higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

12 April 2021

This marking guideline consists of 9 pages.

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QUESTION 1: PRINCIPLES OF ELECTRICITY

1.1
1.1.1 True
1.1.2 True
1.1.3 False
1.1.4 True
1.1.5 False
1.1.6 False
1.1.7 False
1.1.8 True
1.1.9 True
1.1.10 True

(10 × 1) (10)

1.2 **Given:**

$R_1 = 7\Omega$
$R_2 = 5\Omega$

$E_1 = 1,5V$
$r_1 = 1,2\Omega$

$E_2 = 1,1V$
$r_2 = 0,7\Omega$

1.2.1

$$R_T = \frac{R_1 x R_2}{R_1 + R_2} = \frac{(7x5)}{(7+5)} = 2,92\Omega \checkmark$$

$$r_T = r_1 + r_2 = 1,2 + 0,7 = 1,9\Omega \checkmark$$

$$E_T = E_1 + E_2 = 1,5 + 1,1 = 2,6V \checkmark$$

$$E = I(R_T + r_T)$$
$$2,6 = I(2,92 + 1,9)$$
$$I = 0,539A \checkmark$$

ALTERNATE SOLUTION:

$$Rt = \frac{R1xR2}{R1 + R2}$$
$$= \frac{7x5}{7+5} + 1,2 + 0,7 \checkmark$$
$$= 4,817\Omega \checkmark$$

$$It = \frac{Et}{Rt} = \frac{2,6}{4,817} = 0,54A \checkmark\checkmark$$

Current through both cells is equal (I = 0,54 A), since it's a series connection. (4)

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1.2.2 ET = V + IT Rt But Rp = Rt

V = 2,6 – 0,536 (1,9)

= 1,582 V ✓

Or

$V_p = I_p R_p = 0,539x2,92 = 1,574V$ ✓

$I_{R_1} = \frac{V_p}{R_1} = \frac{1,574}{7} = 0,225A$ ✓

$I_{R_2} = \frac{V_p}{R_2} = \frac{1,574}{5} = 0,315A$ ✓ (3)

1.2.3 $E_1 = V_1 + Ir_1$

$1,5 = V_1 + (0,539x1,2)$

$V_1 = 0,853V$ ✓

$E_2 = V_2 + Ir_2$

$1,1 = V_2 + (0,539x0,7)$

$V_2 = 0,723V$ ✓ (2)

1.3 **Given:**

I_1 = 4.1 A

t = 60º

ø = 20º

V = 230 V

α_0 = 0,004/ºC

$R_t = R_ø [1 + \alpha_0 (t - ø)]$

$R_ø = \frac{V}{I1} = \frac{230}{4.1} = 56,098\ \Omega$ ✓

$R_t = 56,098[1 + (0,004)(60° - 20°)]$ ✓

= 65,074 Ω ✓

$I_2 = \frac{V}{Rt} = \frac{230}{65,074} = 3,534\ \Omega$ ✓

$\therefore\ \Delta I = I1 - I2 = 4,1 - 3,534 = 0,566\ A$ ✓ (5)

1.4 **Given:**

$C_1 = 15\mu F$

$V = 60\ V$

$C_2 = 5\ \mu F$

1.4.1 $Q_1 = VC_1 = 60 \times 15 = 900\ \mu C$ ✓

$Q_T = Q_1 + Q_2 = 900 + 0 = 900\ \mu C$ ✓

$C_T = C_1 + C_2 = 15 + 5 = 20\ \mu F$ ✓

$V = \frac{Qt}{Ct} = \frac{900}{20} = 45V$ ✓

OR

$Q_T = Q_1 + Q_2$

$Q_T = VC_1 + VC_2$

$Q_T = V(C_1 + C_2)$

$900 = V(20)$

$V = 45\ V$ ✓

(4)

1.4.2 $Q_1 = VC_1 = 45\ (15) = 675\ \mu C$ ✓

$Q_2 = VC_2 = 45\ (5) = 225\ \mu C$ ✓

(2)

[30]

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QUESTION 2: DC MACHINES

2.1 **Armature reaction:**
Is the distortion of the main flux entering and leaving the armature, caused by the flux set up by armature conductors when they carry current. (2)

2.2 **Given:**

p = 3

c = 2p

IL = 50 A

V = 240 V/50Hz

Z = 864 with Rsh = 0,1 ohms

$\phi = 50x10^{-3} Wb$

$R_{sh} = 120\Omega$

$$I_{sh} = \frac{V}{R_{sh}} = \frac{240}{120} = 2A \checkmark$$

$$I_a = I_L + I_{sh} = 50 + 2 = 52A \checkmark$$

$$E = V + IaRa$$
$$= 240 + (52x0,1) \checkmark$$
$$= 245,2V \checkmark$$

$$E = \frac{2ZNp\emptyset}{60c}$$

$$\therefore N = \frac{60cE}{2Zp\phi} = \frac{60x2x3x245,2}{2x864x3x50x10^{-3}} \checkmark\checkmark$$

N = 340 r/m ✓ (7)

2.3 **Given:**

$I_L = Ise = 65\ A$

$Rsh = 220\ \Omega$

$V = 400\ V$

$Rse = 0,1\ \Omega$

$Ra = 0,15\ \Omega$

$E = 420\ V$

$E = V + IaRa + IseRse + IaRb$ ✓

$Vse = IseRse = (65)(0,1) = 6,5\ V$ ✓

$Vsh = V - Vse = 400 - 6,5 = 393,5\ V$ ✓

$Ish = \frac{V}{Rsh} = 1,819\ A$ ✓

$Ia = Ish + Ise = 1,819 + 65 = 66,819\ A$ ✓

$IaRb = E - V - IaRa - IseRse$ ✓

$= 420 - 400 - (66,819)(0,15) - (65)(0,1)$ ✓

$= 3,477\ V$ ✓ (8)

2.4 **Given:**

$V = 500V$

$R_a = 0,2\Omega$

$R_{st} = ?$

$I_{a(start)} = 125\%of100 = 125A$ ✓ **OR** $I_{a(start)}$ = 1,25 X100 = 125 A ✓

$$I_{a(start)} = \frac{V}{R_a + R_{st}}$$

$$\therefore R_{st} = \frac{V}{I_{a(st)}} - R_a$$

$$= \frac{500}{125} - 0,2$$ ✓

$= 3,8\Omega$ ✓

(3)
[20]

QUESTION 3: AC THEORY

3.1 **Effective value of an alternating current:**
Is that value of alternating current, which produces the same amount of heat energy, at the same rate as a direct current would, if passed through an identical resistance. (2)

3.2

3.2 3.2.1 **For coil A:**

$X_{LA} = 2\pi fL = 2\pi \times 50 \times 200 \times 10^{-3}$= 62,832 Ω ✓

$Xc = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 55 \times 10^{-6}} = 57,875\Omega$ ✓

$Z_A = R + jXL = 36 + j62,832 = 72,415 < 60,819°$ ✓

$Z_{cap} = R - jXc = 30 - j57,875 = 65,188 < -62,6°$ ✓

$Z_A + Z_{cap} = 66 + j4,957 = 66,186 < 4,294°$ ✓

$Zp = \frac{Za \times Zcap}{Za + Zcap} = 71,323 < -6,706°$ Ω ✓✓

For coil B:

$X_{LB} = 2\pi fL = 2\pi \times 50 \times 100 \times 10^{-3} = 31,416\,\Omega$ ✓

$Z_B = 20 + j31,416 = 37,242 < 57,158°$ ✓

$Zt = Zp + Zb = 90,835 + j23,087 = 93,723 < 14,261°$ ✓✓

$It = \frac{Vt}{Zt} = \frac{200 < 0°}{93,723 < 14,261} = 2,134 < -14,261A$ ✓ (12)

3.2.2 $V_{coilA} = I_t Z_p$
$= 2,134 < -14,261 \times 71,323 < -6,706°$ =152,203<-20,967º V ✓✓

$V_{coilB} = I_t Z_B$
$= 2,134 < -14,261 \times 37,242 < 57,158 = 79,474 < 43,257^0\ V$ ✓✓ (4)

3.2.3 $I_A = \frac{Vp}{Zb} = 2,102 < -81,156°\ A$ ✓

$Icap = \frac{Vp}{Zcap} = 2,335 < 41,633°$ A ✓

(2)
[20]

QUESTION 4: TRANSFORMERS

4.1 a) Core-type with concentric windings
b) Shell-type with sandwich windings (2)

4.2 **Given:**

$f = 50Hz$

$N_1 = 20turns$

$N_2 = 273turns$

$A = 400cm^2 = (400x10^{-2})^2 m^2 = 400x10^{-4} m^2$

$E_1 = 220V$

4.2.1

$E = 4,44\phi_m fN$

$220 = 4,44\phi_m x50x20$ ✓

$\phi_m = 0,0495Wb$ ✓

$$B_m = \frac{\phi_m}{A}$$

$$= \frac{0,0495}{400x10^{-4}}$$ ✓

$= 1,238T$ ✓

(4)

4.2.2

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

$$\frac{220}{V_2} = \frac{20}{273}$$ ✓

$V_2 = 3003V$ ✓ (2)

4.2.3 $Voltage/_{Turn} = \frac{V1}{N1} = \frac{220}{20} = 11\ v/t$ ✓✓ (2)

[10]

QUESTION 5: AC MACHINES

5.1 The end plates of a motor

- are mounted at each end of the stator
- house the bearings
- hold the rotor in position relatively to the stator (3)

5.2 a) Resistance-start induction motor
b) Capacitor-start induction motor
b) Capacitor-start capacitor-run induction motor (3)

5.3 Starting winding:

- Has thinner conductors.
- Located on top of the running winding.
- Has high resistance and low inductance.

Running winding:

- Has thicker conductors.
- Located at the bottom of the slots.
- Has low resistance and high inductance.

Any two from each winding (2 × 2) (4)
[10]

QUESTION 6: GENERATION AND SUPPLY OF AC POWER AND MEASURING INSTRUMENTS

6.1 a) Coal power stations and
b) Nuclear power stations (2)

6.2 a) To reduce transport costs.
b) To reduce serious traffic problems on the roads.
c) To keep pollution away from densely populated areas. (3)

6.3 Given:

$Rsh = 0{,}25\ \Omega$
$Rse = 15\ k\Omega$
$Rm = 300\ \Omega$
$Im = 13{,}5\ mA$

$$Ish = \frac{ImRm}{Rsh} = \frac{(13{,}5x10^{-3})(300)}{(0{,}25)} = 16{,}2\ A$$ ✓✓

$$I = Ish + Im = 16{,}2 + 13{,}5x10^{-3} = 16{,}214\ A$$ ✓

$$Rse = \frac{V}{Im} - Rm$$
$$V = Im(Rm + Rse) = 13{,}5x10^{-3}(300 + 15x10^{3}) = 206{,}55\ V$$ ✓✓ (5)
[10]

TOTAL: 100

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