higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE (VOCATIONAL)

## ELECTRICAL PRINCIPLES AND PRACTICE
## NQF LEVEL 4

## 10 November 2022

**This marking guideline consists of 8 pages.**

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## QUESTION 1

1.1 1.1.1 False
1.1.2 True
1.1.3 False
1.1.4 True
1.1.5 False

(5 × 1) (5)

1.2 In loop ABEFA:

$E_1 - E_2 = I_1R_1 + I_3R_2$ but $I_3 = I_1 - I_2$

$80 - 70 = 0{,}2I_1 + 0{,}9(I_1 - I_2)$ ✓

$10 = 0{,}2I_1 + 0{,}9I_1 - 0{,}9I_2$

$10 = 1{,}1I_1 - 0{,}9I_2$.....(1) ✓

In loop ABCDEFA:

$E_1 - E_3 = I_1R_1 + I_2R_3$

$80 - 60 = 0{,}2I_1 + 0{,}8I_2$✓

$20 = 0{,}2I_1 + 0{,}8I_2$.....(2) ✓

$(1) \times 0{,}8$: $8 = 0{,}88I_1 - 0{,}72I_2$ .....(3)

$(2) \times 0{,}9$: $18 = 0{,}18I_1 + 0{,}72I_2$ .....(4)

$(3) + (4)$: $26 = 1{,}06I_1$✓

$I_1 = 24{,}528$ A✓

Substitute ($I_1 = 24{,}528$ A) in (1) **OR** in (2), (3) **OR** (4): ✓

$10 = 1{,}1 \times 24{,}528 - 0{,}9I_2$

$10 = 26{,}981 - 0{,}9I_2$

$-0{,}9I_2 = -16{,}981$

$I_2 = 18{,}868$ A✓

$I_3 = I_1 - I_2$

$= 24{,}528 - 18{,}868$✓

$= 5{,}66$ A✓ (10)

1.3 $X_L = 2\pi fL$

$$f = \frac{X_L}{2\pi L}$$

$$= \frac{400}{2\pi \times 0{,}2} \checkmark$$

$$= 318{,}31 \text{ Hz} \checkmark \quad (2)$$

1.4
- Connect capacitors in parallel to the load(reduce phase difference between the voltage and the current)
- Use synchronous motor
- Use static capacitors
- Use induction motors with phase advancers

(Any 3 X1) (3)

1.5 $I_{rms} = 0{,}707 I_m$

$$I_m = \frac{I_{rms}}{0{,}707}$$

$$= \frac{2{,}121}{0{,}707} \checkmark$$

$$= 3 \text{ A} \checkmark$$

$$\omega = 2\pi f$$

$$= 2\pi \times 100 \checkmark$$

$$= 628{,}32 \text{ rad/s} \checkmark$$

$$i = I_m \sin(\omega t)$$

$$= 3 \sin 628{,}32t \checkmark \quad (5)$$

1.6 1.6.1 It is the maximum instantaneous value ✓measured from its zero value in a half cycle✓

OR

the largest value reached in a half cycle .

1.6.2 Peak to peak vale is the difference between ✓the maximum and minimum values in a cycle✓

OR

peak to peak value is twice the peak value

(2 × 2) (4)

1.7 Effective value or virtual value (1)

**[30]**

## QUESTION 2

2.1 2.1.1

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

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

$$= \frac{300 \times 10^3}{\sqrt{3} \times 380 \times 0{,}96} \checkmark$$

$$= 474{,}795 \text{ A} \checkmark \quad (3)$$

2.1.2

$$I_P = \frac{I_L}{\sqrt{3}}$$

$$= \frac{474{,}795}{\sqrt{3}} \checkmark$$

$$= 274{,}123 \text{ A} \checkmark$$

Alternative:

$$I_p = \frac{P}{3\, V_p \cos\theta}$$

$$= \frac{300 \times 10^3}{3 \times 380 \times 0{,}96}$$

$$= 274{,}123 \text{ A} \quad (2)$$

2.2
- Nuclear energy is produced by fission in a nuclear reactor to produce steam
- The pressurised steam is then fed to the turbine
- The turbine drives the alternator, the output is the electrical energy
- After the steam turbine has expanded and partially condensed the steam
- The remaining vapour is condensed in a condenser
- The condenser is connected to a cooling tower
- Then the water from the cooling tower is pumped back into the nuclear reactor (so that the cycle begins again). (Any 6 × 1) (6)

2.3 2.3.1 A lightning arrestor provides a path for surges to be discharged to earth before a flashover on the line occurs.

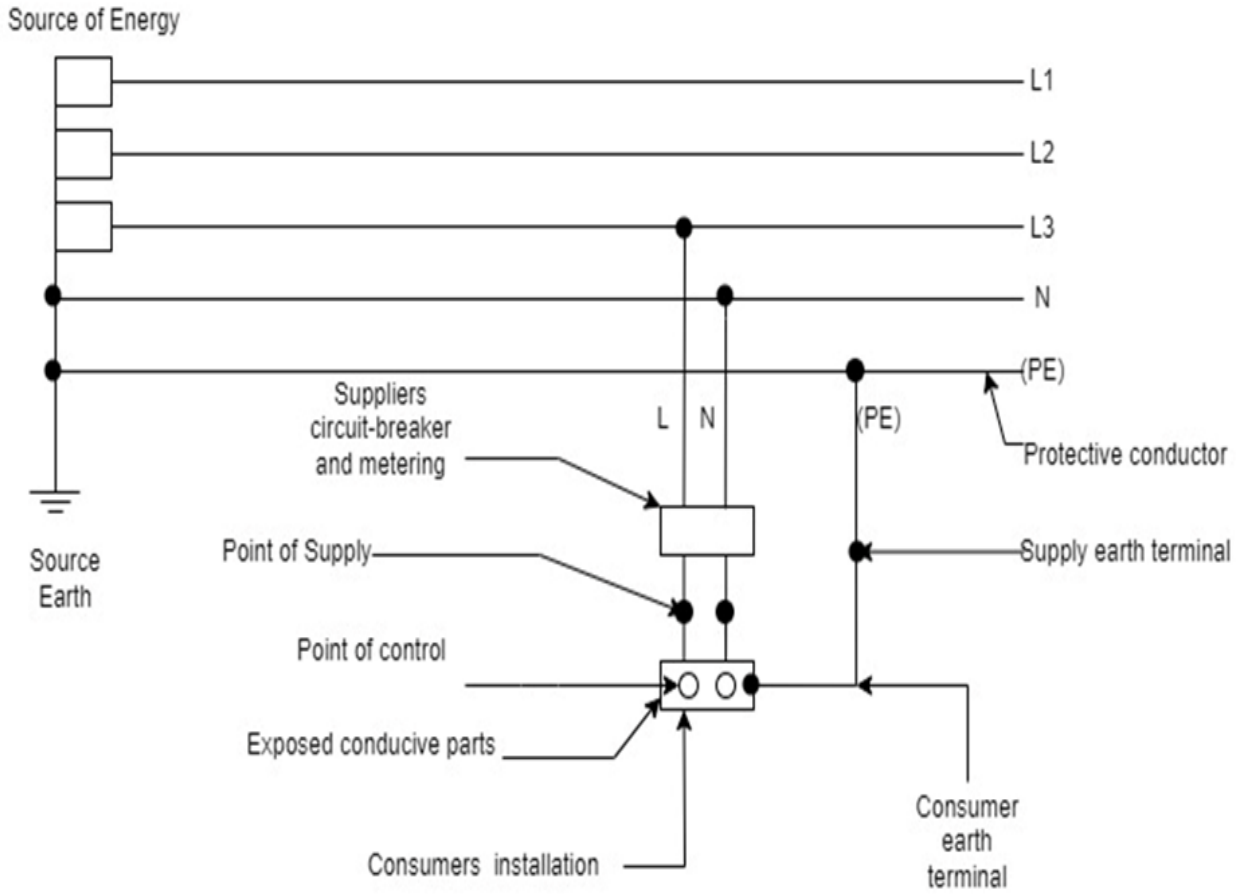
2.3.2 Switchgear is used to isolate, protect, control and monitor low-voltage distribution systems.

(2 × 2) (4)

**[15]**

## QUESTION 3

3.1




2 marks for correct diagram
Any five correct labels (7)

3.2
- To provide a return conductive path for any earth-fault current and earth-leakage current
- To maintain the neutral of the LV system as close as possible to earth potential
- To ensure that the medium-voltage (MV) protection operates in the event of a fault between the MV and LV windings of a transformer
- To reduce the prospective touch voltage as much as is reasonably practical (4)

3.3 3.3.1 It is a conductor, including any clamp or terminal, ✓ by which the connection of the consumer's earth terminal or conductor to an earth electrode or to the supplier's protective conductor, is made✓.

3.3.2 One or more conductive parts that are embedded in the earth ✓for the purpose of making effective electrical contact with the general mass of the earth. ✓

(2 × 2) (4)

**[15]**

**QUESTION 4**

4.1 4.1.1

- Open-circuit test OR No load test
- Short-circuit test OR Impedance test: (2)

4.1.2 Open-circuit test OR No load test:

- Its purpose is to determine the no-load loss or core loss and the no- load primary current ($I_0$).✓

Short-circuit test OR Impedance test:

- Its purpose is to determine the copper loss at full load as well as at any desired load.✓ (2)

4.2 In a potential transformer circuit, the secondary winding is connected to a voltmeter✓ and the primary winding is connected across the line where measurements need to be taken.✓ (2)

4.3 4.3.1 $V_{L1} = V_{P1} = 6\,000\ \text{V}$

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

$$= \frac{346{,}41}{\sqrt{3}} ✓$$

$$= 200\ \text{V} ✓$$

$$\text{Transformation ratio} = \frac{V_{P1}}{V_{P2}}$$

$$= \frac{6\,000}{200} ✓$$

$$= 30:1 ✓$$ (4)

4.3.2 $$I_{P1} = \frac{I_{L1}}{\sqrt{3}}$$

$$= \frac{120}{\sqrt{3}} ✓$$

$$= 69{,}282\ \text{A} ✓$$ (2)

4.4

- On the primary, a smaller winding cross section is required.
- On the secondary, neutral is available, so it can therefore be used for a three-phase, four-wire system.
- There is no distortion in the secondary voltage.
- It can handle a large, unbalanced load. (Any 3 × 1) (3)

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4.5 4.5.1
The loss of power in a transformer as a result of domains in the core having to realign themselves during each cycle of an alternating current. (2)

- Quality and amount of iron in the core (3)
- Flux density
- Frequency

**[20]**

**QUESTION 5**

5.1 5.1.1 $E = V - I(R_a + R_{se})$

$= 1\,000 - 50\,(0{,}6 + 0{,}4)$✓✓

$= 950\ \text{V}$✓

5.1.2 $E = \dfrac{2p\emptyset ZN}{60\,c}$

$N = \dfrac{E60c}{2p\emptyset Z}$

$= \dfrac{950 \times 60 \times 2\,✓}{2 \times 2 \times 0{,}1 \times 315\,✓}$

$= 904.76\ or\ 905\ \text{r/min}$✓

(2 × 3) (6)

5.2 5.2.1 no-volt protection device; overload protection device (2)
5.2.2 field coil (winding); armature (2)
5.2.3 less (1)
5.2.4 no/light (1)

5.3 5.3.1
- In squirrel-cage rotor motors, bars are used.
- In wound-rotor motors, winding wires are used.

5.3.2
- Squirrel-cage rotor motors can be started by direct-on-line (DOL), star-delta or auto-transformer starters.
- Wound-rotor motors can be started by rotor-resistance starter.

5.3.3
- Squirrel-cage rotor motors have low starting torque.
- Wound-rotor motors have high starting torque.

(3 × 2) (6)

5.4
- Winding loss
- Friction loss (2)

**[20]**

**TOTAL: 100**