higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

29 November 2022

This marking guideline consists of 7 pages.

MJ

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QUESTION 1

1.1 E

1.2 J

1.3 G

1.4 K

1.5 I

1.6 B

1.7 A

1.8 C

1.9 F

1.10 D (10 × 1) (10)
[10]

QUESTION 2

2.1
- It forms the outer casing of the machine
- It supports the main field system
- It forms the magnetic circuit of the main poles (3 × 1) (3)

2.2 Commutation – is the reversal of the EMF and current in the short✓circuited coil during its transfer from one commutator segment to the next. ✓ (2)

2.3 2.3.1

$$E = V + I_a R_a$$
$$= 440 + (40 \times 0{,}25) \checkmark$$
$$= 450\ V \checkmark$$

(2)

2.3.2

$$I_{sh} = \frac{V}{R_{sh}} \qquad I_L = I_a - I_{sh} \qquad P = IV$$
$$= \frac{440}{220} \qquad = 40 - 2 \qquad = 440 \times 38$$
$$= 2\ A \checkmark \qquad = 38\ A \checkmark \qquad = 16{,}72\ kW \checkmark$$

(3)
[10]

QUESTION 3

3.1 DC motor operates on the principle of the interaction between two magnetic fields.✓ When a current-carrying conductor is placed in a magnetic field, an interaction takes place between the main field✓ and the field due to the current flowing in the armature conductors.✓ (3)

3.2 A large DC motor can be started without damaging the motor or motor circuit by inserting resistors in the armature circuit. (2)

3.3 Magnetic losses. (1)

3.4
$$T = \frac{0{,}318 I_a Z p \phi}{c}$$
$$\therefore \phi = \frac{(320)(8)}{(0{,}318)(160)(560)(4)} \quad ✓✓$$
$$= 0{,}0225\ Wb \quad ✓$$
$$= 22{,}5\ mWb \quad ✓$$
(4)
[10]

QUESTION 4

4.1
$$W = mg = (31)(9{,}81) = 304{,}11\ N \quad ✓$$
$$Effective\ Load = W - S$$
$$= 304{,}11 - 100$$
$$= 204{,}11\ N \quad ✓$$
(2)

4.2
$$P_{out} = 2\pi nr(W - S)$$
$$= 2\pi(13)(0{,}125)(204{,}11) \quad ✓✓$$
$$= 2{,}084\ kW \quad ✓$$

$$r = \frac{d}{2}$$
$$= \frac{250}{2} = 125\ mm = 0{,}125\ m \quad ✓$$

ALTERNATIVE:

$$P_{out} = \frac{2\pi Nr(W - S)}{60} = \frac{2\pi(780)(0{,}125)(204{,}11)}{60} \quad ✓✓$$
$$= 2{,}084\ kW \quad ✓$$
(4)

4.3
$$P_{in} = VI_L = (230)(0.01 \times 10^{-3}) \quad ✓$$
$$= 2{,}3\ kW \quad ✓$$
(2)

4.4
$$P_{out} = \frac{P_{out}}{P_{in}} \times 100\,\%$$
$$= \frac{2{,}084}{2{,}3} \times 100\,\% \quad ✓$$
$$= 90{,}609\,\% \quad ✓$$
(2)
[10]

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QUESTION 5

5.1 $E_{ave} = 0,637E_m = (0,637)(230)$ ✓
$= 146,51\,V$ ✓ (2)

5.2 $\omega = 2\pi f$
$\therefore f = \frac{\omega}{2\pi} = \frac{314,2}{2\pi}$ ✓
$= 50\ Hz$ ✓ (2)

5.3 $T = \frac{1}{f} = \frac{1}{50} = 0,02\ seconds$ (1)

5.4 $e = E_m \sin 2\pi ft$
$= 230\sin(314,2 \times 0,004 \times 57,3^0)$ ✓✓
$= 218,761\,V$ ✓ (3)

ALTERNATIVE:

$e = E_m \sin 2\pi ft$
$= 230\sin(360 \times 50 \times 0,004)$ ✓✓
$= 218,743\,V$ ✓ (3)

5.5 $E_{rms} = 0,707E_m = (0,707)(230) = 162,61\,V$ ✓
$Crest\ \ factor = \frac{E_m}{E_{rms}} = \frac{230}{162,61} = 1,414$ ✓ (2)
(10)

QUESTION 6

6.1 $I_R = \frac{V_T}{R} = \frac{200}{50} = 4\ A$ (1)

6.2 $X_L = 2\pi fL = 2\pi(60)(40 \times 10^{-3}) = 15,08\,\Omega$ ✓

$I_L = \frac{V_T}{X_L} = \frac{200}{15,08} = 13,263\ A$ ✓ (2)

6.3 $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(60)(140 \times 10^{-6})} = 18,947\,\Omega$ ✓

$I_C = \frac{V_T}{X_C} = \frac{200}{18,947} = 10,556\ A$ ✓ (2)

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6.4 $I_T = \sqrt{(I_R)^2 + (I_L - I_C)^2}$
$= \sqrt{(4)^2 + (13{,}263 - 10{,}556)^2}$ ✓✓
$= 4{,}83\ A$ ✓ (3)

6.5 $Z_T = \frac{V_T}{I_T} = \frac{200}{4{,}83}$ ✓
$= 41{,}408\ A$ ✓ (2)
[10]

QUESTION 7

7.1
- Two operating voltages (line voltage and phase voltage)
- More power can be delivered to the consumer
- Capable to supply a single-phase source
- Simpler construction and relatively cheaper
- Produce a rotating field thus making them self-starting
- Operate at higher efficiencies
- Industrial and domestic consumers can be supplied from the same system
- More economical (Any 2 × 1) (2)

7.2 7.2.1 $P = \sqrt{3}V_L I_L \cos\theta$
$= \sqrt{3}(380)(25)(0{,}86)$ ✓
$= 14150{,}855\ W = 14{,}151\ kW$ ✓ (2)

7.2.2 $Q = \sqrt{3}V_L I_L \sin\theta$ $\cos\theta = 0{,}86 \quad \therefore \theta = 30{,}683^0$ ✓
$= \sqrt{3}(380)(25)(\sin 30{,}683^0)$ ✓
$= 8396{,}521\ W = 8{,}397\ kW$ ✓ (3)

7.2.3 $S = \sqrt{3}V_L I_L$
$= \sqrt{3}(380)(25)$ ✓
$= 16454{,}483\ W = 16{,}454\ kW$ ✓ (2)

7.2.4 $I_P = I_L = 25\ A$ (star-connected) (1)
[10]

QUESTION 8

8.1 8.1.1 $V_{2(P)} = \frac{V_{2(L)}}{\sqrt{3}} = \frac{11000}{\sqrt{3}} = 6350{,}852\ V$ ✓
$Turns\ ratio = \frac{V_{1(P)}}{V_{2(P)}} = \frac{132000}{6350{,}852}$ ✓
$= 20{,}78 : 1$ ✓ (3)

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8.1.2

$$Turns\ ratio = \frac{N_1}{N_2}$$

$$\therefore N_1 = (Turns\ ratio)(N_2) = (20{,}78)(100) \checkmark$$

$$= 2078\ turns \checkmark$$

ALTERNATIVE:

$$\frac{V_{1(P)}}{V_{2(P)}} = \frac{N_1}{N_2} \therefore N_1 = \frac{(V_{1(P)})(N_2)}{V_{2(P)}} = \frac{(132000)(100)}{6350{,}852} \checkmark$$

$$= 2078\ turns \checkmark$$

(2)

8.1.3

$$P_{out} = \sqrt{3} V_L I_L \cos\theta \qquad Where = S = kVA = \sqrt{3} V_L I_L = 20 \times 10^6$$

$$= (20 \times 10^6)(0{,}8) \checkmark\checkmark$$

$$= 16 \times 10^6\ W$$

$$= 16\ MW \checkmark$$

(3)

8.2

- Used for stepping up or stepping down the voltage. ✓
- To isolate the electrical connection between the supply(primary) and the output(secondary). ✓
- Used as motor starters for large induction motors.
- Used as voltage boosters to correct voltage drops in cables.(Any 2 × 1)

(2)

[10]

QUESTION 9

9.1

$$R_T = \frac{V_T}{I_T}$$

$$= \frac{12}{60 \times 10^{-3}} \checkmark$$

$$= 200\ \Omega \checkmark$$

$$R_T = R_M + R_{SE}$$

$$\therefore R_{SE} = R_T - R_M$$

$$= 200 - 15 \checkmark$$

$$= 185\ \Omega \checkmark$$

(4)

9.2

- Two coils are brought together namely primary (input) and secondary windings (output).✓ The supply is connected to input windings.
- The voltage forms a magnetic field between the primary and secondary winding.✓
- The variation of magnetic field induces an EMF of mutual inductance into the secondary winding.✓
- There is no electrical connection between the two coils, only magnetic connection.✓

(4)

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9.3
- It is very accurate.
- It is almost of a uniform scale.
- It prevents pointer from oscillating.
- It is well shielded from any stray magnetic fields. (Any 2 × 1) (2)

[10]

QUESTION 10

10.1 10.1.1 OR gate (1)

10.1.2 AND gate (1)

10.1.3 NOT gate (1)

10.2
- High conductivity.
- Can operate at low temperature.
- Lower output than silicon transistor.
- Used for high frequencies. (Any 2 × 1) (2)

10.3 1011,0101
+1010,1100
$10110,0001_2 \longrightarrow$ ✓✓

$\therefore 10110,0001_2 = 2^4 + 0 + 2^2 + 2^1 + 0 + 0 + 0 + 0 + 2^{-4}$ ✓
$= 16 + 4 + 2 + 0,625$ ✓
$= 22,0625_{10}$ ✓ (5)

[10]

TOTAL: 100

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