higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

19 November 2024

This marking guideline consists of 7 pages.

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QUESTION 1

1.1
1.1.1 structure
1.1.2 magneto-motive force
1.1.3 reluctance
1.1.4 directly
1.1.5 attract
1.1.6 self-inductance
1.1.7 charge
1.1.8 chemical
1.1.9 principal
1.1.10 dielectric

(10 × 1) (10)

1.2 Data:

$R_1 = x = ?$, $V = 110\ V$
$R_2 = 20\ \Omega$, $I_4 = 2\ A$
$R_3 = 30\ \Omega$
$R_4 = 50\ \Omega$

$V_2 = I_4 R_4 = 2x50 = 100\ V$✓= V3 [parallel]

$I_3 = \frac{V_2}{R_3} = \frac{100}{30} = 3{,}3\ A$✓

$I_T = I_3 + I_4 = 3{,}3 + 2 = 5{,}3\ A$✓

$V_1 = V_T - V_2 = 110 - 100 = 100\ V$✓

$I_2 = \frac{V_1}{R_2} = \frac{10}{20} = 0{,}5\ A$✓

$I_1 = I_T - I_2 = 5{,}3 - 0{,}5 = 4{,}8\ A$✓

$R_1 = x = \frac{V_1}{I_1} = \frac{10}{4{,}8} = 2{,}083\ A$✓

$Q_1 = {I_1}^2 R_1 t = 4{,}8^2 x2{,}083x36 = 1727{,}724\ J$✓✓ (9)

1.3 Data:

$C_1 = 90\ \mu F$
$C_2 = 40\ \mu F$
$C_3 = 70\ \mu F$
$C_4 = 35\ \mu F$
$V_T = 110\ V$

1.3.1 $C_{P1} = C_1 + C_2 = 90 + 40 = 130\ \mu F$✓
$C_{P2} = C_3 + C_4 = 70 + 35 = 105\ \mu F$✓
$C_T = \frac{C_{P1} x C_{P2}}{C_{P1} + C_{P2}} = \frac{130x105}{130+105} = 58{,}085\ \mu F$✓✓ (4)

1.3.2 $Q_T = C_T V_T = 58{,}085x10^{-6}x110 = 6{,}389\ mC$✓
$V_1 = \frac{Q_T}{C_{P1}} = \frac{6{,}389x10^{-3}}{130x10^{-6}} = 49{,}146\ V$✓
$V_2 = \frac{Q_T}{C_{P2}} = \frac{6{,}389x10^{-3}}{105x10^{-6}} = 60{,}848\ V$✓ (3)

1.3.3 $Q_1 = C_1 V_1 = 90x10^{-6}x49{,}146 = 4{,}423\ mC$✓
$Q_2 = C_2 V_1 = 40x10^{-6}x49{,}146 = 1{,}966\ mC$✓
$Q_3 = C_3 V_2 = 70x10^{-6}x60{,}848 = 4{,}259\ mC$✓
$Q_4 = C_4 V_2 = 35x10^{-6}x60{,}848 = 2{,}129\ mC$✓ (4)
[30]

QUESTION 2

2.1
- Hoists
- Air compressors
- Vacuum cleaners
- Trolley cars
- Cranes
- Trains
- Electric locomotives

(Any 3 × 1) (3)

2.2 2.2.1 It is to automatically disconnect the motor from the supply in the event of the supply voltage dropping below the rated value.

2.2.2 It is to automatically disconnect the motor from the supply in the event of an overload or short circuit.

(2 × 2) (4)

2.3 Data:

$p = 3$ $c = 2p = 6$
$V = 300\,V$ $I_L = 25\,A$
$R_a = 0{,}2\,\Omega$ $R_{sh} = 100\,\Omega$
$\phi = 20\,mWb$ $75\ slots$
$N = 1\,300\,r/min$ $Conductors\ per\ slot = ?$

$I_{sh} = \frac{V}{R_{sh}} = \frac{300}{100} = 3\,A$✓

$I_a = I_L - I_{sh} = 25 - 3 = 22\,A$✓

$E = V - I_a R_a$
$= 300 - [(22)(0{,}2)]$✓
$= 295{,}6\,V$✓

$Z = \frac{60Ec}{2Np\phi}$

$= \frac{60\ x\ 295{,}6\ x\ 6}{2\ x\ 1300\ x\ 3\ x\ 20x10^{-3}}$✓✓

$= 682{,}154$✓

$= 682\ conductors$

$Conductors\ per\ slot = \frac{Z}{slots}$
$= \frac{682}{75} = 9{,}093 = 9\ slots$ ✓ 9 cond/slot (8)

2.4 Data:

$V = 400\,V$
$p = 2$
$c = 2\ (wave)$
$Z = 470$
$R_{sh} = 150\,\Omega$
$T = ?$
$\phi = 25\,mWb$
$I_L = 55\,A$

$I_{sh} = \frac{V}{R_{sh}}$
$= \frac{400}{150} = 2{,}6\,\Omega$ ✓

$I_a = I_L - I_{sh}$
$= 55 - 2{,}6 = 52{,}4\,A$ ✓

$T = \frac{0{,}318 I_a \phi p Z}{c}$
$= \frac{0{,}318\ x\ 52{,}4\ x\ 2\ x\ 470\ x25x10^{-3}}{2}$✓✓
$= 195,793\ Nm$ ✓ (5)

[20]

QUESTION 3

$X_{L(A)} = 2\pi fL = 2\pi(50)(100x10^{-3}) = 31{,}416\ \Omega$✓
$Z_A = R + jX_L = 20 + j31{,}416 = 37{,}242\angle 57{,}518^0\ \Omega$✓

$X_{L(B)} = 2\pi fL = 2\pi(50)(200x10^{-3}) = 62{,}832\ \Omega$✓
$Z_B = R + jX_L = 36 + j62{,}832 = 72{,}415\angle 60{,}189^0\ \Omega$✓

$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)(55x10^{-6})} = 57{,}875\ \Omega$ ✓
$Z_C = R - jX_C = 30 + j57{,}875 = 65{,}188\angle -62{,}6^0\ \Omega$✓

$Z_B + Z_C = 66 + j4{,}957 = 66{,}186\angle 4{,}295^0\ \Omega$✓✓
$Z_P = \frac{Z_B\ x\ Z_C}{Z_B + Z_C} = 71{,}323\angle -6{,}706^0 = 70{,}835 - j8{,}329\ \Omega\ \Omega$✓✓

$Z_T = Z_A + Z_P = 90{,}835 + j23{,}087 = 93{,}723\angle 14{,}261^0\ \Omega$✓✓

$I_T = \frac{V_T}{Z_T} = \frac{200\angle 0^0}{93{,}723\angle 14{,}261^0} = 2{,}134\angle -14{,}261^0 A$ ✓✓

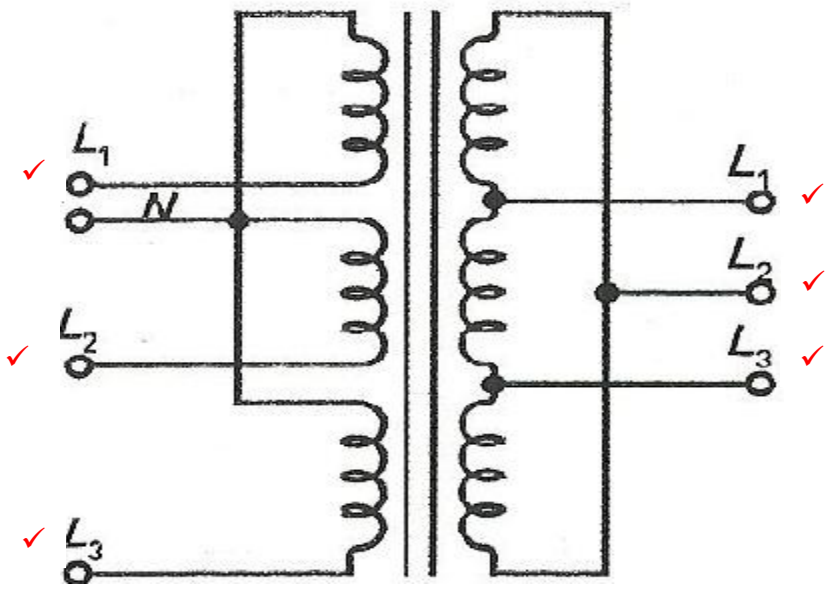
$V_{Coil1} = I_T . Z_A = 2{,}134\angle -14{,}261^0 x\ 37{,}242\ \angle 57{,}518^0 = 79{,}474\angle 43{,}257^0\ V$✓✓
$V_{Coil2} = I_T . Z_P = 2{,}134\angle -14{,}261^0 x\ 71{,}323\ \angle -6{,}706^0 = 152{,}203\angle -20{,}967^0\ V$✓✓

$I_B = \frac{V_{Coil2}}{Z_B} = 2{,}102\angle -81{,}156\ A$✓
$I_C = \frac{V_{Coil2}}{Z_C} = 2{,}335\angle 41{,}633\ A$✓

[20]

QUESTION 4

4.1



Correct diagram (2 marks)
Any 4 correct labels (4 marks) (6)

4.2 Data:

$V_1 = 222\ V = E_1$
$V_2 = 2\ 220\ V = E_2$
$f = 50\ Hz$
$A = 100cm^2 = 100x10^{-4}\ m^2$
$N_1 = 200\ Turns$

$$\phi_m = \frac{E_1}{4{,}44fN_1}$$
$$= \frac{222}{4{,}44x50x200}\checkmark$$
$$= 0{,}005\ Wb\ or\ 5\ mWb\checkmark$$

$$\beta_m = \frac{\phi_m}{A}$$
$$= \frac{0{,}005}{100x10^{-4}} = 0{,}5\ Tesla\checkmark$$

$$N_2 = \frac{V_2\ xN_1}{V_1}$$
$$= \frac{2220x200}{222} = 2\ 000\ Turns\checkmark$$

(4)
[10]

QUESTION 5

5.1 Data:

$p = 3$
$N_r = 400\ r/m$
$V = 410\ v$
$f = 50\ Hz$

5.1.1
$$N_s = \frac{60f}{p}$$
$$= \frac{60\ x\ 50}{3}$$
$$= 1\ 000\ r/m\ \checkmark$$

$$Percentage\ Slip = \frac{N_s - N_r}{N_s}$$
$$= \frac{1\ 000-400}{1\ 000}x100\checkmark$$
$$= 60\%\checkmark$$

(3)

5.1.2
$$Per-unit\ Slip = \frac{N_s - N_r}{N_s}$$
$$= \frac{1\ 000-400}{1\ 000}$$
$$= 0{,}6\ \checkmark$$

(1)

5.2 To reverse the direction of rotation:

5.2.1 By interchanging any two phases among the three (red, yellow and blue).

5.2.2 By changing either the connection of the running winding or the starting winding✓ but not both at the same time.✓

5.2.3 By changing the polarity across the armature or field coils.

(6)
[10]

QUESTION 6

6.1 A − Generation
B − Transmission
C − Distribution
D − Feeder
E − Utilisation (5)

6.2 6.2.1 D
6.2.2 A
6.2.3 F
6.2.4 E
6.2.5 B

(5 × 1) (5)
[10]

TOTAL: 100

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