higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4

27 February 2020

This marking guideline consists of 8 pages.

Copyright reserved

QUESTION 1

1.1
- If the frequency is decreased then Xc will increase, ✓ therefore the voltage across the capacitor will increase. ✓
- At the same time, XL will decrease ✓therefore the voltage across the inductor will decrease. ✓ (4)

1.2 1.2.1 In loop ABEFA

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

$E_1 - E_2 = I_1R_1 + R_2(I_1 - I_2)$

$20 - 16 \ \ = 2I_1 + 1(I_1 - \ I_2)$ ✓

$4 \ \ = 2I_1 + 1I_1 - 1I_2$

$4 \ \ = 3I_1 - 1I_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$ ✓

In loop ABCDEFA

$E_1 = I_1R_1 + R_3I_2$

$20 \ = 2I_1 + 4I_2 \ \ OR \ \ 10 \ = I_1 + 2I_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$ ✓

$(1) \times 4\text{:}\ 16 \ \ = 12I_1 - 4I_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$ ✓

$(2) + (3)\text{:}\ 36 \ \ = 14I_1$✓

$I_1 = 2{,}57\ A$ ✓

$Sub.\ (I_1 = 2{,}57\ A)\ in\ EQ\ 1$

$4 \ \ = 3 \times 2{,}57 - 1I_2$✓

$4 \ \ = 7{,}71 - 1I_2$

$-1I_2 \ \ = -3{,}71$✓

$I_2 = 3{,}71\ A$ ✓

$I_3 = I_1 - I_2 = 2{,}57 - 3{,}71 = -1{,}14\ A$ ✓ (10)

Copyright reserved

1.3

$$R_T = \frac{V_T}{I_T}$$

$$= \frac{40}{4} \checkmark$$

$$= 10\ \Omega \checkmark$$

$$R_T = R_P + R_{6\Omega}$$

$$10 = R_P + 4 \checkmark$$

$$R_P = 6\ \Omega \checkmark$$

$$\frac{1}{R_P} = \frac{1}{R_{12\Omega}} + \frac{1}{R_x}$$

$$\frac{1}{R_X} = \frac{1}{R_P} - \frac{1}{R_{12\Omega}}$$

$$= \frac{1}{6} - \frac{1}{12} \checkmark$$

$$= \frac{1}{12}$$

$$R_X = 12\ \Omega \checkmark$$

$$OR \qquad R_P = \frac{R_{12\Omega} \times R_X}{R_{12\Omega} + R_X}$$

$$6 = \frac{12 \times R_X}{12 + R_X}$$

$$6(12 + R_X) = 12 \times R_X$$

$$12 + R_X = 2R_X$$

$$\therefore R_X = 12\ \Omega$$

(6)

1.4

- The 12 Ω resistor will draw high current for a moment and burn out
- OR Since the solid wire (short) measures almost zero, it causes excessive current which, in turn, causes power dissipation to increase many times and the resistor to burn out.
- The current through the 4 Ω resistor will increase (2)

1.5

- Connect battery to the circuit and switch on the voltmeter to a suitable DC voltage scale.
- Slowly turn Rs(Variable resistor) to bring the voltage on the voltmeter closer to 0V.
- If the voltage increases, turn Rs(Variable resistor) in the opposite direction.
- As the voltage approaches 0V select a suitable mV range on the meter.
- As soon as the voltage on the voltmeter reaches 0 V, the bridge is balanced. (5)

1.6 $X_C = \frac{1}{2\pi fC}$

$= \frac{1}{2\pi \times 50 \times 45 \times 10^{-6}}$ ✓

$= 70{,}736\ \Omega$ ✓

$I_C = \frac{V_C}{X_C}$

$= \frac{230}{70{,}736}$

$= 3{,}25\ A$ ✓ (3)

[30]

QUESTION 2

2.1
- The amount of fuel required is quite small. Therefore, there is a considerable saving in the cost of fuel transportation
- A nuclear power plant requires less space as compared to any other type of the same size.
- It has low running charges as a small amount of fuel is used for producing bulk electrical energy.
- This type of plant is very economical for producing bulk electric power.
- It can be located near the load centres because it does not require large quantities of water and need not be near coal mines. Therefore, the cost of primary distribution is reduced
- There are large deposits of nuclear fuels available all over the world. Therefore, such plants
- can ensure continued supply of electrical energy for thousands of years.
- It ensures reliability of operation (Any 5 × 1) (5)

2.2
- With the increase in transmission voltage, the transmission efficiency increases for a given amount of power that has to be transmitted over a given distance.
- Line losses are reduced, as they are inversely proportional to the transmission voltage.
- Voltage regulation is improved because of reduction in line losses.
- A high transmission voltage reduces the size of the conductors. The cost of the conductors and supporting structural materials is thus greatly reduced.
- It provides flexibility for future system growth.
- An increase in transmission capacity is also available. (Any 5 × 1) (5)

Copyright reserved

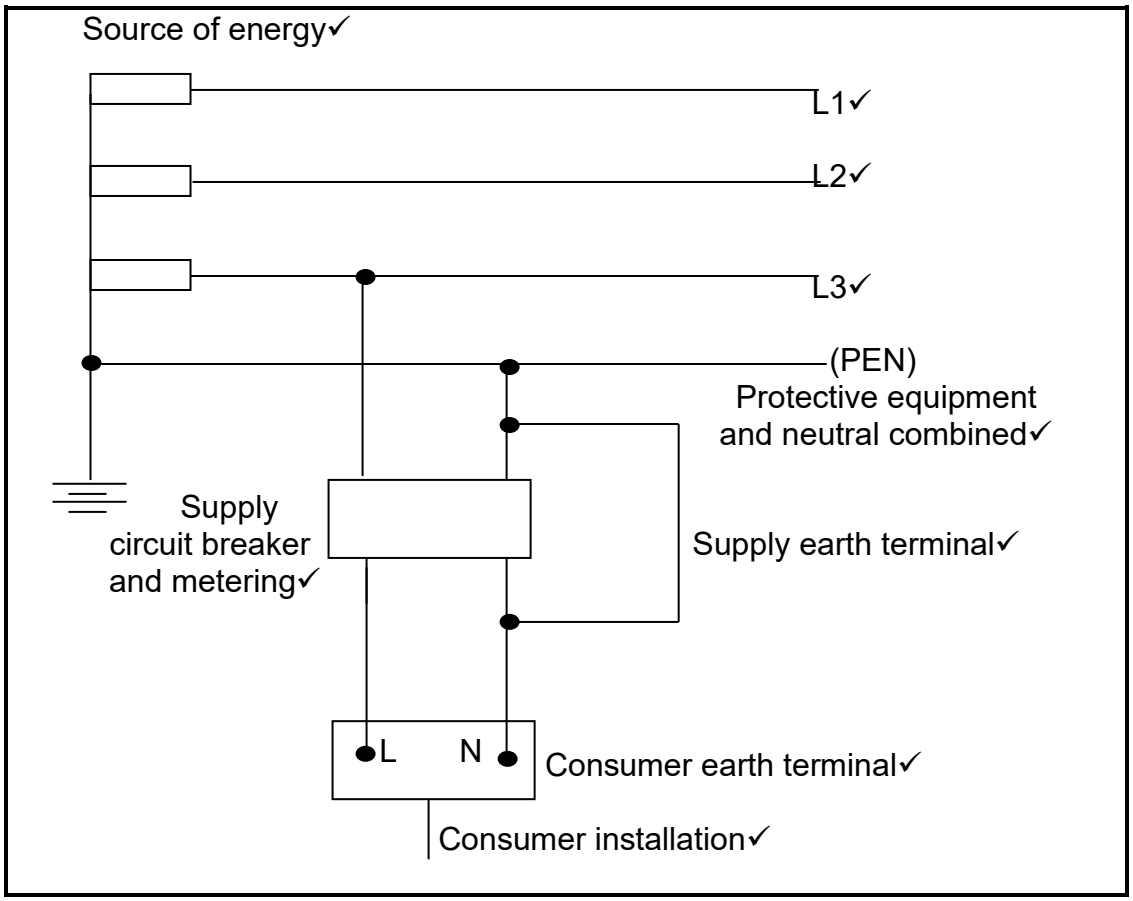
2.3
- Very high voltages are used for transmission systems because the higher the voltage, the cheaper the supply.
- Because P = VI cosΦ, an increase in voltage reduces the current for a given amount of power.
- A lower current thus results in reduced cable and switchgear size and transmission line losses. (3)

2.4
- In a star connection the three-line conductors are each connected to a load
- The outlets from the load are joined together at a junction N, which is called the star or neutral point (2)

[15]

QUESTION 3

3.1



3 Marks for correct sketch
6 Marks for any correct label (9)

3.2 3.2.1 Core-balanced earth leakage relay (1)

3.2.2 A = Shunt trip coil
B = Sensing core
C = Secondary winding
D = Trigger circuit
E = Relay (5)

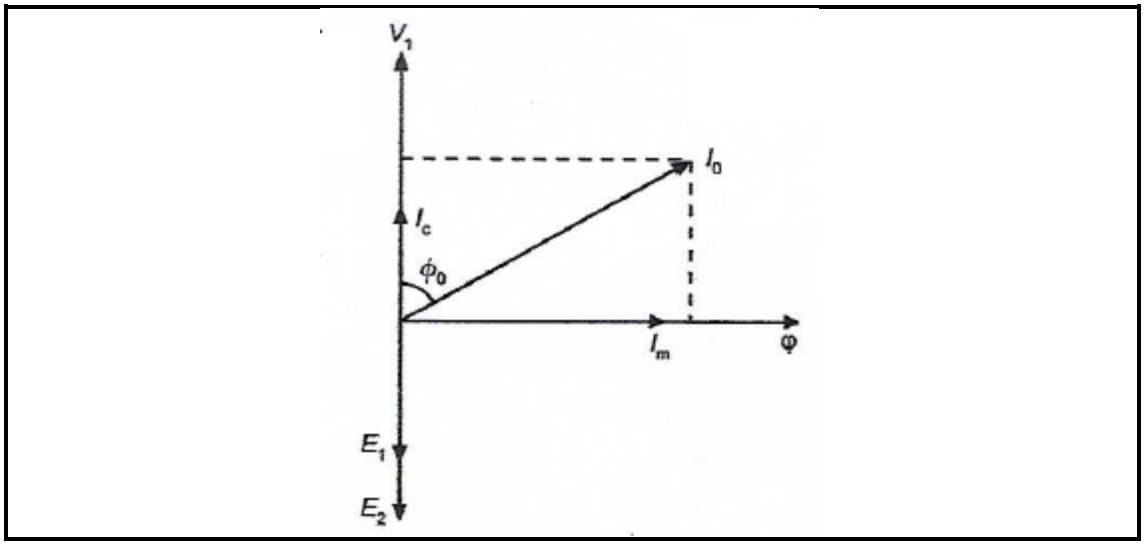
[15]

QUESTION 4

4.1
- Copper losses are losses that occur in the winding in the form of heat energy
- produced by electrical currents in the conductors of transformer windings. (2)

4.2
- Copper loss of a transformer depends on current and iron loss on voltage.
- Hence, total transformer loss depends on volt-ampere (VA) and not on phase angle between voltage and current
- it is independent of load power factor (Any 2 × 1) (2)

4.3



1 Mark for correct sketch
3 Marks for any correct label (4)

4.4 4.4.1

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

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

$$= \frac{3\,000 \times 40}{500} \checkmark$$

$$= 240\,V \checkmark$$ (2)

4.4.2

$$S = V_1 I_1$$

$$I_1 = \frac{S}{V_1}$$

$$= \frac{25\ 000}{3\ 000}\ \checkmark$$

$$= 8{,}33\ A\ \checkmark$$

AND

$$S = V_2 I_2$$

$$I_2 = \frac{S}{V_2}$$

$$= \frac{25\ 000}{240}\ \checkmark$$

$$= 104{,}167\ A\ \checkmark$$

OR

$$\frac{V_1}{V_2} = \frac{I_2}{I_1} \qquad OR \qquad \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

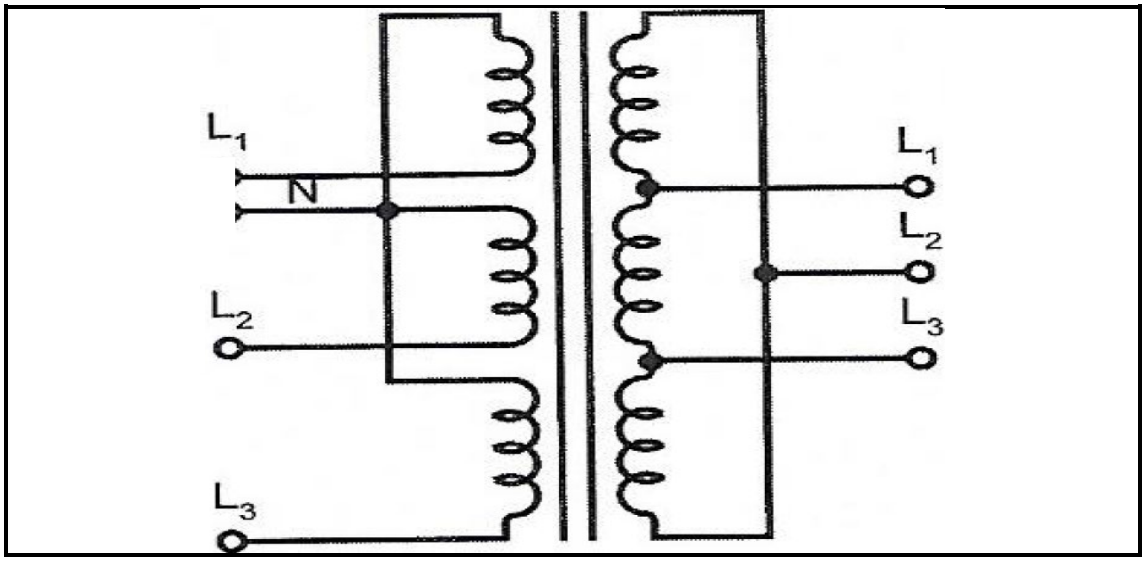
$$I_2 = \frac{V_1 I_1}{V_2} \qquad I_2 = \frac{N_1 I_1}{N_2}$$

$$= \frac{3\ 000 \times 8{,}33}{240} \qquad = \frac{500 \times 8{,}33}{40}$$

$$= 104{,}125\ A \qquad = 104{,}125\ A$$

(4)

4.5



(6)

2 Marks for correct sketch
1 Mark for correct neutral point and label
Half a mark for each correct label of lines

[20]

QUESTION 5

5.1
- It is made of a bimetallic strip that is heated by the current that is drawn by the circuit.
- During overload conditions the current produces enough heat to bend the bimetallic strip.
- This occurs because the two different metals expand at different rates.
- As the bimetal bends, it activates the trip contacts that are connected to the free end of the strip. (4)

5.2 Differentially compound wound generator is when two fields ✓are wound so that the flux oppose one another. ✓ (2)

5.3
- As the flux changes in response to the AC current
- currents are induced in the shaded ring that oppose the changing flux.
- As there is a time delay for the rise of the field in the ring,
- a rotating field takes place, which drags the rotor along. (4 × 1) (4)

5.4
5.4.1 True
5.4.2 True
5.4.3 True
5.4.4 False
(4 × 1) (4)

5.5
$$E = \frac{2p\emptyset ZN}{60\ c}$$

$$= \frac{2 \times 3 \times 0{,}025 \times 612 \times 900}{60 \times 2}\ \checkmark\checkmark$$

$$= 688{,}5\ V\ \checkmark$$

$$E = V + I_a R_a$$

$$V = E - I_a R_a\ \checkmark$$

$$= 688{,}5 - 80 \times 0{,}4\ \checkmark$$

$$= 656{,}5\ V\ \checkmark$$ (6)

[20]

TOTAL: 100

Copyright reserved