



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

28 July 2026

This marking guideline consists of 7 pages.

QUESTION 1: PRINCIPLES OF ELECTRICITY

- 1.1
- | | |
|--------|--------|
| 1.1.1 | True✓ |
| 1.1.2 | False✓ |
| 1.1.3 | False✓ |
| 1.1.4 | False✓ |
| 1.1.5 | True✓ |
| 1.1.6 | False✓ |
| 1.1.7 | True✓ |
| 1.1.8 | True✓ |
| 1.1.9 | True✓ |
| 1.1.10 | True✓ |

(10 × 1) (10)

1.2 Given:

$$\begin{aligned} R_1 &= 10 \, \Omega, & r_1 &= 1,5 \, \Omega \\ R_2 &= 5 \, \Omega, & E_2 &= 1,2 \, V \\ E_1 &= 2,5 \, V, & r_2 &= 0,8 \, \Omega \end{aligned}$$

1.2.1

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{10 \times 5}{10 + 5} = 3,333 \, \Omega \checkmark$$

$$r_T = r_1 + r_2 = 1,5 + 0,8 = 2,3 \, \Omega \checkmark$$

$$E_T = E_1 + E_2 = 2,5 + 1,2 = 3,7 \, V \checkmark$$

$$E_T = I_T (R_T + r_T)$$

$$I_T = \frac{3,7}{3,333 + 2,3} = 0,657 \, A \checkmark \checkmark$$

OR

$$R_T = \left(\frac{R_1 \times R_2}{R_1 + R_2} \right) + r_1 + r_2 \checkmark$$

$$= \left(\frac{10 \times 5}{10 + 5} \right) + 1,5 + 0,8 = 5,633 \, A \Omega \checkmark \checkmark$$

$$I_T = \frac{E_T}{R_T} = \frac{3,7}{5,633} = 0,657 \, A \checkmark \checkmark$$

(5)

1.2.2

$$E_T = V + I_T r_T$$

$$V = 3,7 - (0,657 \times 2,3) = 2,189 \, V \checkmark$$

OR

$$V_P = I_P R_P = 0,657 \times 3,333 = 2,189 \, V$$

$$I_{R1} = \frac{V_P}{R_1} = \frac{2,189}{10} = 0,219 \, A \checkmark$$

$$I_{R2} = \frac{V_P}{R_2} = \frac{2,189}{5} = 0,438 \, A \checkmark$$

(3)

1.2.3 $E_1 = V_1 + I_T r_1$
 $2,5 = V_1 + (0,657 \times 1,5)$
 $V_1 = 1,515 \text{ V} \checkmark$

$E_2 = V_2 + I_T r_2$
 $1,2 = V_2 + (0,657 \times 0,8)$
 $V_2 = 0,674 \text{ V} \checkmark$ (2)

- 1.3 1.3.1
- Copper✓
 - Aluminium✓
 - Iron✓
 - Gold✓
 - Silver✓
- (Any 2 × 1)

- 1.3.2
- Glass✓
 - Plastic✓
 - Paper✓
 - Rubber✓
- (Any 2 × 1)
(2 × 2) (4)

1.4 **Given:**
 $C_1 = 25 \mu\text{F}$
 $V = 90 \text{ V}$
 $C_2 = 15 \mu\text{F}$

1.4.1 $Q_1 = VC_1 = 90 \times 25 = 2250 \mu\text{C} \checkmark$
 $Q_T = Q_1 + Q_2 = 2250 + 0 = 2250 \mu\text{C} \checkmark$
 $C_T = C_1 + C_2 = 25 + 15 = 40 \mu\text{F} \checkmark$

$V = \frac{Q_T}{C_T} = \frac{2250}{40} = 56,25 \text{ V} \checkmark$

OR

$Q_T = Q_1 + Q_2$
 $Q_T = VC_1 + VC_2 = 90 \times 15 = 1350 \mu\text{C}$
 $Q_T = V(C_1 + C_2)$
 $1350 = V(40)$
 $V = 33,75 \text{ V}$ (4)

1.4.2 $Q_1 = VC_1 = 33,75 \times 25 = 843,75 \mu\text{C} \checkmark$
 $Q_2 = VC_2 = 33,75 \times 15 = 506,25 \mu\text{C} \checkmark$ (2)

[30]

QUESTION 2: DC MACHINES

2.1 **Given:**

$$p = 4$$

$$c = 2 \times 4 = 8$$

$$N = 350 \text{ r/p}$$

$$E = 150 \text{ V}$$

$$\Phi = 0,05 \text{ Wb}$$

$$E = \frac{2ZNp\phi}{60c}$$

$$Z = \frac{60 \times 150 \times 8}{2 \times 350 \times 4 \times 0,05} \checkmark \checkmark$$

$$= 514,286 = 515 \checkmark$$

$$\begin{aligned} \text{Conductors per Slot} &= \frac{\text{Conductors}}{\text{Slots}} = \frac{515}{110} \checkmark \\ &= 4,682 = 5 \text{ conductors per slot} \checkmark \end{aligned}$$

(5)

2.2 **Given:**

$$I_L = I_{se} = 75 \text{ A}, \quad R_{se} = 0,2 \Omega$$

$$R_{sh} = 210 \Omega, \quad R_a = 0,25 \Omega$$

$$V = 380 \text{ V}, \quad E = 400 \text{ V}$$

$$E = V + I_a R_a + I_{se} R_{se} + I_a R_b$$

$$V_{se} = I_{se} R_{se} = (75)(0,2) = 15 \text{ V} \checkmark \checkmark$$

$$V_{sh} = V - V_{se} = 380 - 15 = 365 \text{ V} \checkmark \checkmark$$

$$I_{sh} = \frac{V}{R_{sh}} = \frac{380}{210} = 1,809 \text{ A} \checkmark$$

$$I_a = I_{sh} + I_{se} = 1,809 + 75 = 76,809 \text{ A} \checkmark \checkmark$$

$$I_a R_b = E - V - I_a R_a - I_{se} R_{se}$$

$$= 400 - 380 - (76,809 \times 0,25) - (75 \times 0,2) \checkmark \checkmark$$

$$= -14,2023 \text{ V} \checkmark$$

(10)

2.3

Given:

$$\begin{aligned} R_{\text{start}} &= ?, & I_{\text{start}} &= 1,5 I_{\text{FL}} \\ V &= 420 \text{ V}, & R_a &= 0,25 \Omega \\ P &= 15 \text{ kW}, \end{aligned}$$

$$I = P/V = 15\,000/420 = 35,714 \text{ A} \checkmark$$

$$\begin{aligned} I_{\text{start}} &= 1,5 I_{\text{FL}} = 1,5 \times 35,714 \\ &= 53,571 \text{ A} \checkmark \end{aligned}$$

$$\begin{aligned} R_T &= V/I_{\text{start}} = 420/53,571 \\ &= 7,840 \Omega \checkmark \end{aligned}$$

$$\begin{aligned} R_{\text{start}} &= R_T - R_a = 7,840 - 0,25 \checkmark \\ &= 7,59 \Omega \checkmark \end{aligned}$$

(5)
[20]

QUESTION 3: AC THEORY

3.1

3.1.1

For coil A:

$$X_{LA} = 2\pi fL = 2\pi \times 50 \times 200 \times 10^{-3} = 62,832 \Omega \checkmark$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 55 \times 10^{-6}} = 57,875 \Omega \checkmark$$

$$Z_A = R + jX_L = 36 + j62,832 = 72,415 \angle 60,819^\circ \checkmark$$

$$Z_{cap} = R - jX_C = 30 - j57,875 = 65,188 \angle -62,6^\circ \checkmark$$

$$Z_A + Z_{cap} = 66 + j4,957 = 66,186 \angle 4,294^\circ \checkmark \checkmark$$

$$Z_p = \frac{Z_A \times Z_{cap}}{Z_A + Z_{cap}} = 71,323 \angle -6,706^\circ \Omega \checkmark \checkmark$$

For coil B:

$$X_{LB} = 2\pi fL = 2\pi \times 50 \times 100 \times 10^{-3} = 31,416 \Omega \checkmark$$

$$Z_B = 20 + j31,416 = 37,242 \angle 57,158^\circ \checkmark$$

$$Z_t = Z_p + Z_b = 90,835 + j23,087 = 93,723 \angle 14,261^\circ \checkmark \checkmark$$

$$I_t = \frac{V_t}{Z_t} = \frac{200 \angle 0^\circ}{93,723 \angle 14,261^\circ} = 2,134 \angle -14,261^\circ \text{ A} \checkmark \checkmark$$

(14)

$$3.1.2 \quad V_{coilA} = I_t Z_p \\ = 2,134 < -14,261 \times 71,323 < -6,706 \checkmark \\ = 152,203 < -20,967^\circ V \checkmark$$

$$V_{coilB} = I_t Z_B \\ = 2,134 < -14,261 \times 37,242 < 57,158 \checkmark \\ = 79,474 < 43,257^\circ V \checkmark \quad (4)$$

$$3.1.3 \quad I_A = \frac{V_p}{Z_b} = 2,102 < -81,156^\circ A \checkmark$$

$$I_{cap} = \frac{V_p}{Z_{cap}} = 2,335 < 41,633^\circ A \checkmark \quad (2)$$

[20]

QUESTION 4: TRANSFORMERS

- 4.1
- Core-type with concentric windings ✓
 - Shell-type with sandwich windings ✓
- (2)

4.2 **Given:**

$$f = 50 \text{ Hz}$$

$$N_1 = 25 \text{ Turns}$$

$$N_2 = 300 \text{ Turns}$$

$$A = 1,8 \text{ m}^2$$

$$E_1 = 230 \text{ V}$$

$$4.2.1 \quad E = 4,44 \phi_m f N \\ 230 = 4,44 \phi_m \times 50 \times 25 \checkmark \\ \phi_m = 0,0414 \text{ Wb} \checkmark$$

$$B_m = \frac{\phi_m}{A} \\ = \frac{0,0414}{1,8} \checkmark \\ = 0,023 \text{ T} \checkmark \quad (4)$$

$$4.2.2 \quad \frac{V_1}{V_2} = \frac{N_1}{N_2} \\ \frac{230}{V_2} = \frac{25}{300} \checkmark \\ V_2 = 2760 \text{ V} \checkmark \quad (2)$$

$$4.2.3 \quad \text{Voltage} / \text{Turn} = \frac{V_1}{N_1} = \frac{230}{25} = 9,2 \text{ v/t} \checkmark \checkmark \quad (2)$$

QUESTION 5: AC MACHINES

- 5.1
- Resistance-start induction motor✓
 - Capacitor-start induction motor✓
 - Capacitor-start capacitor-run induction motor✓
- (3)
- 5.2
- Starting winding:
- Has thinner conductors✓
 - Located on top of the running winding✓
 - Has high resistance and low inductance
- Running winding:
- Has thicker conductors✓
 - Located at the bottom of the slots✓
 - Has low resistance and high inductance
- Any TWO from each winding (2 × 2) (4)
- 5.3
- Refrigerators✓
 - Automatic washing machines✓
 - Compressors✓
 - Pumps
 - Conveyors
- (Any 3 × 1) (3)

[10]

QUESTION 6: GENERATION AND SUPPLY OF THE AC POWER AND MEASURING INSTRUMENTS

- 6.1
- Coal power stations✓ and nuclear power stations✓ (2)
- 6.2
- To reduce transport costs✓
 - To reduce serious traffic problems on the roads✓
 - To keep pollution away from densely populated areas✓
- (3)
- 6.3
- Wattmeter✓ (1)
- 6.4
- Current coil is connected across a shunt resistor✓
 - Voltage coil is connected in series with a multiplier✓
- (2)
- 6.5
- Given:**
- $R_1 = ?$
- $R_2 = 100 \, \Omega$
- $R_3 = 200 \, \Omega$
- $R_4 = 20 \, \Omega$

$$R_1 = \frac{R_3 R_2}{R_4} = \frac{200 \times 100}{20} = 1\,000 \, \Omega \checkmark \checkmark$$

(2)

[10]

TOTAL: