higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

15 November 2022

This marking guideline consists of 8 pages.

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SECTION A

QUESTION 1: MATERIAL, COMPONENTS AND INTERPRETATION OF DRAWINGS

1.1	1.1.1	False	
	1.1.2	True	
	1.1.3	True	
	1.1.4	True	
	1.1.5	False	
	1.1.6	True	
	1.1.7	False	
	1.1.8	True	
	1.1.9	False	
	1.1.10	False	
		(10 × 1)	(10)
1.2	1.2.1	Nucleus	
	1.2.2	Positive	
	1.2.3	Opposite	
	1.2.4	Lenz's law	
	1.2.5	Directly proportional	
	1.2.6	Yoke	
	1.2.7	Downwards	
	1.2.8	Parallel	
	1.2.9	Series	
	1.2.10	Short-circuited	
		(10 × 1)	(10)
			[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2: PRINCIPLES OF ELECTRICITY

2.1
- They heat up transformers.
- They create a loss in the circuit.
- The power factor deteriorates.
- They are called Eddy currents. (4)

2.2
- Hard magnet material:✓
  It will retain their magnetism and become permanent magnets, used in meters and telephone receivers.✓
- Soft magnetic material:✓
  Lose magnetism quickly (temporary), used in generators and motors.✓ (4)

2.3 2.3.1 $R_T = R_1 + R_2 + R_3$ ✓✓

2.3.2 $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ ✓✓

(2 × 2) (4)

2.4 Positive temperature-coefficient of resistance:
When an increase in the temperature of a material causes the resistance of the material to rise.✓✓ (2)

2.5 Given:
R_1 = 160 Ω, V = 75 V
R_2 = 15 Ω, I_T = 2,5 A
R_x = ?

2.5.1 $R_{//} = \frac{(R_1 + R_2)}{(R_1 + R_2)} = \frac{(160x15)}{(160x15)} = 13,714\Omega$ ✓

$V_1 = I_T R_{//} = 2,5x13,714 = 34,285V$ ✓

$V_2 = V_T - V_1 = 75 - 34,285 = 40,715V$ ✓

$R_x = \frac{V_2}{I_x} = \frac{40,715}{2,5} = 16,286\Omega$ ✓ **BUT** $I_T = I_x = I_1 + I_2 = 2,5A$ (4)

2.5.2 $R_T = R_{//} + R_x = 13,714 + 16,286 = 30\Omega$ (1)

2.5.3 $P = V_T I_T = 75x2,5 = 187,5W$ ✓ **OR** P = I²R = 2,5² × 30 = 187,5 W (1)

[20]

QUESTION 3: DIRECT-CURRENT (DC) MACHINES

3.1 The function of a pole core is to strengthen the magnetic field. (1)

3.2
- Separately-excited
- Self-excited (2)

3.3
- Shunt connected
- Series connected
- Compound connected (3)

3.4
- It is to reduce the high starting current.
- To reduce the high starting current to an acceptable value. (2)

3.5 3.5.1 A high-voltage low-current DC machine: Wave winding

3.5.2 A high-current low-voltage DC machine: Lap winding

(2 × 1) (2)

3.6 Given:

I_L = 210 A
R_{SH} = 60 Ω
R_a = 0,2 Ω
R_{se} = 0,07 Ω
E = ?
V = 240 V

$$I_{SH} = \frac{V + I_L R_{SE}}{R_{SH}}$$
$$= \frac{240 + (210x0,07)}{60} \checkmark$$
$$= 4,245A \checkmark$$

$$I_a = I_L + I_{SH}$$
= 210 + 4,245 = 214,245 A✓

$$E = V + I_a R_a + I_L R_{se}$$
= 240 + (214,245 × 0,2) + (210 × 0,07)✓
= 297,549 V✓ (5)

3.7 Given:

p = 3
c = 2 × 3 = 8
N = 300 r/p
E = 250 V
Φ = 0,07 Wb
No. of Slots = 115 slots
No. of Conductors per Slots =?

$$E = \frac{2ZNp\phi}{60c}$$
$$Z = \frac{E60c}{2Np\phi}$$
$$Z = \frac{250x60x6}{2x300x3x0,07} \checkmark\checkmark$$
$$Z = 714,286 = 714 \checkmark$$

$$Conductors / slot = \frac{Conductors}{Slots} = \frac{714}{115} = 6,209 \checkmark$$
= 6 conductors per slot ✓ (5)

[20]

QUESTION 4: ALTERNATING-CURRENT (AC) THEORY

4.1 AC series circuits:

4.1.1 Consider X_L to be greater than Xc:
- V_L will be greater than Vc, since VL and Vc are in direct opposition,
- The resultant will be (V_L - Vc),
- The overall power factor (cos Φ) will be lagging.

(Any 2 × 1)

4.1.2 Consider Xc to be greater than X_L:
- Vc will therefore be greater than V_L,
- The resultant will be (Vc - V_L),
- The overall power factor (Cos Φ) will be leading. (Any 2 × 1)

(2 × 2) (4)

4.2 AC parallel circuits:

4.2.1 Consider X_L to be greater than Xc:
- I_L will be smaller than Ic, since Ic and I_L are in direct opposition,
- The resultant will be (Ic – I_L),
- The overall power factor (Cos Φ) will be leading. (Any 2 × 1)

4.2.2 Consider Xc to be greater than X_L:
- Ic will therefore be smaller than I_L,
- The resultant will be (I_L – Ic),
- Then the overall power factor (Cos Φ) will be lagging.

(Any 2 × 1)
(2 × 2) (4)

4.3 Methods to improve poor power factor:
- Use capacitor banks
- Use synchronous motors (2)

4.4 Instantaneous values:
$i = 45 \sin 314t$
$i = Im \sin 2\pi ft$

4.4.1 $I_{RMS} = 0,707 \times Im = 0,707 \times 45 = 31,815$ A (1)

4.4.2 $2\pi f = 314$
$f = 50$ Hz (1)

4.4.3 i = ?
t = 1,2 milli sec = 0,0012 sec

i = 45 sin 314t (180/π)
= 45 sin 314 (0,0012)(180/π)✓
= 45 sin 22º✓
= 16,857 A✓ (3)
[15]

QUESTION 5: ALTERNATING CURRENT (AC) MACHINES

5.1
- Their efficiency at full load is in the order of 97%.
- They have no moving parts, their operation is silent.
- Since they have no rotating parts or bearings, they require little care and maintenance. (3)

5.2
- The magnetic circuit
- The windings
- The oil tanks
- The protection device
- The cooling system (5)

5.3
- Refrigerators
- Automatic washing machines
- Compressors (3)

5.4 To reverse the direction of rotation, the connection to either the starting winding or the running winding must be reversed, but not both.✓✓ (2)

5.5
- In order to supply the huge water pressures required for hydro power station.
- Water also cools the power stations. (2)
[15]

QUESTION 6: MEASURING INSTRUMENTS

6.1 SHORT SHUNT:

Given:

$R_v = 1000\Omega = R_m$

$R_A = 0,3\Omega$

$V = 15V$

$I = 0,07A$

$$R_{app} = \frac{V}{I} = \frac{15}{0,07} = 214,286\Omega \checkmark$$

$$I_v = \frac{V}{R_v} = \frac{15}{1000} = 0,015A \checkmark$$

$$R_x = \frac{V}{I - I_v} = \frac{15}{(0,07 - 0,015)} = 272,72\Omega \checkmark$$

$$\%Error = \frac{R_x - R_{app}}{R_x} X100\%$$

$$= \frac{272,72 - 214,286}{272,72} X100\% \checkmark$$

$$= 21\% \checkmark$$

LONG SHUNT:

Given:

$R_v = 1000\Omega = R_m$

$R_A = 0,3\Omega$

$V = 6V$

$I = 2A$

$$R_{app} = \frac{V}{I} = \frac{6}{2} = 3\Omega \checkmark$$

$$R_x = \frac{V}{I} - R_A = \frac{6}{2} - 0,3 = 2,7\Omega \checkmark$$

$$\%Error = \frac{R_x - R_{app}}{R_x} X100\%$$

$$= \frac{2,7 - 3}{2,7} X100\% \checkmark$$

$$= -15\% \checkmark$$

(9)

6.2 The minus sign simply indicates that the apparent resistance calculated was too high. (1)

[10]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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