higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

21 November 2023

This marking guideline consists of 9 pages.

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QUESTION 1

1.1

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

(10 × 1) (10)

1.2 Given:

Aluminium	**Copper**
$\rho = 0,028x10^{-6}\Omega m$	$\rho = 0,017x10^{-6}\Omega m$
$d = 1mm$	$d = ?$
$l = 7,5m$	$l = 6m$
$I = 3A$	$I = 2A$
$I_T = 5A$	

$$R_{al} = \frac{(\rho l)_{al}}{A_{al}} = \frac{0,028x10^{-6}x7,5}{\left[\frac{\pi(1x10^{-3})^2}{4}\right]} = 0,267\Omega \checkmark\checkmark$$

$$V_P = I_{al}xR_{al} = 3x0,267 = 0,801V \checkmark\checkmark$$

$$R_{cu} = \frac{V_P}{I_{cu}} = \frac{0,801}{2} = 0,4005\Omega \checkmark\checkmark$$

$$A_{cu} = \frac{(\rho l)_{cu}}{R_{cu}} = \frac{0,017x10^{-6}x6}{0,4005} = 2,547x10^{-7}m^2 \checkmark\checkmark$$

$$d = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{(4x2,547x10^{-7})}{\pi}} = 0,000569m \checkmark\checkmark$$

(10)

1.3 For loop ABEFA:

$\sum V = 0$

$(15-12)-[I_1+0,2(I_1-I_2)]=0$

$3-[I_1+0,2I_1-0,2I_2]=0$ ✓✓

$3-1,2I_1+0,2I_2=0$

$1,2I_1-0,2I_2=3$.....(1)

For loop ACDFA:

$\sum V = 0$

$(15-9)-(I_1+0,2I_2)=0$ ✓✓

$6-(I_1+0,2I_2)=0$

$I_1+0,2I_2=6$.....(2)

Equation 1 + Equation 2:

$1,2I_1-0,2I_2=3$

$I_1+0,2I_2=6$ ✓✓

$2,2I_1=9$

$I_1=4,090A$

Substitute I_1 in Equation 2:

$I_1+0,2I_2=6$

$4,09+0,2I_2=6$ ✓✓

$0,2I_2=1,91$

$I_2=9,55A$

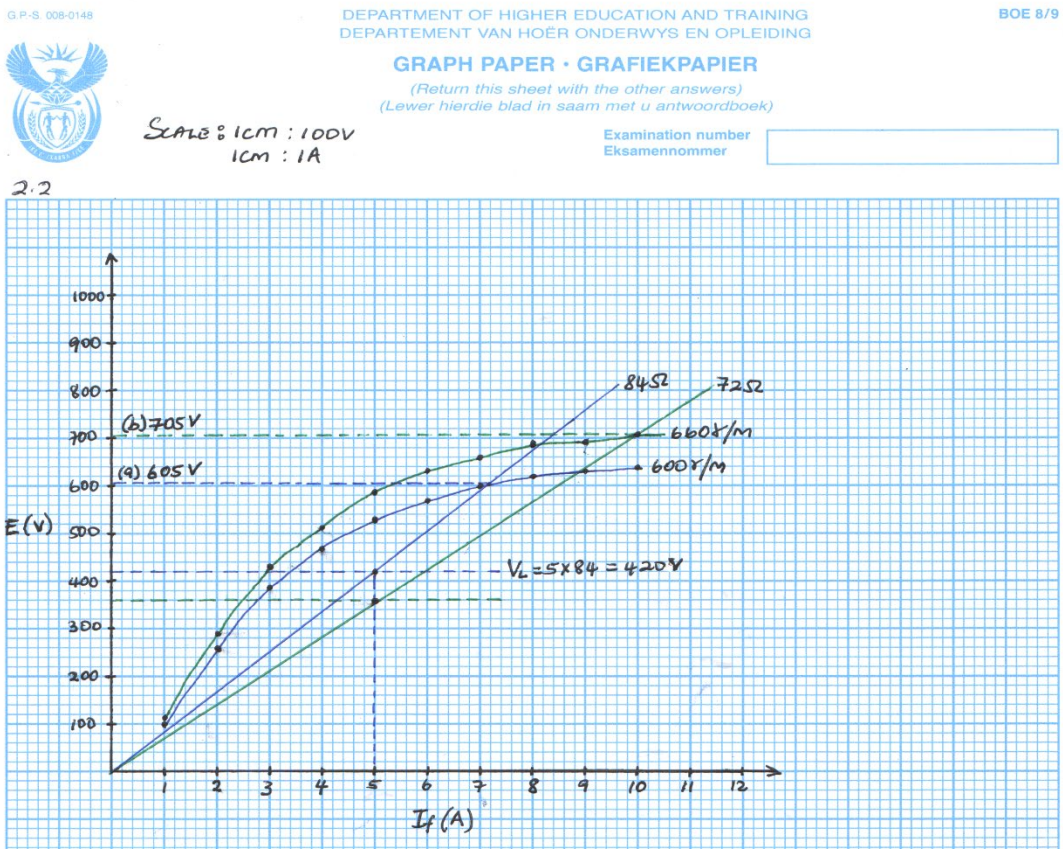
$I_1-I_2=4,090-9,55=-5,46A$ ✓✓

(10)
[30]

QUESTION 2

2.1 A – Interpole
B – Pole core
C – Shaft
D – Field windings
E – Commutator
F – Armature conductors
G – Pole shoe
H – Frame/Yoke (8)

2.2



2.2.1 $Voltage\ is\ \pm 605\ V$
Cartesian plane✓✓
Plotting curve✓
Straight line✓
Reading voltage from point of intersection✓✓ (6)

2.2.2

I (A)	1	2	3	4	5	6	7	8	9	10
E_2 (V)	110	286	429	517	583	627	660	682	693	704

$\therefore Voltage\ is\ \pm 705\ V$
E_2 values✓✓
Plotting curve✓
Straight line✓
Reading voltage from point of intersection✓✓ (6)
[20]

QUESTION 3

3.1 Given:

$$n = \frac{3000}{60} r.p.s$$

$$V_{max} = 25\sqrt{2}V$$

V = 20 V

3.1.1 $$f = \frac{N}{60} = \frac{3000}{60} = 50Hz \checkmark$$ (1)

3.1.2 $$V = V_m \sin \omega t$$

$$= 25\sqrt{2}\sin(2\pi x50xx0,004x57,3) \checkmark$$

$$= 33,6V \checkmark$$ (2)

3.1.3 $$V = V_m \sin \omega t$$

$$20 = 25\sqrt{2}\sin(2\pi x50x57,3t) \checkmark$$

$$\frac{20}{25\sqrt{2}} = \sin 18001t \checkmark$$

$$0,566 = \sin 18001t$$

$$18001t = \sin^{-1} 0,566 \checkmark$$

$$t = \frac{\sin^{-1} 0,566}{18001} \checkmark$$

$$t = 0,0019 \sec \checkmark$$

$$t = 1,9m \sec$$ (5)

3.2 Diagram representing AC and voltage of the same frequency as vectors or phasors with the phase angle between them (2)

3.3 Given:
R = 20 Ω
L = 51 mH
C = 318 µF
V = 220 V
f = 50 Hz

3.3.1 XL = 2πfL = 2π(50)(51) = 16,022 Ω✓

Xc = 1/2πfC = 1/2π(50)(318x10^{-6}) = 10 Ω✓ (2)

3.3.2 $Z^2 = R^2 + (X_L - Xc)^2 = (20)^2 + (6)^2 = 20,88\ \Omega$✓✓

$I = V/Z = 220/20,88 = 10,536\ A$✓

$V_R = IR = 10,536 \times 20 = 210,72\ V$✓

$V_L = IX_L = 10,536 \times 16 = 168,58\ V$✓

$V_{coil} = (V_R)^2 + (V_L)^2 = (211)^2 + (169)^2 = 270\ V$✓✓ (7)

3.3.3 $Vc = Ic\ Xc$
$= 10,536 \times 10$
$= 105,536\ V$✓ (1)
[20]

QUESTION 4

4.1 Data:
$I_o = 2,5\ A$
$Cos\ \emptyset_o = 0,3\ lagging$

4.1.1 $Cos\ \emptyset_o = 0,3$
$\therefore \emptyset_o = 72,542^0$✓ (1)

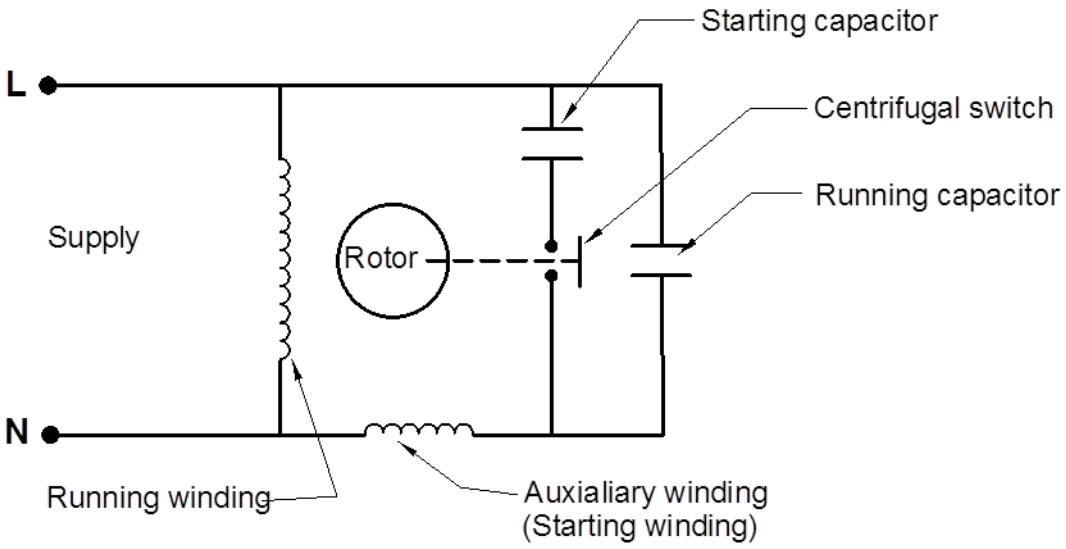
4.1.2 $I_m = I_o Sin\ \emptyset_o = (2,5)(\sin 72,542^0) = 2,385\ A$✓✓ (2)

4.1.3 $I_c = I_o Cos\ \emptyset_o = (2,5)(0,3) = 0,75\ A$✓✓ (2)

4.2 A – Transformer tank
B – Breather
C – Conservator/Expansion tank
D – Buchholz relay
E – Cooling fins/Radiator tubes (5)
[10]

QUESTION 5

5.1



(Any 5 × 1) (5)

5.2
- Very expensive
- Less efficient
- Bigger in size
- More maintenance required
- Have complicated design
- Self-starting
- Limited starting and operating torque

(Any 2 × 1) (2)

5.3 In order to reverse the direction of rotation, reverse the connection to either the starting winding✓ or the running winding,✓ but not both.✓ (3)

[10]

QUESTION 6

6.1
- Solar power station
- Gas turbine power station
- Wind turbine power station (3)

6.2
- It reduces the size (diameter) of the conductors required.
- They can span much greater distances between pylons. (2)

6.3 Wattmeter (1)

6.4 Given:
Rm = 30 Ω
Im = 50 mA = 0,05 A
Vm = ImRm = (0,05)(30) = 0,15 V

6.4.1 Where I_T = 5 A:
$I_T = I_M + I_S$
5 = 0,05 + Is
Is = 4,95 A ✓

Rs = Vs/Is = Vm/Is
= 0,15/4,95
= 0,030 Ω or 30,3 mΩ✓

6.4.2 Where V_T = 50 V:
V_T = Vm + Vser
50 = 0,15 + Vser
Vser = 49,85 V✓

$$R_{ser} = \frac{V_{ser}}{I_{ser}} = \frac{V_{ser}}{I_M}$$
= 49,85/0,05
= 997 Ω✓

(2 × 2) (4)
[10]

TOTAL: 100

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