higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE (VOCATIONAL)

## ELECTRICAL PRINCIPLES AND PRACTICE
## NQF LEVEL 4

## 15 November 2024

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

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## QUESTION 1

1.1 Loop ABEFA

$E_1 - E_2 = I_1 r_1 + r_2 I_2$ ✓

$75 - 55 \quad = 0{,}25I_1 + 0{,}3I_2$ ✓

$20 \quad = 0{,}25I_1 + 0{,}3I_2 \ldots\ldots\ldots\ldots\ldots\ldots (1)$ ✓

Loop BCDEB

$E_2 = R_L(I_1 - I_2) - I_2 r_2$ ✓

$55 \quad = 2{,}5I_1 - 2{,}5I_2 - 0{,}3I_2$ ✓

$55 \quad = 2{,}5I_1 - 2{,}8I_2 \ldots\ldots\ldots\ldots\ldots\ldots (2)$ ✓

$(1) \times 2{,}8\text{: } 56 \quad = 0{,}7I_1 + 0{,}84I_2 \ldots\ldots\ldots (3)$ ✓

$(2) \times 0{,}3\text{: } 16{,}5 \quad = 0{,}75I_1 - 0{,}84I_2 \ldots\ldots\ldots (4)$ ✓

$(3) + (4)\text{: } 72{,}5 = 1{,}45I_1$

$I_1 = 50\ A$ ✓

$Sub.\ (I_1 = 50\ A)\ in\ (1)$

$20 \quad = 0{,}25 \times 50 + 0{,}3I_2$ ✓

$0{,}3I_2 = 7{,}5$ ✓

$I_2 = 25\ A$ ✓

(11)

1.2
1.2.1 C
1.2.2 E
1.2.3 D
1.2.4 B
1.2.5 A

(5 × 1) (5)

1.3 1.3.1
- The frequency is directly proportional to the inductive reactance.
- When the frequency increases, the inductive reactance also increases.
- When the frequency decreases, the inductive reactance also decreases. (Any 1 × 1)

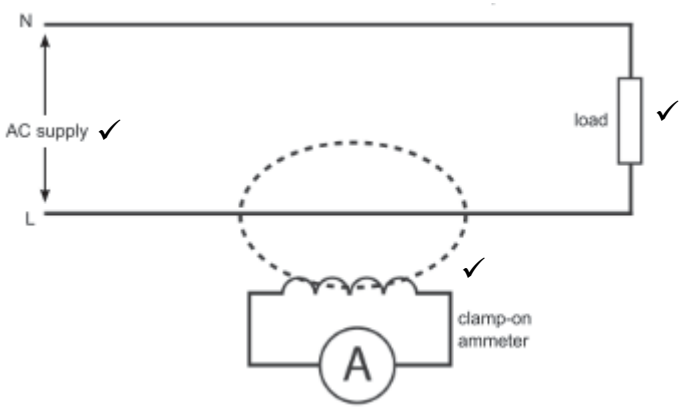
1.3.2
- The frequency is inversely proportional to the capacitive reactance.
- When the frequency increases, the capacitive reactance decreases.
- When the frequency decreases, the capacitive reactance increases.

(Any 1 × 1) (2)

1.4 1.4.1
- $V_C > V_L$
- $X_C > X_L$
- Frequency is lower than resonance frequency

(Any 2 × 1) (2)

1.5 1.5.1




(3)

1.5.2 When you close the jaws around the conductor, ✓ the alternating magnetic field induced in the core produces a current in the secondary winding of an ammeter. ✓ This current causes a deflection on the scale of the meter.✓ (3)

1.6 1.6.1 Form factor
1.6.2 Instantaneous value

(2 × 1) (2)

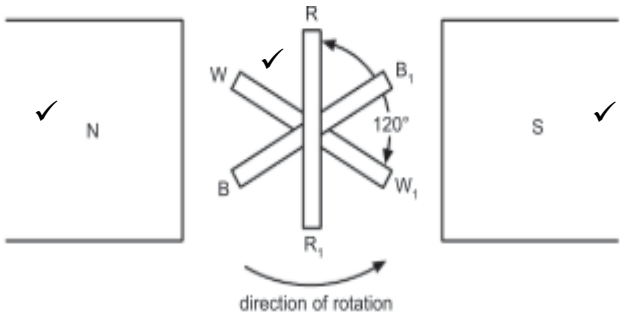
1.7 1.7.1 Waveform - Is a curve that shows the shape of a wave at a given time, it also show the variations of electrical quantities like voltage and current at a given time

1.7.2 Sine waveform - Is a curve that represents periodic oscillations of constant amplitude as given by a sine function.

(2)
**[30]**

## QUESTION 2

2.1




(3)

2.2
- Three-phase current is cheaper to generate than single-phase current.
- A three-phase distribution system can also provide single-phase current.
- Three-phase motors need less maintenance.
- A rotating magnetic field is easily produced in a three-phase induction motor.
- There is less power loss in the value for a given amount of load power.
- Three-phase motors produce a constant shaft torque, resulting in less variation and vibration.
- Rectified three-phase does not require as much filtering as rectified single-phase.
- Three-phase systems need less copper or less conducting material than single-phase systems for a given voltage rating.(smaller conductor sizes)
- Three-phase has higher power factor as compared to single-phase motors of the same rating. (Any 5 × 1) (5)

2.3 $P = \sqrt{3}\, V_L I_L cos\theta$

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

$$= \frac{5000}{\sqrt{3} \times 380 \times 10} \checkmark$$

$$= 0{,}76 \checkmark$$

(3)

2.4
2.4.1 $V_L = \sqrt{3}\, V_P \checkmark$
2.4.2 $V_L = V_P \checkmark$
2.4.3 $I_L = I_P \checkmark$
2.4.4 $I_L = \sqrt{3}\, I_P \checkmark$

(4 × 1) (4)

**[15]**

## QUESTION 3

3.1
- TN – C
- TN – C – S
- TN – S
- TT
- IT

(Any 3 × 1) (3)

3.2 3.2.1 Single-phase earth leakage relay (1)

3.2.2
A – Sensing core
B – Test button
C – Primary coil
D – Secondary coil (4)

3.2.3 Under normal working conditions, the current through the live and neutral conductors is equal in magnitude but flows in opposite directions.✓ The current in load-carrying conductors at any given moment is balanced,✓ which results in no EMF being induced in the secondary winding.✓ (3)

3.3
3.3.1 False
3.3.2 False
3.3.3 True
3.3.4 True

(4 × 1) (4)

**[15]**

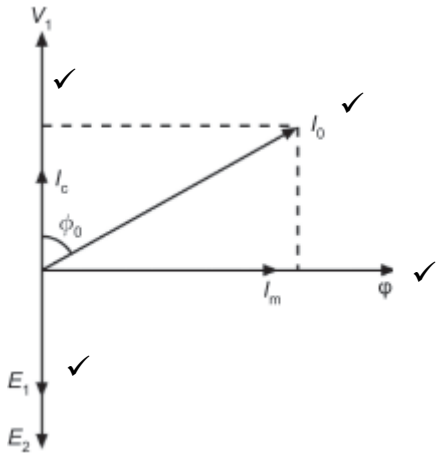
## QUESTION 4

4.1 4.1.1 Eddy current losses are undesirable currents which occur in a conductor when it is exposed to an alternating magnetic field.✓

4.1.2 Copper losses are as a result of the heat produced by electric currents in the conductors of transformer windings.✓

(2 × 1) (2)

4.2




(4)

4.3
- A shell-type transformer is the one in which the core of a transformer encircles the windings.
- A core-type transformer is the one in which the windings surround the core. (2)

4.4 4.4.1

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

$$= \frac{400}{\sqrt{3}} \checkmark$$

$$= 230{,}940\ V \checkmark$$

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

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

$$= \frac{230{,}940 \times 1}{20} \checkmark$$

$$= 11{,}547\ V \checkmark \quad (4)$$

4.4.2

$$\frac{I_{P2}}{I_{P1}} = \frac{N_1}{N_2} \qquad \boldsymbol{OR} \qquad \frac{I_{P2}}{I_{P1}} = \frac{V_{P1}}{V_{P2}}$$

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

$$= \frac{20 \times 1}{20} \checkmark \qquad = \frac{20 \times 11{,}547}{230{,}940}$$

$$= 1\ A \checkmark \qquad = 1\ A$$

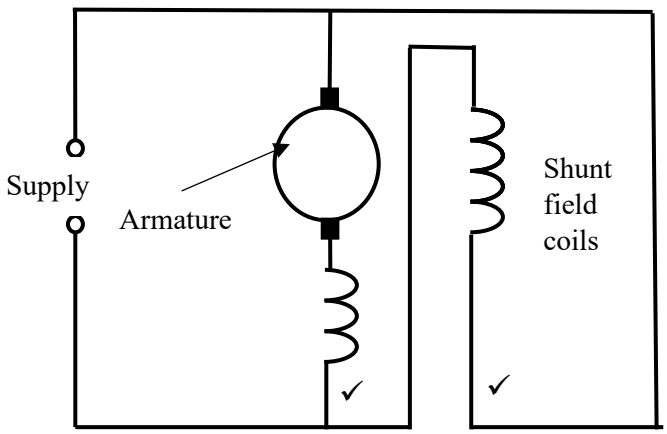
$$\therefore I_{P1} = I_{L1} = 1\ A \checkmark \quad (3)$$

4.4.3
- The third primary or secondary winding has a loos connection (the conductor is not secured on the connector block)
- The third primary or secondary winding is burnt open or open circuit (2)

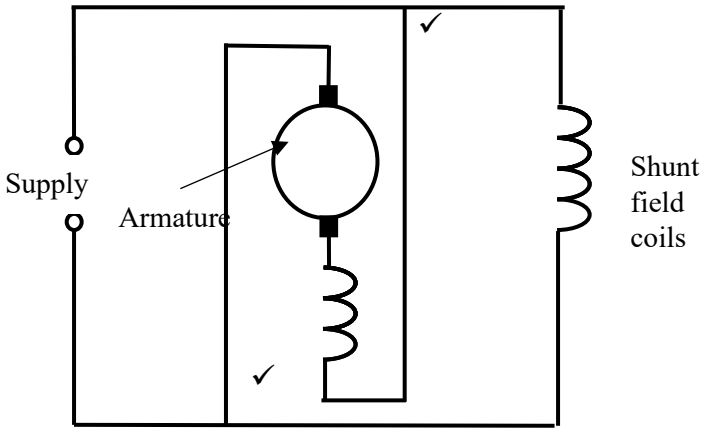
4.5 4.5.1 Voltages✓ and currents✓ (2)
4.5.2 Voltage transformer✓ (1)
**[20]**

## QUESTION 5

5.1




(4)




5.2 5.2.1 (3)

$$I_{sh} = \frac{V}{R_{sh}}$$

$$= \frac{300}{100} \checkmark$$

$$= 3\,A \checkmark$$

$$I_a = I + I_{sh}$$

$$= 50 + 3$$

$$= 53\,A \checkmark$$

5.2.2 $E = V + I_a(R_a + R_{se})$ (3)

$= 300 + 53\ (0{,}02 + 0{,}01)$ ✓

$= 300 + 1{,}59$✓

$= 301{,}59\ V$ ✓

5.3
- Main winding or running winding
- Auxiliary winding or starting winding
- Capacitor
- Squirrel-cage rotor (4)

5.4
- When the supply is switched off or fails.
- When there is a drop in supply voltage(voltage drop) or low voltage. (2)

5.5
- Supply voltage
- Loading
- Line frequency
- Phasing (4)

**[20]**

**TOTAL: 100**

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