higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

ELECTRO-TECHNOLOGY N3

23 NOVEMBER 2016

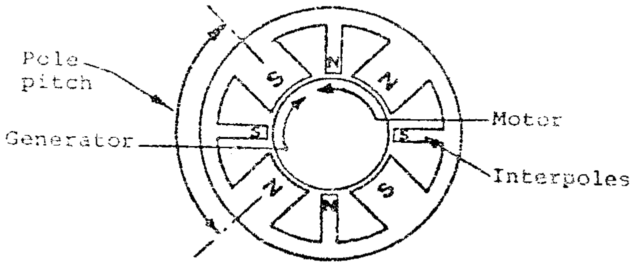
This marking guideline consists of 7 pages.

QUESTION 1

1.1 1.1.1 Commutation – is the reversal of the EMF and current✓ to the short-circuited coil✓ during its transfer from one commutator segment to the next.✓ (3)

1.1.2 Pole pitch – is the angular distance between the centre of two adjacent poles. ✓ (1)

1.2



(4 marks for 4 labels. 2 marks for correct sketch) (6)
[10]

QUESTION 2

2.1
- Damaging brushes OR the commutator surface.
- To short circuit by formation of an arc. (2)

2.2 Short compound motor – is when a series field coil is connected in series✓with a parallel connection of a shunt field coil and armature. ✓ (2)

2.3 2.3.1 Motor commutation – is to provide a difference in polarity between the armature and the field in order to produce motion. (1)

2.3.2 Generator commutation – is to produce a steady voltage which remains constant. (1)

2.4 Given: P = 4; C = 2; Φ = 40 mWb = 0,04 Wb; N = 14 r/sec; E = 120 V
Total number of conductors in armature =?

$$E = \frac{2p\Phi ZN}{60C}$$

$$Z = \frac{E \times 60C}{2p\Phi N}$$

$$= \frac{120V \times 2}{2 \times 4 \times 0{,}04 \times 14}$$ ✓✓

= 53,571✓✓ or 54 conductors ⟶ Answer (4)
[10]

QUESTION 3

3.1
- Friction loss
- Wind loss
- Iron loss

(Any 2 x 1) (2)

3.2
- Speed [N]
- Flux [Φ]

(2)

3.3 3.3.1

$$\text{Flux } [\Phi] = \frac{T \times c}{0{,}318 \times Z \times p \times I_a}$$

$$= \frac{980 \times 2 \times 4}{0{,}318 \times 660 \times 4 \times 400} \checkmark\checkmark$$

= 0,023 Wb OR 23,346 mWb✓ ⟶ Answer (3)

3.3.2

$$\text{Flux } [\Phi] = \frac{T \times c}{0{,}318 \times Z \times p \times I_a}$$

$$= \frac{980 \times 2}{0{,}318 \times 660 \times 4 \times 400} \checkmark\checkmark$$

= 0,00584 Wb OR 5,836 mWb✓ ⟶ Answer (3)

[10]

QUESTION 4

4.1 4.1.1 When the current reaches overload magnitude, ✓ the heating coil will heat the bimetal strip✓ to the extent that it will bend far enough✓ to operate the tripping contacts. ✓ (4)

4.1.2 By the time taken for the bi-metal strip to bend. (1)

4.2 4.2.1 Oil

4.2.2 Overload coil

4.2.3 Oil dashpot

4.2.4 Piston

4.2.5 Plunger (5)

[10]

QUESTION 5

5.1 5.1.1 Current through Resistor $[I_R] = \frac{210\,V}{70\,\Omega}$

$= 3\text{ A}$ ✓ ⟶ Answer (1)

5.1.2 Current through Capacitor $\{I_C] = 210\,V \times 2 \times 3{,}142 \times 60 \times 130 \times 10^{-6}$ ✓

$= 10{,}293\text{ A}$ ✓ ⟶ Answer (2)

5.1.3 Current through Inductor $[I_L] = \frac{210\,V}{2 \times 3{,}142 \times 60 \times 0{,}04}$ ✓

$= 13{,}924\text{A}$ ✓ ⟶ Answer (2)

5.2 5.2.1 $Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{70^2 + (20.402 - 15.082)^2}$ ✓✓

$= 70{,}202\ \Omega$ ✓ ⟶ Answer (3)

5.2.2 $I_t = \frac{V_t}{Z} = \frac{210\,V}{70{,}202\,\Omega}$ ✓

$= 2{,}991\text{ A}$ ✓ ⟶ Answer (2)

[10]

QUESTION 6

6.1 The virtual value $= \sqrt{\frac{i_1{}^2 + i_2{}^2 + i_3{}^2 + \ldots\ldots i_n{}^2}{n}}$ amps

$= \sqrt{\frac{10^2 + 20^2 + 36^2 + 38^2 + 28^2 + 14^2}{6}}$ ✓

$= \sqrt{\frac{100 + 400 + 1296 + 1444 + 784 + 196}{6}}$ ✓

$= \sqrt{703{,}333}$ ✓

$= 26{,}520\text{ A}$ ✓ ⟶ Answer (4)

6.2 The average value $= \frac{i_1 + i_2 + i_3 + \ldots. + i_n}{n}$

$= \frac{10A + 20A + 36A + 38A + 28A + 14A}{6}$ ✓

$= \frac{146}{6}$ ✓

$= 24{,}333\text{ A}$ ✓ ⟶ Answer (3)

6.3 The form factor $= \frac{I_{rms}}{I_{ave}}$

$= \frac{26{,}520A}{24{,}333A}$

$= 1{,}089$ ✓ ⟶ Answer (1)

6.4 The crest factor = $\frac{I_m}{I_{rms}}$

= $\frac{40}{26,520}$

= 1,508 ✓ ⟶ Answer (1)

6.5 Peak wave or sine wave or sinusoidal wave. ✓ (1)

[10]

QUESTION 7

7.1 Power = VI

Current = $\frac{70}{140}$ ✓

= 0,5 A✓ ⟶ Answer (2)

7.2 Voltage = IR

Resistance = $\frac{140}{0,5}$ ✓

= 280 Ω✓ ⟶ Answer (2)

7.3 Impedance (Z) = $\frac{Voltage}{Current}$

= $\frac{200\,V}{0,5\,A}$ ✓

= 400 Ω ✓ ⟶ Answer (2)

7.4 The inductance value of the circuit (L) = ?

Z = $\sqrt{R^2 + X_L{}^2}$

X_L = $\sqrt{400^2 - 280^2}$ ✓

= 285,657 Ω ✓ ⟶

X_L = 2цfL

L = $\frac{285,657\Omega}{2 \times 3,142 \times 60}$ ✓

= 0,758 H or 758 mH✓ ⟶ Answer (4)

[10]

QUESTION 8

8.1
- It delivers higher power.
- It generates a higher torque.
- A three-phase supply is more versatile when connected in star (V_L and V_{PH}).
- In the case of alternators, the same size prime mover is required for both single and three-phase. (Any 3 x 1) (3)

8.2 8.2.1 The apparent power [S} = $\sqrt{3}$VI

= $\sqrt{3}$ x 380 V x 9 A

= 5 923,613 VA✓

= 5,924 kVA✓ ⟶ Answer (2)

8.2.2 The actual power [P] = $\sqrt{3} \times V_L \times I_L \times Cos\,\theta$

= $\sqrt{3} \times 380 \times 9 \times 0{,}85$ ✓

= 5 035,072 W✓

= 5,035 kW✓ ⟶ Answer (3)

8.2.3 The phase current of the motor winding [I_{ph}] = $\frac{I_L}{\sqrt{3}}$ Delta connection

= $\frac{9A}{\sqrt{3}}$ ✓

= 5,196 A✓ ⟶ Answer (2)

[10]

QUESTION 9

9.1

Moving-iron Instrument	Dynamo-meter Instrument
• Uneven scale	• Uneven scale
• Pointer/Needle	• Pointer/Needle
• Balance weight	• Balance weight
• Spring	• Spring

(4)

9.2 9.2.1 As a voltmeter:

$R_t = \frac{V_t}{I_t} = \frac{6V}{0{,}006A}$

= 1 000 Ω ⟶ Answer✓

$R_{series} = R_t - R_m$

= 1 000 Ω – 120 Ω✓

= 880 Ω ⟶ Answer✓ (3)

9.2.2 As an ammeter:
Voltage across ammeter
$V_m = I_m R_m = 0{,}006\ A \times 120\ \Omega$
= 0,72 V ⟶ Answer✓
Current through shunt

$I_s = I_t - I_m = 2A - 0{,}006A$
= 1,994 A ⟶ Answer✓

$R_s = \frac{V_s}{I_s} = \frac{0{,}72\ V}{1{,}994\ A}$
= 0,361 Ω ⟶ Answer✓ (3)
[10]

QUESTION 10

10.1 10.1.1 5 valence electrons (2)

10.1.2 3 valence electrons (2)

10.2 Capacitor (1)

10.3 Motor-speed control; time-delay circuits; battery charger; heater control; relay circuit; regulated power supplies; static switches; phase controls
(Any 5 x 1) (5)
[10]

TOTAL: 100