higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

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This marking guideline consists of 8 pages.

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SECTION A

QUESTION 1: GENERAL

1.1	1.1.1	E
	1.1.2	J
	1.1.3	F
	1.1.4	K
	1.1.5	A
	1.1.6	G
	1.1.7	B
	1.1.8	H
	1.1.9	C
	1.1.10	L

(10 × 1) **[10]**

1.2	1.2.1	Atom
	1.2.2	Inversely
	1.2.3	Reduced
	1.2.4	Faraday's laws
	1.2.5	Capacitor
	1.2.6	Downwards
	1.2.7	Increases
	1.2.8	Primary
	1.2.9	Stepping up
	1.2.10	Short shunt

(10 × 1) **[10]**

TOTAL SECTION A: 20

SECTION B

QUESTION 2: PRINCIPLES OF ELECTRICITY

2.1 It is that force which tends to produce an electric current in a circuit. (2)

2.2
- Lines of magnetic flux never intersect.
- Each line of magnetic flux forms a closed loop.
- Lines of magnetic flux are like stretched elastic cords, always trying to shorten themselves.
- Lines of magnetic flux which are parallel and going in the same direction repel one another.
- The direction of a line of magnetic flux at any point in a nonmagnetic medium, such as air, is that of the north-seeking pole of a compass needle placed at that point. (5)

2.3 Given:

$R_1 = 6\Omega$
$R_2 = 4\Omega$
$R_3 = 10\Omega$
$R_5 = 5\Omega$
$E = 25V$
$r = 0,25\Omega$

$$R_T = \frac{\left[(R_1 + R_2)x(R_3 + R_4)\right]}{\left[(R_1 + R_2) + (R_3 + R_4)\right]}$$
$$= \frac{\left[(6+4)x(10+5)\right]}{\left[(6+4)+(10+5)\right]} \checkmark$$
$$= 6\Omega \checkmark$$

$$E = I(R_T + r)$$
$$25 = I(6 + 0,25)$$
$$I = 4A \checkmark$$

$$V_P = IR_P = 4x6 = 24V \checkmark$$

$$I_{R_1} = \frac{V_P}{(R_1 + R_2)} = \frac{24}{10} = 2,4A$$
$$I_{R_2} = I_{R_1} = 2,4A \checkmark$$

$$V_{R_1} = I_{R_1}R_1 = 2,4x6 = 14,4V \checkmark$$
$$V_{R_2} = I_{R_2}R_2 = 2,4x4 = 9,6V \checkmark$$

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$$I_{R_3} = \frac{V_P}{(R_3 + R_4)} = \frac{24}{15} = 1,6A$$
$$I_{R_4} = I_{R_3} = 1,6A \checkmark$$

$$V_{R_3} = I_{R_3} R_3 = 1,6x10 = 16V \checkmark$$
$$V_{R_4} = I_{R_4} R_4 = 1,6x5 = 8V \checkmark$$ (10)

2.4 Given:

$$R_1 = 40\Omega$$
$$t_1 = 10^0 C$$
$$R_2 = 48,25\Omega$$
$$t_2 = 60^0 C$$
$$\alpha_0 = ?$$

$$\frac{R_1}{R_2} = \frac{1+\alpha_0 t_1}{1+\alpha_0 t_2}$$
$$R_2(1+\alpha_0 t_1) = R_1(1+\alpha_0 t_2)$$
$$R_2 + R_2\alpha_0 t_1 = R_1 + R_1\alpha_0 t_2$$
$$R_2\alpha_0 t_1 - R_1\alpha_0 t_2 = R_1 - R_2$$
$$\alpha_0(R_2 t_1 - R_1 t_2) = R_1 - R_2$$

$$\alpha_0 = \frac{R_1 - R_2}{(R_2 t_1 - R_1 t_2)} \checkmark$$
$$\alpha_0 = \frac{(40 - 48,25)}{\left[(48,25x10) - (40x60)\right]} \checkmark$$
$$= 0,0043 /^0 Cat 0^0 C \checkmark$$ (3)

[20]

QUESTION 3: DC MACHINES

3.1 3.1.1 A shunt connected machine has its field coils connected in parallel with the armature.

3.1.2 A series connected machine has its field coils connected in series with the armature.

3.1.3 A compound connected machine is a combination of a shunt and a series machine.

(3 × 2) (6)

3.2
- The field coils may be connected incorrectly.
- The iron core of the pole pieces may have lost their residual magnetism.
- Brushes may be jammed in their holders, the brushes or the commutator may be dirty, there may be an open or short-circuited field circuit or loose brush connections. (3)

3.3 Given:

$E_1 = 100V$

$\phi_1 = 0,020Wb$

$N_1 = 800r/m$

3.3.1 $\phi_2 = 0,020Wb$

$N_2 = 1000r/m$

$$\frac{E_1}{E_2} = \frac{N_1\phi_1}{N_2\phi_2}$$

$$\frac{100}{E_2} = \frac{800x0,020}{100x0,020}$$ ✓✓

$E_2 = 125V$ ✓

3.3.2 $\phi_2 = 0,024Wb$

$N_2 = 900r/m$

$$\frac{E_1}{E_2} = \frac{N_1\phi_1}{N_2\phi_2}$$

$$\frac{100}{E_2} = \frac{800x0,020}{900x0,024}$$ ✓✓

$E_2 = 135V$ ✓

(2 × 3) (6)

3.4 Given:

$I_L = 60A$

$R_a = 0,1\Omega$

$R_{se} = 0,025\Omega$

$R_{sh} = 60\Omega$

$E = 248V$

$V = ?$

$$I_{sh} = \frac{V}{R_{sh}} = \frac{V}{60}$$

$I_a = I_L + I_{sh}$

$$\therefore I_a = 60 + \frac{V}{60}$$

$E = V + I_aR_a + I_aR_{se}$

$V = E - I_aR_a - I_aR_{se}$

$$V = 248 - \left[\left(60 + \frac{V}{60}\right)(0,1)\right] - \left[\left(60 + \frac{V}{60}\right)(0,025)\right]$$ ✓✓

$V = 248 - (6 + 0,00166V) - (1,5 + 0,0004166V)$ ✓

$V = 240,5 - 0,002077V$ ✓

$V = 240V$ ✓

(5)
[20]

QUESTION 4: AC THEORY

4.1 4.1.1 It is the value that has the same heating effect as a direct current of the same value.

4.1.2 It is the average of the instantaneous values over a half-cycle.

(2 × 2) (4)

4.2
- There are losses in the transmission lines.
- The power factor decreases when the kVA increases.
- Larger cables are required to carry a larger current.
- Switches, switchgear, transformers and instruments must be capable of operating under large currents. (4)

4.3 Given:
l = 0,40 m
b = 0,20 m
N = 1 000 turns
B = 0,015 Wb/m²
n = 10 r/s

$e = E_m \sin\theta$
$e = 2\pi BANn \sin 2\pi ft$
$e = 2\pi x0,015x(0,4x0,2)x1000x10x\sin 2\pi ft$ ✓✓
$e = 75,4\sin 6,3ft$ ✓

(3)

4.4 Given:
$f = 50Hz$
$V_{rms} = 200V$
$V_{inst} = 141,4V$

$V_{\max} = \frac{V_{rms}}{0,707} = \frac{200}{0,707} = 282,9V$ ✓

$V = V_{\max} \sin 2\pi ftx57,3$
$141,4 = 282,9\sin 2\pi x50x57,3t$ ✓
$0,5 = \sin 18001t$
$t = \frac{\sin^{-1} 0,5}{18001}$ ✓
$t = 0,00167s = 1,67mS$ ✓

(4)
[15]

QUESTION 5: AC MACHINES

5.1 Given:

$V_1 = 240V$

$f = 50Hz$

$\phi_m = 0,003Wb$

$V_2 = 50V$

$E_1 = 4,44\phi_m fN_1$

$240 = 4,44x0,003x50N_1$ ✓✓

$N_1 = 360turns$ ✓

$\frac{N_1}{N_2} = \frac{V_1}{V_2}$

$\frac{360}{N_2} = \frac{240}{50}$ ✓

$N_2 = 75turns$ ✓

For Primary:

$\frac{V_1}{N_1} = \frac{240}{360} = 0,667V / turn$ ✓

For Secondary:

$\frac{V_2}{N_2} = \frac{50}{75} = 0,667V / turn$ ✓ (7)

5.2 5.2.1

- They are less efficient.
- They are not self-starting.
- They are more expensive.
- Their physical size is bigger.
- They have a lower starting torque. (Any relevant answer) (4 × 1) (4)

5.2.2

- They are cheaper.
- They are self-starting.
- They are more efficient.
- Their physical size is smaller.
- They have a higher starting torque.

(Any relevant answer) (4 × 1) (4)

[15]

QUESTION 6: MEASURING INSTRUMENTS

6.1 Given:

$I = 10A$

$R_v = 5\Omega$

$V = 220x10^{-3}V$

6.1.1 $V = I_x R_x$

$V = (I - I_v)R_x$

$220x10^{-3} = (10 - 0)R_x$ ✓

$R_x = 0,022\Omega$ ✓ (2)

6.1.2 $I_v = \frac{V}{R} = \frac{220x10^{-3}}{5} = 0,0441A$ ✓

$V = I_x R_x$

$V = (I - I_v)R_x$

$0,22 = (10 - 0,044)R_x$ ✓

$R_x = 0,02209\Omega$ ✓ (3)

6.2 $\%Error = \frac{R_x - R_{app}}{R_x}$

$= \frac{R_x - \frac{V}{I}}{R_x}$

$= \frac{0,02209 - \frac{0,22}{10}}{0,02209}$ ✓✓

$= 0,44\%$ ✓ (3)

6.3 Given:

R_1 = ?

R_2 = 77,6 Ω

R_3 = 1 000 Ω

R_4 = 100 Ω

$\frac{R_1}{R_2} = \frac{R_3}{R_4}$

$\frac{R_1}{77,6} = \frac{1000}{100}$ ✓

$R_1 = 776\Omega$ ✓ (2)

[10]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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