higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3

8 December 2020

This marking guideline consists of 7 pages.

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QUESTION 1

1.1 1.1.1 Free electrons have left the valence shell.

1.1.2 Potential difference is the difference in electrical potential between two points in a circuit.

1.1.3 Electromotive force is the greatest potential difference that can be produced by a source of electric current in a circuit.

(3 × 2) (6)

1.2 The resistance of carbon decreases as the temperature increases. (2)

1.3 The variation in resistance with a change in temperature is so small that is negligible. (2)

1.4 Resistivity is directly proportional to the resistance of a material. (2)

1.5 $R_t = R_\theta[1 + \propto_\theta (t - \emptyset)]$

$= 30[1 + 0{,}0043(50 - 30)]$✓✓

$= 32{,}58\ \Omega$✓ (3)

[15]

QUESTION 2

2.1 2.1.1
- Railway crossings
- Telephones
- Fire alarms
- Burglar alarms
- Doorbells
- Alarms in industrial plants (Any TWO)

2.1.2
- Steel mills
- Foundries
- Scrapyards (Any TWO)

(2 × 2) (4)

2.2 2.2.1 parallel
2.2.2 cross-sectional area
2.2.3 2×10^{-7}

(3 × 1) (3)

2.3 2.3.1 $E = Blv$

$= 5 \times 0{,}12 \times 2$✓

$= 1{,}2\ \text{V}$✓

2.3.2 $F = BlI$

$= 5 \times 0{,}12 \times 10$✓

$= 6\ \text{N}$✓

(2 × 2) (4)

2.4 2.4.1 $mmf = NI$

$= 100 \times 3$

$= 300\ \text{A}$✓ (1)

2.4.2 $H = \frac{mmf}{l}$

$= \frac{300}{4}$✓

$= 75\ \text{A/m}$✓ (2)

2.5 2.5.1 False
2.5.2 True

(2 × 1) (2)

2.6 Extend the thumb, index and middle finger of the right hand so that all are at right angles to each other.✓ If the index finger points in the direction of the magnetic field,✓ and the thumb points in the direction of motion,✓ then the middle finger will point in the direction of the induced emf.✓ (4)

[20]

QUESTION 3

3.1 $I_1 + 2 = 4 + 5$✓

$I_1 = 4 + 5 - 2$✓

$I_1 = 7\ \text{A}$✓ (3)

3.2 3.2.1

$$C_S = \frac{C_1 \times C_2}{C_1 + C_2}$$

$$= \frac{4 \times 3}{4 + 3} \checkmark$$

$$= 1{,}714\ \mu\text{F} \checkmark$$

OR

$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{1}{4} + \frac{1}{3}$$

$$= \frac{7}{12}$$

$$C_S = \frac{12}{7} = 1{,}714\ \mu\text{F}$$

$$C_P = C_S + C_3$$

$$= 1{,}714 + 2$$

$$= 3{,}714\ \mu\text{F} \checkmark$$

$$C_T = \frac{C_P \times C_4}{C_P + C_4}$$

$$= \frac{3{,}714 \times 6}{3{,}714 + 6} \checkmark$$

$$= 2{,}294\ \mu\text{F} \checkmark$$

OR

$$\frac{1}{C_T} = \frac{1}{C_P} + \frac{1}{C_4}$$

$$= \frac{1}{3{,}714} + \frac{1}{6}$$

$$= 0{,}436$$

$$C_T = \frac{1}{0{,}436} = 2{,}294\ \mu\text{F}$$

(5)

3.2.2

$$Q_T = C_T V_T$$

$$= 2{,}294 \times 10^{-6} \times 10 \checkmark$$

$$= 22{,}94\ \mu\text{C} \checkmark$$

$$V_{C4} = \frac{Q_T}{C_4}$$

$$= \frac{22{,}94}{6} \checkmark$$

$$= 3{,}823\ \text{V} \checkmark$$

(4)

3.3 The total resistance will increase and the total current will decrease. (2)

3.4 3.4.1 $L = \frac{N\emptyset}{I}$

$= \frac{400 \times 6 \times 10^{-3}}{5}$ ✓

$= 0{,}48\ \text{H}$ ✓

3.4.2 $E = -\frac{Ldi}{dt}$

$= -\frac{0{,}48 \times (5-0)}{0{,}04}$ ✓

$= -60\ \text{V}$ ✓

OR

$E = -\frac{Nd\emptyset}{dt}$

$= -\frac{400 \times 6 \times 10^{-3}}{0{,}04}$

$= -60\ \text{V}$

(2 × 2) (4)

3.5 $P = VI\ cos\theta$

$I = \frac{P}{V\ cos\theta}$

$= \frac{4\ 000}{230 \times 0{,}9}$ ✓

$= 19{,}324\ \text{A}$ ✓ (2)

3.6
- Polycarbonate
- Paper
- Mica
- Ceramic
- Variable air
- Polyester
- Polystyrene

(Any 4 × 1) (4)

3.7 $S = V_1 I_1$

$$I_1 = \frac{S}{V_1}$$

$$= \frac{100 \times 10^3}{2\,400} \checkmark$$

$$= 41{,}667 \text{ A} \checkmark$$

$S = V_2 I_2$ **OR** $\frac{V_1}{V_2} = \frac{I_2}{I_1}$

$I_2 = \frac{S}{V_2}$ $I_2 = \frac{V_1 I_1}{V_2}$

$= \frac{100 \times 10^3}{240} \checkmark$ $= \frac{2\,400 \times 41{,}667}{240}$

$= 416{,}667 \text{ A} \checkmark$ $= 416{,}667 \text{ A}$ (4)

3.8 Line current is the current flowing through any line conductor. (2)
[30]

QUESTION 4

4.1 It is used to measure current,✓ voltage✓and resistance.✓
(Any relevant answer) (3)

4.2
- One-wattmeter method for a balanced load.
- Two-wattmeter method for balanced or unbalanced loads.
- Three-wattmeter method for a three-phase four-wire system for balanced and unbalanced loads. (3)

4.3
- AC and DC systems
- Free from hysteresis and eddy-current errors
- Ammeter reading up to 10 A and voltmeter reading up to 600 V with significant accuracy (2 × 1) (2)

4.4 4.4.1
- Tong tester
- Clamp-on ammeter (Any 1 × 1) (1)

4.4.2 Open the jaws of the meter and place them around the conductor in which the current must be measured. Close the jaws and read off the value of the current. (3)

4.5 $I_{SH} = I_T - I_m$

$= 4 - 0{,}005$

$I_{SH} = 3{,}995\ \text{A}$✓

$R_{SH} = \frac{R_m I_m}{I_{SH}}$

$= \frac{20 \times 0{,}005}{3{,}995}$✓

$R_{SH} = 0{,}025\ \Omega$✓ (3)

[15]

QUESTION 5

5.1 5.1.1 In a series generator the field windings are connected in series with the armature.

5.1.2 In a shunt generator the field windings are connected in parallel with the armature.

5.1.3 A compound generator is a combination of a series and a shunt generator.

(3 × 2) (6)

5.2 A DC motor starter is used to limit the initial starting current of the motor to a safe value. (2)

5.3 In a lap winding the two ends of each armature coil are connected to adjacent commutator segments,✓✓ whilst in a wave winding the two ends of each coil are connected to the commutator segments placed between adjacent poles of the same polarity.✓✓ (2 + 2) (4)

5.4 Capacitor-start capacitor-run motors have excellent starting torque of about 300% of the full-load torque.✓ Thus their power factor during starting is high, although their running torque is poor.✓ Their power factor while running is low, their efficiency is poor and they cannot take overload.✓ (3)

5.5 $V = E + I_a R_a$

$I_a = \frac{V - E}{R_a}$

$= \frac{400 - 380}{5}$✓✓

$= 4\ \text{A}$✓ (3)

5.6 This method works on the principle that the speed of the DC motor can be changed by varying the back emf. (2)

[20]

TOTAL: 100

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