higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3

6 December 2023

This marking guideline consists of 8 pages.

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QUESTION 1

1.1
- An electron is a an elementary particle charged✓ with small and constant quantity of negative electricity ✓
- While free electrons are electrons in the outermost shell✓ that are ready to be shared with other atoms. ✓

(4)

1.2 $R_T = R_0(1 + \alpha_0 t)$

$24 = 20(1 + 0{,}0043t)$✓

$1 + 0{,}0043t = 1{,}2$

$0{,}0043t = 0{,}2$✓

$t = 46{,}512\ °C$✓ (3)

1.3
1.3.1 The resistance will increase.

1.3.2 The resistance will increase.

1.3.3 The resistance will decrease.

1.3.4 The resistance will remain the same or unchanged.

(4 × 1) (4)

1.4 A charge is the excess of negative or positive electricity.✓ on a body or in space.✓ (2)

1.5
1.5.1 Positive temperature coefficient of resistance (PTC)

1.5.2 Negative temperature coefficient of resistance (NTC)

(2 × 1) (2)

[15]

QUESTION 2

2.1
- Like charges (poles) repel each other and unlike charges (poles) attract each other.
- The force exerted by one pole on the other pole is directly proportional to the product of the pole strength
- The force exerted by one pole onto the other pole is inversely proportional to the square of the distance between them.

(Any 1 × 2) (2)

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2.2 2.2.1 $F = BIl\ sin\theta$

$= 0{,}5 \times 5 \times 0{,}6 \times sin90°$✓

$= 1{,}5\ \text{N}$✓

2.2.2 $F = BIl\ sin\theta$

$= 0{,}03 \times 5 \times 0{,}6 \times sin60°$✓

$= 0{,}078\ \text{N}$✓

(2 × 2) (4)

2.3 2.3.1 Lenz's law ✓and Faraday's right-hand rule✓ (2)

2.3.2 right-hand grip rule (1)

2.3.3 magnetomotive force (1)

2.3.4 magnetic field (1)

2.4 The direction of the induced e.m.f is always such that it tends to set up a current opposing✓ the motion or the change of flux responsible for that inducing e.m.f. ✓

(2)

2.5 2.5.1 $E = Blv\ sin\theta$

$$B = \frac{E}{lvsin\theta}$$

$$= \frac{7{,}25}{0{,}175 \times 12{,}5 \times sin90°}$$ ✓

$= 3{,}314\ \text{T}$✓

2.5.2 $F = BIl\ sin\theta$

$$I = \frac{F}{Blsin\theta}$$

$$= \frac{11}{3{,}314 \times 0{,}175 \times sin90°}$$ ✓

$= 18{,}967\ \text{A}$✓

(2 × 2) (4)

2.6
- Place your right-hand over the solenoid with your fingers pointing in the direction of the current.
- and with your thumb at 90^0 to your fingers.
- Your thumb will point in the direction of the north pole.

(3)
[20]

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QUESTION 3

3.1 3.1.1

$$V_T = V_1 + V_2$$

$$= 150 + 100$$

$$= 250 \text{ V}✓$$

$$C_T = \frac{Q_T}{V_T}$$

$$= \frac{2\,300 \times 10^{-6}}{250}✓$$

$$= 9{,}2 \text{ µF}✓ \quad (3)$$

3.1.2

$$C_1 = \frac{Q_T}{V_1}$$

$$= \frac{2\,300 \times 10^{-6}}{150}✓$$

$$= 15{,}333 \text{ µF}✓$$

$$C_2 = \frac{Q_T}{V_2}$$

$$= \frac{2\,300 \times 10^{-6}}{100}✓$$

$$= 23 \text{ µF}✓$$

OR

$$C_T = \frac{C_1 C_2}{C_1 + C_2}$$

$$9{,}2 = \frac{15{,}333 C_2}{15{,}333 + C_2}$$

$$6{,}133 C_2 = 141{,}064$$

$$\therefore C_2 = 23 \text{ µF} \quad (4)$$

3.2 Electromotive force is the voltage measured across the terminals of a battery✓ when there is no current flow.✓ Terminal voltage is the voltage measured across the terminals of a battery✓ when there is current flow.✓ (2 + 2) (4)

3.3 3.3.1

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

$$= \frac{12}{1{,}5}✓$$

$$= 8\ \Omega✓ \quad (2)$$

3.3.2

$$R_{P1} = \frac{R_1 \times R_2}{R_1 + R_2}$$ ✓

$$= \frac{10 \times 15}{10 + 15}$$ ✓

$$= 6\ \Omega$$ ✓

OR

$$\frac{1}{R_{P1}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{10} + \frac{1}{15}$$

$$= \frac{5}{30}$$

$$= \frac{30}{5} = 6\ \Omega$$

$$R_{P2} = R_T - R_{P1}$$

$$= 8 - 6$$

$$= 2\ \Omega$$ ✓

$$R_{P2} = \frac{R_X \times R_3}{R_X + R_3}$$

OR

$$\frac{1}{R_{P2}} = \frac{1}{R_X} + \frac{1}{R_3}$$

$$2 = \frac{R_X \times 15}{R_X + 15}$$ ✓

$$2(R_X + 15) = 15R_X$$ ✓

$$2R_X + 30 = 15R_X$$

$$13R_X = 30$$ ✓

$$R_X = 2{,}307\ \Omega$$ ✓

$$\frac{1}{R_X} = \frac{1}{R_{P2}} - \frac{1}{R_3}$$

$$= \frac{1}{2} - \frac{1}{15}$$

$$= \frac{13}{30}$$

$$R_X = \frac{30}{13}$$

$$R_X = 2{,}307\ \Omega$$

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OR

$V_{P1} = I_T R_{P1}$ $V_{P2} = V_T - V_{P1}$

$= 1{,}5 \times 6$ $= 12 - 9$

$= 9\ \text{V}$ $= 3\ \text{V}$

$I_{R3} = \frac{V_{P2}}{R_3}$ $I_X = I_T - I_{R3}$

$= \frac{3}{15}$ $= 1{,}5 - 0{,}2$

$= 0{,}2\ \text{A}$ $= 1{,}3\ \text{A}$

$R_X = \frac{V_{P2}}{I_X}$

$= \frac{3}{1{,}3}$

$= 2{,}308\ \Omega$ (7)

3.3.3
- The second parallel resistors will be eliminated by the short circuit.
- The total resistance will decrease
- The volt drop across R_{p1} change (will be equal to the total voltage)
- The total current will increase
- The total current will flow through the short circuit

(Accept any other relevant answer) (2 x 1) (2)

3.4 $E = L\frac{di}{dt}$

$3{,}2 = L \times 16$ ✓

$L = \frac{3{,}2}{16}$ ✓

$= 0{,}2\ \text{H}$ ✓ (3)

3.5
- Oil-immersed self-cooled transformer
- Oil-immersed forced air-cooled transformer
- Oil-immersed forced oil-cooled transformer (3)

3.6
- Line voltage is measured between any two lines of the three phase system.
- Phase voltage is measured between any line and neutral of the three phase system. (2)

[30]

QUESTION 4

4.1
- Use an AC voltage scale of at least twice the nominal (rated) voltage with a minimum of 500V
- Switch off the supply
- Ensure all the switches and circuit breakers are in the close position
- Load may be disconnected
- Apply the test voltage between the earth continuity conductor and the whole system of live conductors.
- The insulation resistance measured shall be at least 1,0MΩ (6)

4.2
- Damping device
- Controlling device
- Deflecting/Operating device (3)

4.3
- The scale is uniform
- Has high torque to weight ratio
- Low power consumption
- The range can be extended using series and shunt resistors.

(Any 3 × 1) (3)

4.4
- Low sensitivity
- Scale not uniform
- Cost more than moving-iron instruments
- Can only be used as voltmeters and ammeters

(Any 3 × 1) (3)

[15]

QUESTION 5

5.1
- Variable losses
- Constant losses

(2)

5.2
5.2.1 two
5.2.2 The number
5.2.3 low-current/high-voltage

(3 × 1) (3)

5.3
- Magnet
- Coil/winding
- Commutator
- Brushes

(3 × 1) (3)

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5.4 $E = V + I_a R_a$

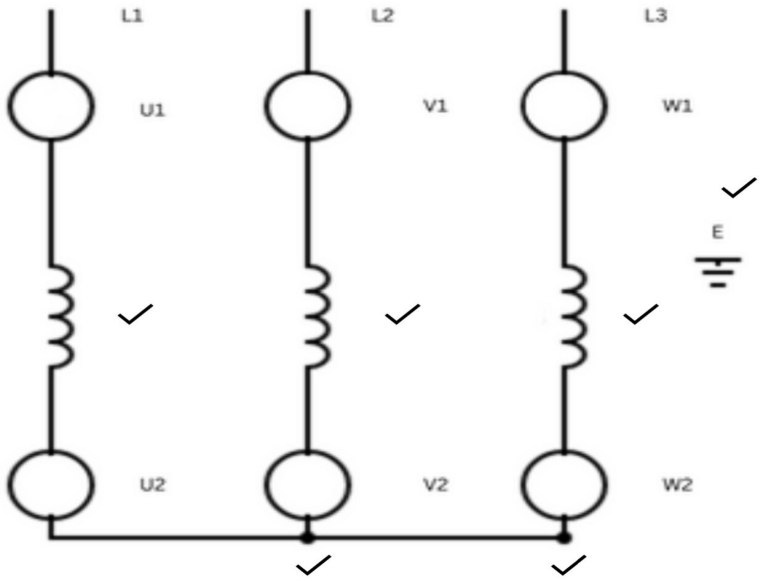
$I_a = \frac{E - V}{R_a}$ ✓

$= \frac{210 - 150}{5}$ ✓

$= 12\ \text{A}$ ✓ (3)

5.5 An autotransformer starter is used to reduce the starting current✓ by reducing the voltage during the initial starting period.✓ (2)

5.6



(6 x 1) (6)

5.7
- Industrial application
- Consumer application (small appliances) (Any 1 x 1) (1)

[20]

TOTAL: 100