higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

ELECTROTECHNICS N4

12 APRIL 2016

This marking guideline consists of 8 pages.

QUESTION 1

1.1 1.1.1 $C_S = \frac{1}{\frac{1}{12}+\frac{1}{6}} = 4\mu F$ ✓✓ (2)

1.1.2 $Q_T = Q_1 = Q_2 = VC$ =20 x 4 μF = <u>80 μC</u> ✓✓
V = Q/C = 80/12 & 80/6
= 6,67 V ✓ & 13,33 V ✓ (4)

1.2 Eddy currents ✓ They heat up the core ✓ and is a waste of energy ✓ (3)

1.3 1.3.1 $I_a = I_T - I_C$
$= 300 - 100$ ✓
$= 200A$

$A_a = \frac{\pi d_a^2}{4} = \frac{\pi(5x10^{-3})^2}{4} = 1,963495408x10^{-5} m^2$ ✓✓

$R_a = \frac{P_a x L_a}{A_a}$ but

$= \frac{0,028x10^{-6} x1\,500}{1,963495408x10^{-5}}$ ✓

$= 2,139042435\ \Omega$ (4)

1.3.2 ✓ $d = \sqrt{\frac{4P_cL_c}{\pi R_C}} = \sqrt{\frac{4x0,018x10^{-6} x1\,500}{\pi(4,27808487)}} = 2,835\ mm$ ✓

$Va = IaRa$
$= 200x2,1390424352 = 427,808487\ V$ ✓

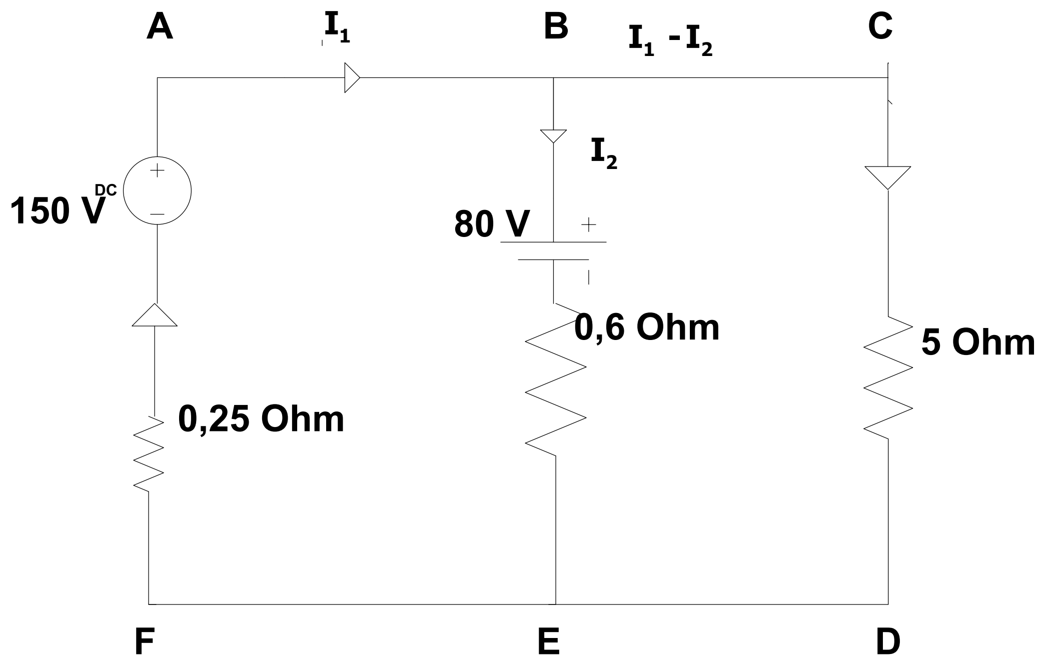
$R_C = \frac{V_C}{I_C} = \frac{427,8084870}{100} = 4,27808487\ \Omega$ ✓ (4)

1.4 $R_t = R_{30}[1 + \alpha_{30}(t - 40°)]$
$= 500[1 + 0,004(60° - 40°)]$
$= 500[1 + 0,004(20)]$ ✓✓✓
$= 540\ \Omega$
$= 540 - 500 = 40\ \Omega$ (3)

[20]

QUESTION 2

2.1



Consider loop: ABEFA

$\sum E - \sum IR = 0$

$(E_1 - E_2) - (I_1R_1 - I_2R_2) = 0$

$\mathbf{(E_1 - E_2) - (I_1R_1 - I_2R_2) = 0}$

$\mathbf{(150 - 80) - (0{,}25I_1 - 0{,}6I_2) = 0}$ ✓

$\mathbf{70 - 0{,}25I_1 + 0{,}6I_2 = 0 \ldots\ldots\ldots(1)}$

:loop:ACDFA

$\sum E - \sum IR = 0$

$\mathbf{E - [I_1R_1 + R_3(I_1 - I_2)] = 0}$

$\mathbf{150 - 0{,}25I_1 - 5I_1 + 5I_2 = 0}$ ✓

$\mathbf{150 - 5{,}25I_1 + 5I_2 = \ldots\ldots(2)}$

Eq. (1) x (5/0,6) = $\underline{583{,}333 - 2{,}0833I_1 + 5I_2 = 0}$ ✓…(3)

Add (2) and (3) = $733{,}333 - 7{,}333I_1 = 0$

Thus: $I_1 = 733{,}333/7{,}333 = \underline{100\text{ A}}$ ✓

Substitute I_1 = 100 A into Eq. (1)

$70 - 0{,}25(100) + 0{,}6I_2 = 0$

$-I_2 = 70 - 25/0{,}6 = -45/0{,}6$

$-I_2 = -\underline{75\text{ A}}$ Thus ✓

$I_2 = \underline{75\text{ A}}$

$I_1 - I_2 = 100 - 75 = 25\text{ A}$

2.1.1 I_1 = 100 A from pos. to neg. ✓ (5)

2.1.2 I_2 = 75 A from neg. to pos. ✓ (2)

2.1.3 $V_L = 25 \times 5 = 125$ V. ✓ (2)

2.2 $V = I R$
$100 = 20 R$
$R_T = \underline{5\ \Omega}$ ✓

2.2.1 $R_{SE} = R_T - R_P = 5 - \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}}$ $\therefore$ $V_{SE} = IR_{SE}$ $V_P = V_T - V_{SE}$

$= 5 - \frac{1}{\frac{1}{9}+\frac{1}{9}}$ ✓ $= 20 \times 0,5$ $= 100 - 10$

$= 5 - \frac{1}{0,222}$ $= \underline{10V}$ ✓ $= 9\underline{0\ V}$ ✓

$= 5 - 4,5$

$= \underline{0,5\ \Omega}$ ✓ (5)

2.2.2 $I_p = 20A$

but $V_P = 90$ V

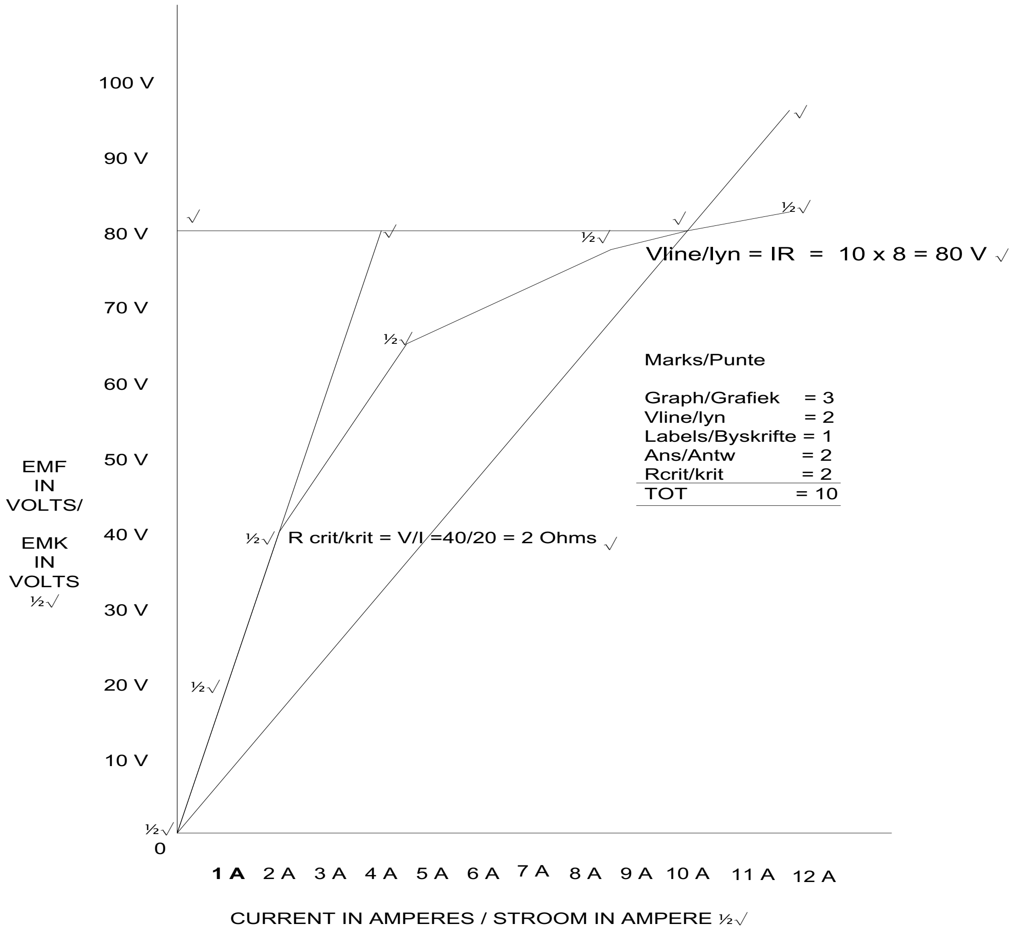
$\therefore$ $I_{5\Omega} = \frac{V_P}{R_1} = \frac{90}{9} = 10\ A$ ✓✓
$I_{20\Omega} = \frac{V_P}{R_2} = \frac{90}{9} = 10\ A$ (2)

2.3 Ampere is defined as the <u>current</u> which is maintained in two straight parallel conductors of infinite length of negligible cross-sectional area, and placed <u>1 metre apart</u> in a vacuum, would produce between the conductors <u>a force</u> of 2×10^{-7} Newton per metre of length. ✓✓✓ (3)

2.4 They are almost uneffected by temperature ✓ (1)
[20]

QUESTION 3

3.1



(10)

3.2

$$I_{SH} = \frac{V + I_L R_{SE}}{R_{SH}}$$

$$= \frac{290 + (40x0,25)}{30} \checkmark\checkmark$$

$$= \frac{300}{30}$$

$$= 10\ A$$

$$I_a = I_L + I_{SH}$$

$$= 40 + 10 \checkmark$$

$$= 50\ A$$

$$E = V + I_a R_a + I_L R_{SE}$$

$$= 290 + (50x0,4) + (40x0,25) \checkmark\checkmark$$

$$= 320\ V$$

(5)

3.3
- Brush shifting✓
- Using interpoles✓
- By placing compensating windings in the pole shoes✓ (3)

3.4 To limit the initial starting current to an acceptable value✓✓ (2)

[20]

QUESTION 4

4.1 $E_1 = 4{,}44\Phi_m fN_1$

4.1.1 $\Phi_m = E_1 / 4{,}44f\ N_1$

$= 1110/4{,}44x50x200x10x10^{-4}$

$=$ 25 Tesla✓✓✓ (3)

4.1.2 $N_2 = \frac{V_2 x N_1}{V_1} = \frac{111x200}{1110} = 20$ **Turns** ✓✓ (2)

4.2 4.2.1 $V_{rms} = 0{,}707\ V_m$

$V_m = \frac{424{,}2}{0{,}707} = 600$ V✓

4.2.2 $T = \frac{1}{f}$

$f = \frac{1}{t} = \frac{1}{25x10^{-3}} =$ 40 Hz ✓

(2 x 1) (2)

4.3 $i_1 = 6{,}708\angle 30° = 5{,}8093 + j3{,}354$

$i_2 = 6{,}708\angle -30° = 5{,}8093 - j3{,}354$ ✓✓

Total current $=11{,}6186 + j\ 0$

$= 11{,}6186\angle 0°$✓

$i_T = 11{,}6186\ \text{Sin}(wt + 0°)A$ ✓ (4)

4.4 4.4.1

$$\mathbf{Z_1} = \mathbf{15 + j10} = \mathbf{18{,}03\angle 33{,}69^\circ} \checkmark$$

$$\mathbf{Z_2} = \mathbf{15 - j10} = \mathbf{18{,}03\angle -33{,}69^\circ} \checkmark$$

$$\mathbf{Z_1 + Z_2} = \mathbf{30 - j0} = 30\angle 0\,\Omega \checkmark$$

$$\mathbf{Z_T} = \frac{\mathbf{Z_1} X \mathbf{Z_2}}{\mathbf{Z_1 + Z_2}}$$

$$= \frac{\mathbf{18{,}03\angle 33{,}69^\circ x 18{,}03\angle -33{,}69^\circ}}{\mathbf{30\angle 0^\circ}} \checkmark$$

$$= \mathbf{10{,}833\angle 0^\circ = 10{,}833 - j0,\Omega}$$

$$V = I\,Z \quad \therefore \mathbf{I_T} = \frac{\mathbf{V}}{\mathbf{Z_T}} = \frac{\mathbf{270{,}825\angle 0^\circ}}{\mathbf{10{,}833\angle 0^\circ}} = \underline{25\angle 0^\circ A} \checkmark$$

(4)

4.4.2

$$\mathbf{I_1} = \frac{\mathbf{V}}{\mathbf{Z_1}} = \mathbf{270{,}825\angle 0^\circ / 18{,}03\angle 33{,}69 = 15{,}023\angle -33{,}69^\circ} A \checkmark$$

(1)

4.4.3

$$\mathbf{I_1} = \frac{\mathbf{V}}{\mathbf{Z_1}} = \mathbf{270{,}825\angle 0^\circ / 18{,}03\angle 33{,}69 = 15{,}023\angle -33{,}69^\circ} A \checkmark$$

$$\mathbf{I_2} = \frac{\mathbf{V}}{\mathbf{Z_2}} = \mathbf{270{,}825\angle 0^\circ / 18{,}03\angle 33{,}69 = 15{,}023\angle 33{,}69^\circ} A \checkmark$$

(2)

4.4.4 $P=V^2/R = 270{,}825^2/10{,}833 = 6{,}77$ Kw or

$P=I^2R = 25^2 \times 10{,}833 = 6{,}77$ kW or

$P = VI = 270{,}825 \text{ X } 25 = 6{,}77$Kw ✓ (1)

4.4.5

$$\mathbf{Cos\Theta} = \frac{R}{Z} = \frac{10{,}833}{10{,}833} = \mathbf{1} \checkmark$$

(1)

[20]

QUESTION 5

5.1 5.1.1

$$\frac{\mathbf{V_P}}{\mathbf{V_S}} = \frac{\mathbf{N_P}}{\mathbf{N_S}} \quad \therefore \quad \mathbf{V_P} = \frac{\mathbf{V_S N_P}}{\mathbf{N_S}} = \frac{\mathbf{200x40}}{\mathbf{20}} = \underline{400\ V} \checkmark\checkmark$$

(2)

5.1.2

$$\therefore \mathbf{I_P} = \frac{\mathbf{V_S I_S}}{\mathbf{V_P}} = \frac{\mathbf{200x20}}{\mathbf{400}} = \underline{10\ A} \checkmark\checkmark$$

(2)

5.1.3 $\mathbf{P = V_S I_S Cos\,Q = 200 \times 20 \times 0{,}6 = 2\,400\ W} \checkmark$ (1)

5.2 Air, Paper, Mica, Ceramic, Polycarbonate, Electrolytic (Any 3 x 1) (3)

5.3 It produces a constant torque and lets the motor run quietly and ensures that it operates at a good power factor.✓✓✓ (3)

5.4 Natural cooling by atmospheric circulation✓
Oil-immersed with natural cooling✓ (2)

5.5 Radial and ring feeders✓✓ (2)

5.6 $$I_V = \frac{V}{R_V} = \frac{200}{800} = 0{,}25\ \text{A}\ \checkmark$$

$$I_R = \frac{V}{R} = \frac{200}{200} = 1\ \text{A}\ \checkmark$$

$$I_T = I_R + I_V = 1 + 0{,}25 = 1{,}25\ \text{A}\ \checkmark$$

$$V_X = V_T - V_R = 400 - 200 = 200\ \text{V}\checkmark$$

$$R_x = \frac{V_X}{I_T} = \frac{200}{1{,}25} = 160\ \Omega\ \checkmark$$

(5)
[20]

TOTAL: 100