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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QUESTION 1

1.1
1.1.1 C
1.1.2 B
1.1.3 D
1.1.4 A
1.1.5 D
1.1.6 C
1.1.7 A
1.1.8 A
1.1.9 B
1.1.10 A

(10 × 1) **[10]**

QUESTION 2

2.1

$R_1 = 8\Omega$
$R_2 = 5\Omega$
$R_3 = 20\Omega$
$E = 24v$
$r = 0,12\Omega$

$V_1 = ?$
$V_2 = ?$
$V_3 = ?$

$$R_{external} = \frac{(13x20)}{(13+20)} = 7,8787\Omega \checkmark$$

$$I_T = \frac{E}{R+r} = \frac{24}{7,879+0,12} = 3A \checkmark$$

$$E = V + V_{drop}$$
$$24 = V + Ir$$
$$24 = V + (3x0,12) \quad \checkmark$$
$$V = 23,64v$$

$$I_1 = \frac{V}{R} = \frac{23,64}{13} = 1,818A \checkmark$$

$$I_2 = \frac{V}{R} = \frac{23,64}{20} = 1,182A \checkmark$$

$V_8 = I_1R_1 = 1,818x8 = 14,548v \checkmark$
$V_5 = I_1R_2 = 1,818x5 = 9,0923v \checkmark$
$V_{20} = I_1R_3 = 1,182x20 = 23,64v \checkmark$

(8)

2.2 $C_u L = 16m$
$d = 1mm$
$I = 10A$

$\rho_{cu} = 0,017\mu\Omega m = 0,017x10^{-6}\mu\Omega$
$\rho_{al} = 0,0289\mu\Omega m = 0,0289x10^{-6}\mu\Omega$

$$R_{cu} = \rho\frac{L}{A} = \frac{(0,017x10^{-6}x16)}{0,78539x10^{-6}} = 0,346\Omega \checkmark$$

$$A = \frac{\pi d^2}{4} = \frac{\pi(1)^2}{4} = 0,785mm^2 = 0,785x10^{-6}m^2 \checkmark$$

$$V_P = IR = 10x0,346 = 3,463v \checkmark$$

$$R_{al} = \frac{V_P}{I} = \frac{3,463}{15} = 0,231\Omega \checkmark$$

$$A = \rho\frac{L}{R} = \frac{(0,02289x10^{-6}x16)}{0,231} = 2,00276x10^{-6}m^2 = 2mm^2 \checkmark\checkmark$$

$$A = \frac{\pi d^2}{4}$$
$$d^2 = \frac{4A}{\pi} = \frac{4(2)}{\pi} = 2,55 \quad \checkmark$$

$$d = \sqrt{2,55} = 1,597mm \checkmark$$

(8)

2.3 N = 1200 windings
I = 2A
S = 14 000 A/Wb
$\phi = ?$

$$\phi = \frac{mmf}{S}$$ but mmf = NI

$$\phi = \frac{NI}{S}$$

$$= \frac{1200x2}{14000} \checkmark$$

= 0,1714 Wb✓

(2)
[18]

QUESTION 3

3.1 $N = 350$

$\phi = 4,8mWb = 4,8x10^{-3}Wb$

$I = 8$

$L = ?$

$E = ?$

$t = 0,02Sec$

$$L = \frac{\phi N}{I} = \frac{(4,8x10^{-3}x350)}{8} = 0,21H \checkmark\checkmark$$

$$E = \frac{LI}{t} = \frac{(0,21x8)}{0,02} = 84V \checkmark\checkmark$$ (4)

3.2 $E_1 = 48v$ $E_2 = 36\Omega$

$r_1 = 0,2\Omega$ $r_2 = 0,5\Omega$

$R = 20\Omega$ $R = 20\Omega$

In loop ACDFA:

$\sum E = \sum IR$

$48 = 20(I_1 + I_2) + 0,2(I_1)$ ✓✓

$48 = 20I_1 + 20I_2 + 0,2I_1$

$48 = 20,2I_1 + 20I_2 .....(1)$

In loop BCDEB:

$\sum E = \sum IR$

$36 = 20(I_1 + I_2) + 0,5(I_1)$ ✓✓

$36 = 20I_1 + 20I_2 + 0,5I_1$

$36 = 20,5I_1 + 20I_2 .....(2)$

(1) x 20,5:

$984 = 414,1I_1 + 410I_2 .....(3)$ ✓

(2) x 20:

$720 = 400I_1 + 410I_2 .....(4)$ ✓

(3) – (4):

$264 = 14,1I_1$ ✓

$I_1 = 18,723A$

Substitute I_1 into (2):

$$36 = 20(18,723) + 20,5I_2 \checkmark$$
$$I_2 + -16,51A$$

Current through battery = $I_2 = -16,51A$
The negative indicates charge current.

Current through generator = $I_1 = 18,723A$

Potential difference:

(PD) = I x R
$$= (I_1 + I_2)(20)$$
$$= (2,212)(20) \checkmark\checkmark$$
$$= 44,247V$$ (10)

3.3
- Overcompounded
- Level compounded
- Undercompounded
- Differentially compounded (Any 2 × 1) (2)

3.4 The direction of the induced EMF is such that it works against (opposes) the applied voltage by which it is created. (2)
[18]

QUESTION 4

4.1 DC machines are named according to the method used to connect the field coils.

- Separately excited:✓ DC supply to the field coils is completely separate from the connections to the armature.✓
- Self excited may be subdivided into 3, namely:

(i) Series connected:✓ Field windings connected in series with the armature so that both must carry the same current.✓

(ii) Shunt connected:✓ Field coils connected in parallel with the armature so the field and armature must operate with the same voltage ✓

(iii) Compound connected:✓ Two sets of field coils; one set is connected in parallel with the armature and the other set in series. They may be connected in short-shunt or long-shunt.✓

(8)

4.2
- By using interpoles
- By means of compensating windings placed in the pole shoes
- Brush shifting. By moving the brushes forward in a generator or backwards in a motor. (3)

4.3 Holding the field windings in place✓ and increasing the cross-sectional area.✓ (2)

4.4
- Air
- Mica
- Paper
- Ceramic
- Electrolytic
- Polycarbonate (Any 5 × 1) (5)

[18]

QUESTION 5

5.1

$$i_1 = 60\sin(wt + \frac{\pi}{4})$$

$$i_2 = 45\sin(wt - \frac{\pi}{6})$$

$$i_1 = 60\sin(wt + \frac{\pi}{4}) = 60\angle 45^0 = 42,426 + j42,426 \checkmark\checkmark$$

$$i_2 = 45\sin(wt - \frac{\pi}{6}) = 45\angle -30^0 = 38,971 - j22,5 \checkmark\checkmark$$

$$i_T = i_1 + i_2 = 81,397 + j19,926 = 83,8\angle 13,76^0 \checkmark\checkmark\checkmark$$

$$I_{rms} = 0,707 I_{\max} = 0,707x83,8 = 59,25A \checkmark$$

$$I_{ave} = 0,637 I_{\max} = 0,637x83,8 = 53,38A \checkmark$$

(9)

5.2

$$Z_1 = 5 + j3$$

$$Z_2 = 2 - j7$$

5.2.1

$$Z_1 = 5 + j3 = 5,83\angle 31^0 \checkmark$$

$$Z_2 = 2 - j7 = 2,828\angle -45^0 \checkmark$$

$$Z_T = Z_1 + Z_2 = 7 - j4 = 8,062\angle -29,7^0 \checkmark$$

$$I_T = \frac{V_T}{Z_1} = \frac{230\angle 0°}{8,062\angle -45^\circ} = 28,53\angle 29,7° \checkmark\checkmark$$

(5)

5.2.2 $I_1 = \frac{V}{Z_1} = \frac{230\angle 0°}{5,83\angle 31°} = 39,6\angle -31° \checkmark\checkmark$

$I_2 = \frac{V}{Z_2} = \frac{230\angle 0°}{2,828\angle -45°} = 81,33\angle 45° \checkmark\checkmark$

(4)
[18]

QUESTION 6

6.1 $S = 4,4kVA$
$f = 50Hz$
$V_1 = E_1 = 440V$
$V_2 = E_2 = 120V$
$N_2 = 48$

6.1.1 $\frac{V_1}{V_2} = \frac{N_1}{N_2}$ ✓✓

$N_1 = \frac{48x440}{120} = 176$

6.1.2 $VA = I_1V_1$ $VA = I_2V_2$

$4400 = I_1x440$ ✓ $4400 = I_2x120$ ✓

$I_1 = 10A$ $I_2 = 36,67A$

6.1.3 $E_1 = 4,44\phi_m fN_1$
$E_2 = 4,44\phi_m fN_2$
$120 = (4,44)(\phi_m)(50)(48)$ ✓
$\phi_m = 0,01126Wb = 11,26mWb$ ✓

(3 × 2) (6)

6.2 I = 12 A
V = 225 V
f = 50 Hz
θ = 36º

6.2.1 P_{in} = VI Cos θ
= (225)(12) Cos 36º✓
= 2184 W✓

6.2.2 I = ?
Cos θ = 0,97

P = VI Cos θ
2184 = I (225)(0,97) ✓
I = 10,008 A✓

(2 × 2) (4)

6.3 $R_m = 240\Omega$
$I_m = 50mA = 0,05A$
$I_T = 25A$

$V_m = I_m R_m = (0,05)(240) = 12V$ ✓

$I_T = I_m + I_s$
$25 = 0,05 + I_s$ ✓
$I_s = 24,95A$

$R_s = \frac{V_s}{I_s} = \frac{V_m}{I_s} = \frac{12}{24,95} = 0,481\Omega$ ✓

(3)

6.4
- The single-phase induction motor is similar in construction to the three-phase squirrel cage motor, but the field produced by the stator current, instead of rotating, is fixed in space, its magnitude changing sinusoidally.✓✓
- Such a field is equivalent to two fields of equal magnitude rotating in opposite directions at equal speeds, each being half the maximum value of the alternating field. The single-phase motor is therefore not self-starting.✓✓✓

(5)
[18]

TOTAL: 100

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