higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

24 JULY 2018

This marking guideline consists of 9 pages.

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QUESTION 1

1.1 structure
1.2 magneto-motive
1.3 anti-clockwise
1.4 short-shunt
1.5 an alternator
1.6 AC
1.7 reluctance
1.8 slip-ring motor
1.9 Power stations
1.10 Multipliers

(10 × 1) **[10]**

QUESTION 2

2.1 $P = I^2 R$

$100 = (0,5)^2 xR$ ✓

$R = 400\Omega$

$V_p = IR = (0,5)(400) = 200V$ ✓

$V_x = 250 - 200 = 50V$ ✓

$I_1 = \frac{V_P}{1000} = \frac{200}{1000} = 0,2A$ ✓

$I_T = 0,5 + 0,2 = 0,7A$ ✓

$V_x = I_x xR_x = I_T R_x$

$50 = 0,7R_x$ ✓

$R_x = 71,428\Omega$

OR

$R_P = \frac{(400x1000)}{(400+1000)} = 285,714\Omega$ ✓✓

$V_T = I_T R_T$

$250 = 0,7R_T$ ✓✓

$R_T = 357,143\Omega$

$R_T = R_P + R_x$

$R_x = R_T - R_P = 357 - 285 = 71,428\Omega$ ✓✓

(6)

2.2 $A = ?$

$L = 74m$

$I = 16A$

$V_D = 6,4V$

$\rho_{cu} = 0,017\mu\Omega m$

$V = IR$

$6,4 = 16R$ ✓✓

$R = 0,4\Omega$

$R = \rho\frac{L}{A}$

$0,4 = \frac{(0,017x10^{-6}x74)}{A}$ ✓✓

$A = 3,145x10^{-6}m^2 = 3,145mm^2$ (4)

2.3 $R_1 = 128\Omega$ $R_2 = 136\Omega$

$t_1 = 22°C$ $t_1 = ?$

$\alpha_0 = 0,004$ $\alpha_0 = 0,004$

$\frac{R_1}{R_2} = \frac{R_0(1+\alpha_0 t_1)}{R_0(1+\alpha_0 t_2)}$

$\frac{128}{136} = \frac{1+(0,004)(22)}{1+(0,004)(t_2)}$ ✓✓

$\frac{128}{136} = \frac{1,088}{1+0,004(t_2)}$ ✓

$t_2 = 39^0C$ ✓ (4)

2.4 $C_1 = 5\mu F$

$C_2 = 8\mu F$

$V = 90V$

$C_T = \frac{C_1xC_2}{C_1+C_2} = \frac{5x8}{5+8} = 3,0769\mu F$ ✓

$Q_T = V_TC_T = 90x3,0769 = 276,92\mu C$ ✓

$Q_T = Q_1 = Q_2 = 276,92\mu C$

$Q = VC$

$V_1 = \frac{Q_1}{C_1} = \frac{276,92}{5} = 55,385V$ ✓

$V_2 = \frac{Q_2}{C_2} = \frac{276,92}{8} = 34,615V$ ✓

(4)

[18]

QUESTION 3

3.1
- Battery
- Generator
- Solar energy
- Thermocouple
- Friction or static electricity (Any 2 × 1) (2)

3.2 3.2.1 Pure metals – Resistance will increase

3.2.2 Carbon – Resistance will decrease

(2 × 1) (2)

3.3 L = 15 m
V = 12 m/s
B = 0,7 T (Wb/m²)
I = 0,5 A

E = BLV = (0,7)(15)(12) = 126 V✓

F = BIL = (0,7)(0,5)(15) = 5,25 N✓

P = IV = IE
= 0,5 × 126✓✓
= 63 W (4)

3.4 In loop ABEFA:

$$\sum E = \sum IR$$

$$28 - 20 = 0,5I_1 + 0,2(I_1 + I_2) \quad ✓✓$$

$$8 = 0,7I_1 + 0,2I_2 \text{.....}(1)$$

In loop ACDFA:

$$\sum E = \sum IR$$

$$28 - 16 = 0,7I_2 + 0,2(I_1 + I_2) \quad ✓✓$$

$$12 = 0,2I_1 + 0,9I_2 \text{.....}(2)$$

(2) x 3,5:

$$42 = 0,7I_1 + 3,15I_2 \text{.....}(3) \quad ✓✓$$

(3) – (1):

$$34 = 2,95I_2$$

$$I_2 = 34 / 2,95 = 11,525A \quad ✓✓$$

Substitute I_2 in (1):

$$8 = 0,7I_1 + 0,2(11,525) \quad ✓✓$$

$$I_1 = 8,136A$$

(10)
[18]

QUESTION 4

4.1

- The iron core of the pole pieces may have lost their residual magnetism. In this case the residual magnetism must be restored by passing a direct current through the field windings in the correct direction. (2)

- If the field coils are connected incorrectly, the current induced by the residual magnetism will flow through the field coils in the opposite direction. This will result in the field strength of the pole cores being decreased instead of being increased and the generator will not excite. To rectify the fault, the connection of the field windings must be reversed. (3)

- Other conditions that may prevent a generator from exciting include the following:
  - brushes jammed in their holders
  - dirty brushes or commutator
  - an open or short-circuited field circuit
  - loose brush connections
  - an armature speed that is too low
  - a field circuit resistance that is too high. (3) (8)

4.2

$R_x = ?$

$V = 440V$

$P = 10kW$

$R_a = 0,67\Omega$

$R_f = 161\Omega$

$$I_L = \frac{P}{V} = \frac{1000}{440} = 22,7A \checkmark$$

$$I_f = \frac{V}{R_f} = \frac{440}{161} = 2,7A \checkmark$$

$$I_a = I_L - I_f = 22,7 - 2,7 = 20A \checkmark$$

$$I_{start} = 1,5I_a = (1,5)(20) = 30A \checkmark$$

E = 0 for starting (standstill):

$V = E + I_a(R_a + R_x)$

$440 = 0 + 30(0,67 + R_x)$

$R_x = 13,99\Omega \checkmark\checkmark\checkmark$ (7)

4.3 $Z = 540$

$p = 2(4\,poles)$

$c = 2p = (2)(2) = 4$

$\phi = 0,025Wb$

$E = 406V$

$$E = \frac{2\phi ZpN}{60c}$$

$$406 = \frac{(2)(0,025)(540)(2)N}{(60)(4)} \checkmark\checkmark\checkmark$$

$N = 1804r/m$ (3)

[18]

QUESTION 5

5.1 $f = 50Hz$

$E_m = 311$

$t = ?$

$e = 180v$

$$e = E_m \sin 2\pi ft(\frac{180}{\pi})$$

$$180 = 311\sin 2\pi(50)t(\frac{180}{\pi}) \checkmark$$

$$\sin^{-1}(\frac{180}{311}) = 2\pi(50)t \checkmark$$

$t = 0,00196\sec = 1,96m\sec \checkmark$ (3)

5.2 $e_1 = 75\sin(wt + \frac{\pi}{6})$

$= 75\sin(wt + 30°) = 75\angle 30°$

$= 64,952 + j37,5 \checkmark\checkmark$

$e_2 = 98\sin(wt - \frac{\pi}{4})$

$= 98\sin(wt - 45°) = 98\angle -45°$

$= 69,296 - j69,296 \checkmark\checkmark$

$e_T = e_1 + e_2$

$= 134,248 - j31,796 = 137,962\angle -13,324°$

$= 13,962\sin(wt - 13,324^{\circ}) \checkmark$

$E_{rms} = 0,707E_m$

$= 0,707(137,962) = 97,539V \checkmark$ (6)

5.3 $R = 5\Omega$ $I_T = ?$

$L = 0,011H$ $V = 225V$

$C = 198\mu F$ $f = 50Hz$

$X_L = 2\pi fL = 2\pi(50)(0,011) = 3,456\Omega$ ✓

$X_C = \frac{1}{2\pi fC} = \frac{10^6}{2\pi(50)(198)} = 16,076\Omega$ ✓

$Z_1 = 5 + j3,456 = 6,078\angle 34,65°$ ✓

$Z_2 = 0 - j16,076 = 16,076\angle -90°$ ✓

$I_1 = \frac{V}{Z_1} = \frac{225\angle 0°}{6,076\angle 34,65°} = 37\angle -34,6° = 30,47 - j21$ ✓

$I_2 = \frac{V}{Z_2} = \frac{225\angle 0°}{16,076\angle -90°} = 13,996\angle 90° = 0 - j13,996$ ✓

$I_T = I_1 + I_2 = 30,472 - j7,025 = 31,271\angle -13°$ ✓

Therefore:
Supply current = 31,271 A✓
Displacement angle = 13°✓ (9)

[18]

QUESTION 6

6.1 6.1.1

$\frac{N_1}{N_2} = \frac{V_1}{V_2}$ ✓

$\frac{142}{N_2} = \frac{250}{60}$

$N_2 = 34,08 = 34 turns$ ✓ (2)

6.1.2

$E_1 = 4,44\phi_m fN_1$

$250 = 4,44\phi_m(50)(142)$ ✓✓

$\phi_m = 0,00793$

$\phi_m = BA$

$0,00793 = B(0,04)$ ✓✓

$B = 0,198T(Wb/m^2)$ (4)

6.1.3 $I_2 = ?$
$P = 5kW$
$Cos\phi = 0,8$

$P = V_2 I_2 Cos\phi$
$5000 = (60)I_2(0,8)$ ✓✓
$I_2 = 104,167A$ (2)

6.2 $R_m = 75\Omega$
$I_m = 300mA = 0,3A$

$V_m = I_m R_m = 0,3x75 = 22,5v$ ✓
$V_T = V_m + V_{se}$
$60 = 22,5 + V_{se}$ ✓
$V_{se} = 37,5V$

$R_{se} = \frac{V_{se}}{I_{se}} = \frac{V_{se}}{I_m} = \frac{37,5}{0,3} = 125\Omega$ ✓✓ (4)

6.3
- It is cheaper.
- Control circuits are more reliable.
- Supply (AC) is always available.
- AC motors are smaller and lighter.
- Maintenance is less than for DC motors. (Any 3 × 1) (3)

6.4
- Sources – In order to be near by their supply sources, e.g. mines.
- Pollution – In order not to affect the communities around those stations.
- Danger – In order to avoid any dangers that may occur to human kind and livestock. (Any relevant 3 × 1) (3)

[18]

TOTAL: 100

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