



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE
ELECTRICAL TRADE THEORY N2**

(11041872)

**20 November 2020 (X-Paper)
09:00–12:00**

This question paper consists of 7 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
ELECTRICAL TRADE THEORY N2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
 2. Read all the questions carefully.
 3. Number the answers according to the numbering system used in this question paper.
 4. Where applicable, answers must be in accordance with the SABS (SANS) Code of Practice SANS 10142-1:2003 for the Wiring of Premises.
 5. Sketches must be neat, labelled and large enough to show the required detail.
 6. Round off answers to TWO decimals.
 7. Write neatly and legibly.
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QUESTION 1: CONDUCTORS AND CABLES

- 1.1 The declared voltage between phases at the supply point of an installation is 400 V.
Calculate the maximum voltage that can be expected between a phase and neutral conductor at any outlet in the installation. (2)
- 1.2 Name FIVE variables that should be considered when selecting a cable for a specific application.  (5)
- 1.3 Name FOUR advantages of installing cables in open air. (4)
- [11]**

QUESTION 2: SWITCHGEAR, CONTACTORS AND RELAYS

- 2.1 State whether the following joints are better suited for low voltage or high voltage applications:
- 2.1.1 Conductors joined together with screw connectors.
- 2.1.2 Crimped and taped joint housed in a metal joint box containing no resin.  (2 × 1) (2)
- 2.2 In which TWO sub-circuits in house wiring will one use a switch disconnector? (2)
- 2.3 With reference to circuit breakers, explain what is meant by the following:
- 2.3.1 Free-trip mechanism
- 2.3.2 Interpole barriers
- 2.3.3 Common trip  (3 × 2) (6)
- 2.4 Explain why metal joint boxes are not suitable for joining cables buried in soil. (1)
- 2.5 Silver and tungsten are combined to form contacts for circuit breakers.
Explain why tungsten is suitable for this combination. (1)
- [12]**

QUESTION 3: DC MOTORS AND STARTERS

- 3.1 DC machines are named according to the method used to connect the field coils related to armature. 
Name TWO main types of internal connections of a DC machine. (2)
- 3.2 Draw a neat, labelled circuit diagram of the following types of compound wound motors:
- 3.2.1 A long-shunt compound motor
- 3.2.2 A short-shunt compound motor (2 × 3) (6)
- 3.3 Name ONE condition where the protection devices in a face-plate starter will protect the motor against possible damages. (1)
- 3.4 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (3.4.1–3.4.2) in the ANSWER BOOK. 
The direction of rotation of a DC motor may be reversed by reversing the direction of the current through the (3.4.1) ... or through the (3.4.2) ... (2 × 1) (2)
- 3.5 What type of a DC motor has a low starting torque? (1)
[12]

QUESTION 4: AC MOTORS AND STARTERS

- 4.1 Indicate the type of an AC motor for which the following starters will be used:
- 4.1.1 Resistance starters 
4.1.2 Direct-on-line starters
4.1.3 Star-delta starters (3 × 1) (3)
- 4.2 Explain why the rotor of an induction motor cannot run at synchronous speed. (2)
- 4.3 Give an indication of the readings that you would expect when conducting the following tests on the stator winding of a three-phase motor:
- 4.3.1 Short-circuit test
4.3.2 Insulation resistance test to earth 
4.3.3 Insulation resistance between windings (3 × 1) (3)

- 4.4 State how energy is transferred from the stator to the rotor in an induction motor.  (1)
- 4.5 Briefly describe how a squirrel-cage rotor is constructed. (3)
- 4.6 Wound-rotor induction motors are widely used for larger AC applications.
- 4.6.1 Explain how they are connected at start-up.
- 4.6.2 Explain how they are connected when running at full speed. (2 × 1) (2)
- 4.7 What does the regulation stipulate about the overcurrent protective device when single phasing occurs in a three-phase motor? (1)
- [15]**

QUESTION 5: EARTHING

- 5.1 Describe what must be done to prevent electric shock through electrical equipment with metallic frames and / or metallic enclosures. (1)
- 5.2 Explain the concept *touch voltage*  (2)
- 5.3 Define *floating earth* (2)
- 5.4 Define *earth continuity conductor* (2)
- 5.5 State how earth continuity conductors above overhead lines are earthed. (2)
- 5.6 Explain why earth continuity conductors are above overhead lines. (2)
- 5.7 What is the purpose of a cable gland with regard to armoured cable? (1)
- [12]**



QUESTION 6: PROTECTION

- 6.1 What is the minimum leakage current required to operate an earth-leakage relay? (1)
- 6.2 Explain how the earth leakage relay protects you if you hold the bare neutral wire and then touch the bare live wire. (2)
- 6.3 When wiring a circuit, state where the fuse should be installed?  (1)
- 6.4 Explain the operation of a bimetal-type overload relay during overload conditions. (4)

6.5 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (6.5.1–6.5.2) in the ANSWER BOOK.

6.5.1 An earth leakage protection device shall disconnect only a live conductor in a single-phase system.

6.5.2 A varistor is incorporated into a low voltage surge arrester.

(2 × 1)

(2)
[10]

QUESTION 7: MEASURING INSTRUMENTS

7.1 Name TWO measuring instruments that only need to be coupled across the load in order to obtain the reading.

(2)

7.2 Name the measuring instrument used to determine each of the following:

7.2.1 Ratio of true power to apparent power

7.2.2 The highest average value of power in kW (or kVA) during the time period of metering.

7.2.3 The power supplied to a point of supply.

(3 × 1)

(3)

7.3 Where is a ripple relay installed in a domestic installation?

(1)
[6]

QUESTION 8: TRANSFORMERS

8.1 A three-phase transformer is connected in star-delta and the winding ratio is 10:1. The primary line voltage is 2,2 kV.

Calculate the secondary line voltage

(4)

8.2 A single-phase step-down transformer of 11 kV / 220 V has 3000 primary turns.

Calculate the following:

8.2.1 The number of secondary turns

8.2.2 The primary current when the transformer delivers 1500 A

(2 × 2)

(4)

- 8.3 A single-phase transformer is connected to a load and draws a current of 10 amps from a 110 V supply at an angle of $36,87^\circ$.

Calculate the following:

8.3.1 The apparent power

8.3.2 The true power  (2 × 2) (4)
[12]

QUESTION 9: ELECTRONICS

9.1 Explain how a transistor operates during saturation region. (2)

9.2 Explain the operation of a power controller circuit (AC circuit) where the thyristor is used as the controlling device. (3)

9.3 With reference to the diode, explain what you understand by *reverse voltage rating*.  (2)

9.4 Explain why a full-wave bridge rectifier is more preferable in low voltage power supplies as compared to a half-wave rectifier. (1)

9.5 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (9.5.1–9.5.2) in the ANSWER BOOK.

One of the first and still most popular uses of diodes is to (9.5.1) ... current by converting it to (9.5.2) ... current for a wide range of purposes.

 (2 × 1) (2)
[10]

TOTAL: 100

FORMULA SHEET

Any applicable formula may also be used.

Star:

$$V_L = \sqrt{3} V_{PH}$$
$$I_L = I_{PH}$$

Delta:

$$V_L = V_{PH}$$
$$I_L = \sqrt{3} I_{PH}$$

Transformer:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1} = \frac{E_1}{E_2}$$

Single-phase

Apparent power: $S = VI$

True power: $P = VI \cos \phi$

Reactive power: $Q = VI \sin \phi$

Three-phase

Apparent power: $S = \sqrt{3} V_L I_L$

True power: $P = \sqrt{3} V_L I_L \cos \phi$

Reactive power: $Q = \sqrt{3} V_L I_L \sin \phi$

Fault current: $I_{fc} = \frac{CIF \times A}{\sqrt{t}}$