



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

5 December 2024

This marking guideline consists of 8 pages.

QUESTION 1

- 1.1 Interpoles
- 1.2 Field poles
- 1.3 Autotransformer
- 1.4 Shunt motors
- 1.5 Cathode-ray oscilloscope
- 1.6 Doping
- 1.7 NOT gate
- 1.8 Wave winding
- 1.9 Yoke
- 1.10 Laminated plates

(10 × 1) [10]

QUESTION 2

- 2.1 The magnetic flux that remains in the field system even after the magnetising force has been removed. ✓✓

OR

The magnetism which remains in the iron even after the current has been switched off. ✓✓

(Any 1 × 2) (2)

- 2.2
- Series motors produce a very high starting and operating torque
 - Series motors are variable speed motors.
- (2)

- 2.3 2.3.1
- $$T = \frac{0,318 I_a \phi p Z}{c}$$
- $$\phi = \frac{T \times c}{0,318 I_a p Z}$$
- $$= \frac{(980)(8)}{0,318(400)(4)(660)} \checkmark$$
- $$= 0,023 \text{ Wb} = 23,347 \text{ mWb} \checkmark$$
- $c = 2p = (2)(4) = 8 \checkmark$
- (3)

- 2.3.2
- $$T = \frac{0,318 I_a \phi p Z}{c}$$
- $$\phi = \frac{T \times c}{0,318 I_a p Z}$$
- $$= \frac{(980)(2)}{0,318(400)(4)(660)} \checkmark$$
- $$= 0,006 \text{ Wb} = 5,837 \text{ mWb} \checkmark$$
- $c = 2 \checkmark$
- (3)
[10]

QUESTION 3

- 3.1
- Separately excited.
 - Self-excited
- (2)
- 3.2 3.2.1 The full-load terminal voltage is greater than the no-load terminal voltage. ✓
- OR**
- Series field is the more dominant field.
- OR**
- Shunt field is the less dominant field.
- (Any 1 × 1)
- 3.2.2 The full-load terminal voltage is less than the no-load terminal voltage. ✓
- OR**
- Shunt field is the more dominant field.
- OR**
- Series field is the less dominant field.
- (Any 1 × 1)
- 3.2.3 The full-load terminal voltage is nearly the same as the no-load terminal voltage. ✓
- OR**
- Neither field is dominant.
- (Any 1 × 1)
(3 × 1) (3)
- 3.3 3.3.1
- $$P_o = VI_L$$
- $$I_L = \frac{P_o}{V} = \frac{8000}{280} = 28,571 \text{ A} \checkmark$$
- $$I_{sh} = \frac{V}{R_{sh}} = \frac{280}{100} = 2,8 \text{ A} \checkmark$$
- $$I_a = I_L + I_{sh} = 28,571 + 2,8 = 31,371 \text{ A} \checkmark$$
- (3)
- 3.3.2
- $$E = V + I_a R_a$$
- $$R_a = \frac{E - V}{I_a}$$
- $$= \frac{300 - 280}{31,371} \checkmark$$
- $$= 0,638 \Omega \checkmark$$
- (2)
[10]

QUESTION 4

4.1 Efficiency is defined as the ratio of output power to input power. (1)

4.2 4.2.1
$$I_a = I_L - I_{sh} = 31 - 2,667$$

$$= 28,333 \text{ A } \checkmark$$

Armature winding copper loss $= I_a^2 R_a$
 $= (28,333)^2 (0,45)$
 $= 361,242 \text{ W } \checkmark$ (2)

4.2.2
$$I_{sh} = \frac{V}{R_{sh}} = \frac{400}{150} = 2,667 \text{ A } \checkmark$$

Shunt field winding copper loss $= I_{sh}^2 R_{sh}$
 $= (2,667)^2 (150)$
 $= 1066,933 \text{ W } \checkmark$ (2)

4.2.3 Total copper losses $= 361,242 + 1066,933$
 $= 1428,175 \text{ W } \checkmark$

Total losses = Total copper losses + constant losses
 $= 1428,175 + 275$
 $= 1703,175 \text{ W } \checkmark$ (2)

4.2.4 Efficiency $= \frac{VI - (I_a^2 R_a + I_s V + C)}{VI} \times 100\%$
 $= \frac{(400)(31) - [(361,242) + (1066,933) + (275)]}{(400)(31)} \times 100\% \checkmark \checkmark$
 $= 86,265 \% \checkmark$

(3)
[10]

QUESTION 5

- 5.1 Form factor is defined as ratio of the RMS value to the AVERAGE value of the wave. (2)
- 5.2 5.2.1
$$\begin{aligned} I_{rms} &= 0,707 \times I_m \\ &= 0,707(48) \\ &= 33,936 \text{ A } \checkmark \end{aligned}$$
- $$\begin{aligned} I_{ave} &= 0,637 \times I_m \\ &= 0,637(48) \\ &= 30,576 \text{ A } \checkmark \end{aligned}$$
- Form factor =
$$\frac{I_{rms}}{I_{ave}} = \frac{33,936}{30,576} = 1,11 \checkmark$$
 (3)
- 5.2.2
$$\begin{aligned} i &= 48 \sin (314,2t) \\ &= 48 \sin (314,2 \times 2 \times 10^{-3} \times 57,3^\circ) \checkmark \checkmark \\ &= 28,219 \text{ A } \checkmark \end{aligned}$$
 (3)
- 5.2.3
$$\begin{aligned} w &= 2\pi f = 314,2 \\ f &= \frac{314,2}{2\pi} \checkmark \\ &= 50,006 \text{ Hz} = 50 \text{ Hz } \checkmark \end{aligned}$$
 (2)
- [10]**

QUESTION 6

- 6.1 6.1.1
$$\begin{aligned} Z_t &= \frac{V_t}{I_t} \\ &= \frac{230}{3,5} \checkmark \\ &= 65,714 \Omega \checkmark \end{aligned}$$
 (2)
- 6.1.2
$$\begin{aligned} Z_T &= \sqrt{R^2 + X_L^2} \\ X_L &= \sqrt{Z^2 - R^2} \\ &= \sqrt{(65,714)^2 - (60)^2} \checkmark \\ &= 26,802 \Omega \checkmark \end{aligned}$$
 (2)
- 6.1.3
$$\begin{aligned} X_L &= 2\pi FL \\ F &= \frac{X_L}{2\pi L} = \frac{26,802}{2\pi(25 \times 10^{-3})} \checkmark \checkmark \\ &= 170,627 \text{ Hz } \checkmark \end{aligned}$$

$$\begin{aligned}
 6.2 \quad E &= Blv \\
 B &= \frac{E}{lv} = \frac{22,5}{(400 \times 10^{-3})(50)} \checkmark \checkmark \\
 &= 1,125 \text{ Wb/m}^2 \checkmark
 \end{aligned}$$

(3)
[10]

QUESTION 7

$$\begin{aligned}
 7.1 \quad I_{\text{active}} &= I \cos \phi \\
 &= (11,5)(0,85) \checkmark \\
 &= 9,775 \text{ A} \checkmark
 \end{aligned}$$

(2)

$$\begin{aligned}
 7.2 \quad \cos \phi &= 0,85 \\
 \phi &= \cos^{-1}(0,85) = 31,788^\circ \checkmark \\
 I_{\text{reactive}} &= I \sin \phi \\
 &= (11,5)(\sin 31,788) \checkmark \\
 &= 6,058 \text{ A} \checkmark
 \end{aligned}$$

(3)

$$\begin{aligned}
 7.3 \quad P &= VI \cos \phi \\
 &= (220)(11,5)(0,85) \checkmark \checkmark \\
 &= 2150,5 \text{ W} = 2,151 \text{ kW} \checkmark
 \end{aligned}$$

(3)

$$7.4 \quad Z = \frac{V}{I} = \frac{220}{11,5} = 19,13 \Omega \checkmark \checkmark$$

(2)
[10]

QUESTION 8

$$\begin{aligned}
 8.1 \quad 8.1.1 \quad T.R &= \frac{V_{1(P)}}{V_{2(P)}} = \frac{6600}{220} \checkmark \\
 &= 30:1 \checkmark
 \end{aligned}$$

(2)

$$\begin{aligned}
 8.1.2 \quad \frac{V_{1(P)}}{V_{2(P)}} &= \frac{I_{2(P)}}{I_{1(P)}} \\
 I_{1(P)} &= \frac{V_{2(P)} \times I_{2(P)}}{V_{1(P)}} = \frac{(220)(200)}{6600} \checkmark \\
 &= 6,667 \text{ A} \checkmark \\
 I_{1(L)} &= \sqrt{3} I_{1(P)} = \sqrt{3} \times (6,667) \checkmark \\
 &= 11,547 \text{ A} \checkmark
 \end{aligned}$$

(4)

$$8.1.3 \quad S = \frac{\sqrt{3} V_{1(L)} I_{1(L)}}{1000} = \frac{\sqrt{3} \times (6600)(11,547)}{1000} \checkmark$$

$$= 132 \text{ kVA} \checkmark$$

OR

$$S = \frac{3 V_{2(P)} I_{2(P)}}{1000} = \frac{3 \times (220)(200)}{1000} \checkmark$$

$$= 132 \text{ kVA} \checkmark$$

(2)

8.2 To protect large transformers against harmful effects of overloads and short circuit.

(2)

[10]

QUESTION 9

- 9.1
- Eddy current damping ✓
 - Air damping ✓

(2)

- 9.2
- 9.2.1
- Can be used in both AC and DC circuits. ✓
 - Very accurate. ✓

(2)

- 9.2.2
- Uneven/non-linear scale. ✓
 - Expensive ✓

(2)

9.3 To prevent error due to temperature changes.

(1)

9.4

$$V_m = I_m R_m$$

$$= (50 \times 10^{-3})(8) = 0,4 \text{ V} \checkmark$$

$$I_{sh} = I - I_m = 2 - (50 \times 10^{-3}) = 1,95 \text{ A} \checkmark$$

$$R_{sh} = \frac{I_m V_m}{I_{sh}} = \frac{0,4}{1,95} = 0,205 \Omega \checkmark$$

(3)

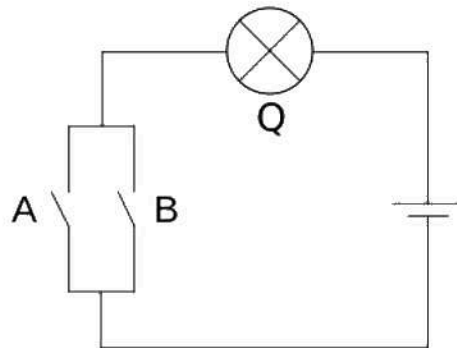
[10]

QUESTION 10

10.1 10.1.1 OR gate

(1)

10.1.2



✓✓✓✓

(1 mark each for input A & B, 1 mark for output Q and 1 mark for the correct diagram)

(4)

- 10.2
- NPN transistor
 - PNP transistor

(2)

10.3 $110,111_2 = (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) + (1 \times 2^{-3}) \checkmark$
 $= 4 + 2 + 0 + 0,5 + 0,25 + 0,125 \checkmark$
 $= 6,875_{10} \checkmark$

(3)

[10]

TOTAL: 100