higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4

21 November 2023

This marking guideline consists of 8 pages.

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QUESTION 1

1.1 1.1.1 Kirchhoff's current law states that the sum of currents flowing towards the junction✓ is equal to the sum of currents leaving the junction. ✓ (2)

1.2 In loop ABEFA

$E = I_1R_1 + I_3R_4\ (But\ I_3 = I_1 - I_2)$

$12 = 2I_1 + 3(I_1 - I_2)$ ✓

$12 = 2I_1 + 3I_1 - 3I_2$

$12 = 5I_1 - 3I_2$……(1) ✓

In loop BCDEB

$E = I_2(R_2 + R_3) - I_3R_4$

$0 = I_2(4 + 5) - 3(I_1 - I_2)$ ✓

$0 = 9I_2 - 3I_1 + 3I_2$

$0 = -3I_1 + 12I_2$……(2) ✓

From (2) $-3I_1 = -12I_2$

$I_1 = 4I_2$……(3) ✓

$Sub.(I_1 = 4I_2)\ in\ (1)$

$12 = 5(4I_2) - 3I_2$✓

$12 = 20I_2 - 3I_2$

$17I_2 = 12$ ✓

$I_2 = 0{,}706\ A$ ✓

$Sub.(I_2 = 0{,}706\ A)\ in\ (3)$

$I_1 = 4 \times 0{,}706$ ✓

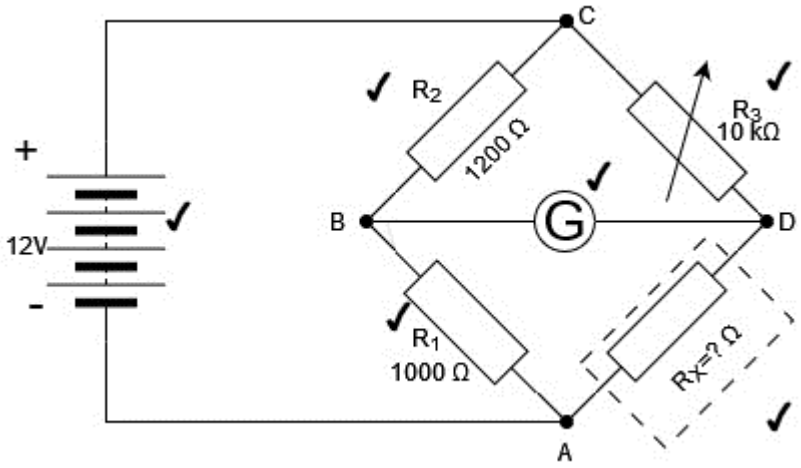
$I_1 = 2{,}824\ A$ ✓

$I_3 = I_1 - I_2$✓

$I_3 = 2{,}824 - 0{,}706\ = 2{,}118\ A$ ✓ (12)

1.3 A V_P (Peak voltage) OR V_{max} maximum voltage OR amplitude
B V_{RMS} OR effective value
C V_{AVE} (Average voltage)
D $V_{(P-P)}$ OR peak to peak voltage
E Cycle (5 x 1) (5)

1.4



(6)

1.5 1.5.1 The resistance is the opposition of current flow ✓while the reactance is the opposition of change in current flow✓ (2)

1.5.2 The Impedance is the vector sum of the resistance✓ and the difference of the two reactance✓ (inductive and capacitive) (2)

1.5.3 $\boldsymbol{Z = \sqrt{R^2 + (X_L - X_C)^2}}$ (1)
[30]

QUESTION 2

2.1
- The coal is pulverized in a ball mill or pulveriser.
- The pulverized coal is then burned in the boiler
- The heat released by the combustion of coal produces steam at elevated temperature and pressure
- Steam turbines receives controlled steam from the boiler , which drives the the three phase ac generator(alternator)
- The alternator delivers the electric energy at its rated voltage (5)

2.2 $P = \sqrt{3}\, V_L I_L cos\theta$

$= \sqrt{3} \times 380 \times 12 \times 0{,}8$ ✓

$= 6{,}319\ kW$ ✓ (2)

2.3
- Aluminium conductor steel-reinforced (ACSR)
- All aluminium conductor (AAC)
- All aluminium alloy conductor (AAAC) (3)

2.4
- Total current
- Voltage of the circuit (2)

2.5
- Valve
- Pellet
- Air-gap (3)

[15]

QUESTION 3

3.1 3.1.1 Earth leackage current

3.1.2 Fault current

3.1.3 Supply

3.1.4 2,5 mm^2

3.1.5 0,2 Ω (5)

3.2
- Where possible switch off the main supply
- Disconnect the main neutral so as to minimize parallel neutral or earth paths
- Connect the test leads to the line supply.
- Connect the black lead to earth and the red lead to phase
- Press to test and record the value indicated on the loop impedance tested

(5)

3.3 3.3.1 **T -** one or more parts are connected direct to earth; and✓
I - all live parts are isolated from earth or one point is connected to earth through impedance. ✓ (2)

3.3.2
- TN-C
- TN-C-S (3)
- TN-S

[15]

QUESTION 4

4.1
- The primary winding is supplied with an AC voltage that sets a fluctuating magnetic field in the primary side.✓
- This changing magnetic field cuts through the secondary winding and induces an EMF in the secondary winding.✓
- The amount of voltage on the secondary side depends on the number of turns on the secondary winding.✓ (3)

4.2 4.2.1

$$V_{P1} = \frac{V_{L1}}{\sqrt{3}}$$

$$= \frac{3\,300}{\sqrt{3}} \checkmark$$

$$= 1\,905{,}256\,V \checkmark$$

$$\frac{V_{P1}}{V_{P2}} = \frac{N_1}{N_2}$$

$$V_{P2} = \frac{V_{P1}N_2}{N_1}$$

$$= \frac{1\,905{,}256 \times 55}{550} \checkmark$$

$$= 190{,}526\,V = V_{L2} \checkmark$$

4.2.2

$$\frac{V_{P1}}{V_{P2}} = \frac{N_1}{N_2}$$

$$V_{P2} = \frac{V_{P1}N_2}{N_1}$$

$$= \frac{3\,300 \times 55}{550} \checkmark$$

$$= 330\,V \checkmark$$

$$V_{L2} = \sqrt{3}\,V_{P2}$$

$$= \sqrt{3} \times 330 \checkmark$$

$$= 571{,}577\,V \checkmark$$

(2 × 4) (8)

4.3 4.3.1 True
4.3.2 True
4.3.3 False
4.3.4 True
4.3.5 True

(5 × 1) (5)

4.4 4.4.1 No (1)

4.4.2
- The three transformer windings are not balanced
- Transformer 3 secondary winding is broken(open) as it reads infinity
- All three transformers must have balanced resistance or within the 5% tolerance. (3)

[20]

QUESTION 5

5.1 5.1.1
- Wound or slip ring rotor
- Squirrel cage rotor

(2)

5.1.2
- Wound rotor have slots cut into the circumference, ✓ rotor windings are then placed inside the slots. ✓The rotor windings are then connected in star(one end of each windings is bridged out) ✓
- Squirrel cage rotor have slightly skewed slots cut into their circumference. ✓ Then solid copper or aluminium bars are inserted into the slots, ✓ then the bars are connected to each other by means of the end ring✓

(6)

5.2
- No-load current (I_0)
- No-load power factor ($\cos \Theta_0$)
- Winding and friction losses
- No-load core losses
- No-load input
- No-load resistance (R_0) and reactance (X_0)

(Any 2 × 1) (2)

5.3 5.3.1 A under-compounded generator is a generator in which the output voltage gradually decreases with an increase in load current.

5.3.2 A cumulatively compounded generator is the generator in which the two fields are wound so that their magnetic fields aid one another.

(2 × 1) (2)

5.4 A thermal-overload protection device disconnects the motor from the supply when excessive heat is generated in the motor circuitry. (1)

5.5 5.5.1

$$E = \frac{2p\emptyset ZN}{60\ c}$$

$$Z = \frac{E60c}{2p\emptyset N} \checkmark$$

$$= \frac{300 \times 60 \times 2}{2 \times 3 \times 55 \times 10^{-3} \times 800} \checkmark$$

$$= 136{,}364 \checkmark$$

(3)

5.5.2

$$T = \frac{0{,}318 I_a Zp\emptyset}{c}$$

$$= \frac{0{,}318 \times 17 \times 136{,}364 \times 3 \times 55 \times 10^{-3}}{2} \checkmark$$

$$= 60{,}818\ N.m \checkmark$$

(2)

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5.6 $N_S = \frac{60f}{p}$

$p = \frac{60f}{N_S}$

$= \frac{60 \times 60}{1\ 200}$

$= 3$ ✓

$\therefore Number\ of\ poles = 3 \times 2 = 6$ ✓ (2)

[20]

TOTAL: 100

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