkmark \\ = 254,034 \text{ V} \checkmark \quad (2)$$

$$7.2.3 \quad I_P = I_L = 21 \text{ A} \checkmark \quad (1)$$

$$7.2.4 \quad Z_P = \frac{V_P}{I_P} = \frac{254,034}{21} \checkmark \\ = 12,097 \Omega \checkmark \quad (2) \\ [10]$$

QUESTION 8

$$8.1 \quad 8.1.1 \quad V_{2(P)} = \frac{V_{2(L)}}{\sqrt{3}} = \frac{380}{\sqrt{3}} \checkmark \\ = 219,393 \text{ V} \checkmark \quad (2)$$

$$8.1.2 \quad T.R = \frac{V_{1(P)}}{V_{2(P)}} = \frac{6600}{219,393} \checkmark \\ = 30,083 : 1 = 30 : 1 \checkmark \quad (2)$$

(4)

(2 × 1) (2)

[10]

(2 × 1) (2)
[10]

- (Any 2 × 1) (2)

- (Any 2 × 1) (2)

(2 × 3) (6)
[10]

QUESTION 10

10.1 10.1.1 $N = 2^8 = 256$ combinations
 10.1.2 $N = 2^4 = 16$ combinations

(2 × 1) (2)

- 10.2 • High value of voltage gain
 • Low input impedance/high output impedance
 • Current gain is less than 1
 • No inversion of the signal

(4)

10.3 10110
 (–) 1011
 1011

(1 mark for each correct digit)

(4)

[10]

TOTAL: 100