higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL SYSTEMS AND CONSTRUCTION
NQF LEVEL 4

(12041034)

17 November 2022 (X-paper)
09:00–12:00

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

463Q1N2217

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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. Start each question on a new page.
5. Use only a black or a blue pen.
6. Write neatly and legibly.

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QUESTION 1

1.1 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	A structure that provides a path for directing energy from one place to another	A	electrostatic precipitator
1.1.2	When electrons in the transmission lines are attracted to air	B	flue gas exhaust
1.1.3	Heat in the steam is transferred to the cold water in the tubes over which the steam is passed	C	galvanometer
1.1.4	The outlet of gas into the air or atmosphere	D	transmission lines
1.1.5	A device that removes particles from a flowing gas	E	corona
		F	condenser

(5 × 1) (5)

1.2 Explain the difference between *medium* and *low voltage distribution networks*. (4)

1.3 List ONE disadvantage of using high-voltage air-blast switches. (1)

1.4 List TWO advantages of medium-voltage networks. (2)

1.5 Give the function of the following components as used in medium-voltage overhead networks:

1.5.1 Transformers.

1.5.2 Metering equipment.

(2 × 2) (4)

1.6 Explain the procedure to be followed in order to switch an alternator into the grid. (4)

[20]

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QUESTION 2

2.1 Draw a circuit diagram of a direct-on-line starter that can be used to control a three-phase induction motor.

Show both the control and the power circuits. (6)

2.2 List any THREE components that are needed to construct the circuit in QUESTION 2.1. (3)

2.3 Before any construction work can be done, electrical conductors must be de-energised.

Name TWO incidences that might take place if electrical conductors are not de-energised. (2)

2.4 What is the main function of a timer switch in a star-delta starter? (1)

2.5 List any THREE installation tests that can be performed by *multifunction safety compliance analysers.* (3)

[15]

QUESTION 3

3.1 State THREE aspects contained in Eskom's network development plan that must be considered before any network planning is done. (3)

3.2 Conductors for overhead lines must be tightened so that they are not too tight or have too much of slack.

What would be the effect of the following:

3.2.1 Overhead line conductors that are too slack.

3.2.2 Overhead line conductors that are too tight.

(2 × 1) (2)

3.3 A servitude is the right that one person or entity has over the property of another person or entity.

List any FOUR kinds of servitudes to consider when planning your installation. (4)

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3.4 When planning and preparation work has been completed and authorized, construction work can begin by preparing holes or foundations for the poles, erecting structures and connecting the stays.

3.4.1 What is the general spacing of residential electrical poles? (1)

3.4.2 What is the depth of the hole for low-voltage poles? (1)

3.4.3 What is the function of stays that are used in the erection of poles (2)

3.5 You and your team have completed the construction of a three-phase medium voltage overhead line supply.

Which tasks should be completed before the inspection sheets and pre-commissioning reports are completed? (2)
[15]

QUESTION 4

4.1 Draw a wiring diagram of a three-phase, three-wire distribution system with TWO single-phase transformers, (A and B):

Transformer A supplies operations and living quarters.
Transformer B supplies a motor pool and lights. (7)

4.2 It is important to identify and correlate components with building plans and electrical diagrams.

List THREE such aspects that you need to identify their location and how they are wired. (3)

4.3 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.3.1–4.3.5) in the ANSWER BOOK.

4.3.1 When working on extra-high voltage, one should wear a face shield and flame-resistant clothing.

4.3.2 A risk evaluation should only be conducted after the work has been completed.

4.3.3 The earth leakage relay should trip when the leakage current reaches 50 mA.

4.3.4 The insulation resistance between live and earth conductors of an installation should be 0,5 MΩ.

4.3.5 One of the activities that one should do in order to plan well is to prepare the environment.

(5 × 1) (5)

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4.4 State the function of each of the following test instruments:

4.4.1 Hipot tester

4.4.2 LCR meter

4.4.3 Earth ground tester

4.4.4 Multimeter

4.4.5 Phase rotation meter

(5 × 1) (5)
[20]

QUESTION 5

5.1 List THREE housekeeping and safety measures you will consider when planning and preparing for repairs to three-phase systems. (3)

5.2 An underground cable is suspected to be faulty.

List THREE types of techniques/methods that can be used to locate an underground cable fault. (3)

5.3 An imbalanced line voltage, measured at the terminals of a three-phase motor may be as a result of many causes.

List THREE possible causes for this imbalance. (3)

5.4 Explain the following basic fault-finding principles that you will apply when carrying out fault-finding on three-phase systems:

5.4.1 Keep It Simple, Stupid (KISS).

5.4.3 Test by isolation.

(2 × 2) (4)

5.5 List TWO causes for a transformer to overheat. (2)
[15]

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QUESTION 6

6.1 FIGURE 1 below shows a wind energy system.

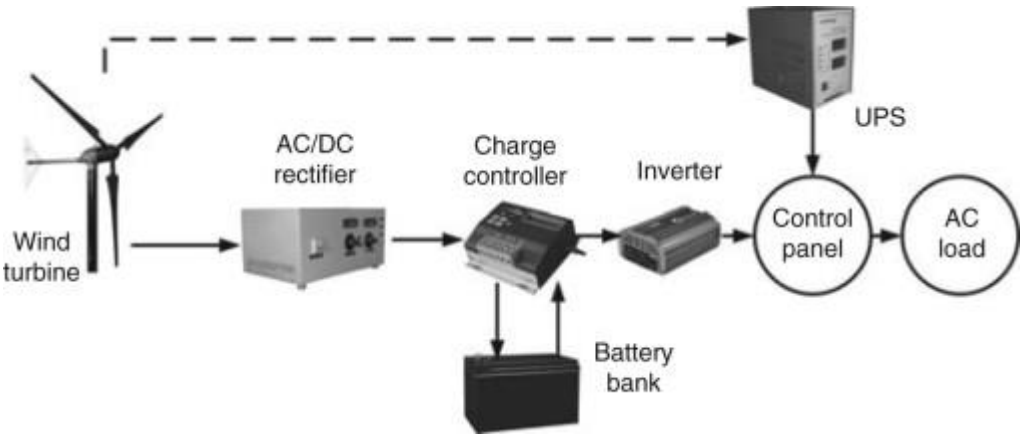

FIGURE 1

State the function of the following components:

6.1.1 Batteries

6.1.2 Charge controllers

(2 × 2) (4)

6.2 A 12 V battery will deliver electricity at a constant rate of 4 kWh for the duration of 622 hours. The battery discharge depth is 75%.

Determine the capacity of the battery. (7)

6.3 When deciding on a battery size or bank for a solar panel system, days of autonomy have to be taken into account.

Explain what is meant by *days of autonomy.* (2)

6.4 State the TWO general rules to be considered when choosing the current wire size with specific reference to voltage drop. (2)

[15]

TOTAL: 100

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FORMULA SHEET

ELECTRICAL SYSTEMS AND CONSTRUCTION L4

1. $E_{\min} = \frac{E_{daily} \times days}{BDD}$

2. $Ah = \frac{E_{\min}}{Battery \cdot voltage}$

3. $Ah = \frac{E_{\min} \times k \times k_c \times k_a}{Battery \cdot voltage}$

4. $Voltage \cdot drop = Vcons\tan t \times l \times I$

5. $Voltage \cdot drop\% = \frac{V_{DROP}}{V_{SUPPLY}} \times 100\%$

6. $P_A = \frac{Wattage \times time}{1000}(kWh)$

7. $P_T = P_{A1} + P_{A2} + P_{AN}(kWh)$

8. $C_T = P_T \times Days/mnth \times E\cos t/kWh$

9. $P_W = \frac{1}{2}\rho A v^3$

10. $P_T = \frac{1}{2}\rho A v^3 \cdot C_T$

11. $P = V \times I$

12. $P_a = V_{rms} \times I_{rms}$

13. $P_a = P_f \times P$

14. $P_T = P_a \times units$

15. $P_{INPUT} = \frac{P_{OUT}}{\eta}$

16. $P_a = \frac{P_{INPUT}}{\eta}$

17. $R = \frac{R_W \times I}{1000}$

18. $V_{DROP} = \frac{R_W \times l \times I}{1000}$

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