higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ELECTRICAL TRADE THEORY N3

(11041263)

28 November 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and a 1-page formula sheet.

124Q1E2328

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTRICAL TRADE THEORY N3
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. Sketches must be neat, labelled and large enough to show the required detail.
5. Where applicable, answers must be in accordance with the SABS (SANS) Code of Practice SANS 10142-1:2003 for Wiring of Premises.
6. Formulae used in Electrical Trade Theory N3 can be found at the end of the question paper.
7. Answer must be given to THREE decimals.
8. Use only black or blue pen.
9. Write neatly and legibly.

Copyright reserved

QUESTION 1: ALTERNATING CURRENT CIRCUIT THEORY

1.1 Three-phase motors are cheaper and smaller for the same power rating than single-phase motors.

State THREE other advantages of three-phase motors over single-phase motors. (3)

1.2 Prove that total power in a balanced star or delta system are both equal to $\sqrt{3}\, V_L I_L \cos\theta$ (5)

1.3 An alternating current is represented by a non-sinusoidal waveform and has the following ordinates:

Phase angle in degrees	0º	30º	60º	90º	120º	150º	180º
Current in amperes	**0**	**28**	**33**	**35**	**28**	**9,5**	**0**

Without drawing the waveform, determine the following:

1.3.1 The average value (6)

1.3.2 The RMS value (2)

1.3.3 The form factor (2)

[18]

QUESTION 2: DOMESTIC APPLIANCES

2.1 Name any THREE types of washing machines. (3)

2.2 State the functions of the following switches:

2.2.1 Three-heat switch

2.2.2 Simmerstat switch

(2 × 2) (4)

2.3 Briefly explain the principle of operation of a solar powered water heater. (5)

[12]

Copyright reserved

QUESTION 3: LIGHTING SYSTEM

3.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1.1–3.1.4) in the ANSWER BOOK.

3.1.1 Incandescent bulbs are very energy efficient.

3.1.2 Halogen light bulbs last two to three times longer than regular incandescent light bulbs.

3.1.3 A fluorescent tube is in fact a mercury vapour discharge lamp.

3.1.4 Removing the glow starter in a fluorescent lamp circuit after it has been switched on, the lamp will switch off.

(4 × 1) (4)

3.2 Refer to Figure 1 below and answer the questions that follow:

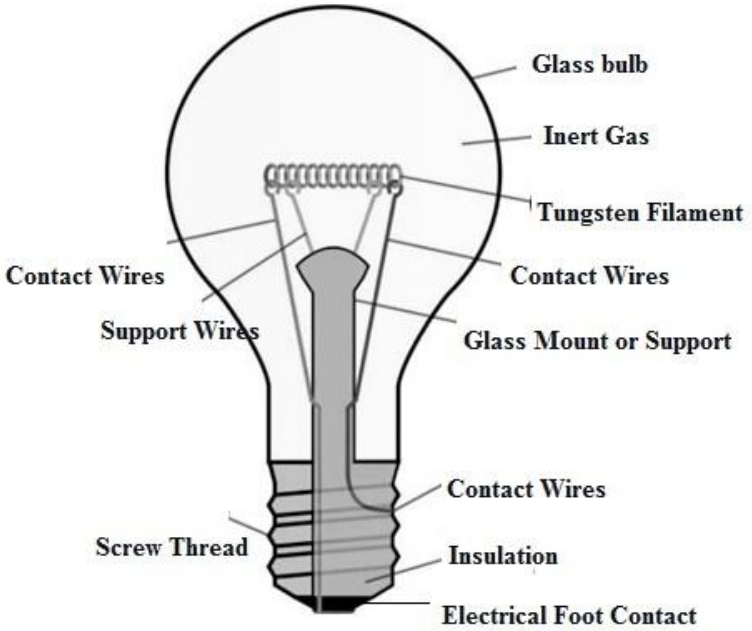

FIGURE 1

3.2.1 What is the function of the inert gas found inside the glass bulb?

3.2.3 Briefly explain the operation of an incandescent lamp.

(2 × 2) (4)

[8]

QUESTION 4: PROGRAMMABLE LOGIC CONTROLLER

4.1 A programmable logic controller is designed for (4.1.1) ... and (4.1.2) … arrangements. (2)

4.2 State any THREE languages used to program PLCs. (3)

[5]

Copyright reserved

QUESTION 5: DIRECT CURRENT MACHINES

5.1 State the purpose of an open-circuit test conducted on DC machines. (2)

5.2 Draw a fully labelled characteristic curve of a DC series motor clearly showing speed against armature current. (3)

5.3 A brake test was applied to a DC series motor and the following data was recorded:

- Terminal voltage = 230 V
- Load current = 25 A
- Effective diameter of pully = 350 mm
- Speed of the motor = 980 r/min
- Mass = 37,5 kg
- Reading on spring balance = 102 N

Determine the efficiency of the DC motor and show all the calculations. (10)
[15]

QUESTION 6: ALTERNATING CURRENT MACHINES

6.1 A four pole, three-phase, star connected induction motor is supplied at 1,1 kV, 50 Hz and rotates at 1 250 r/min. Determine the following:

6.1.1 The synchronous speed of the motor.

6.1.2 The percentage slip at which the motor is operating.

(2 × 2) (4)

6.2 Draw a fully labelled circuit diagram of a resistance starter used to start for a three-phase slip-ring induction motor. (6)
[10]

QUESTION 7: TRANSFORMER

7.1 Briefly explain the difference between the *natural air cooling* and *forced air cooling* methods as used to cool transformers. (4)

7.2 Explain fully how moisture is prevented from entering the transformer. (3)

7.3 There are different kinds of losses that occur in the transformer, such as iron, copper, stray & dielectric losses.

7.3.1 Name TWO types of iron losses. (2)

7.3.2 What do you understand by *dielectric losses*? (1)
[10]

Copyright reserved

QUESTION 8: EARTHING SYSTEMS

8.1 State TWO effects that a missing neutral will have in electrical systems. (2)

8.2 Define the following terms:

8.2.1 Touch voltage (2)

8.2.2 Systems earthing (2)

8.3 Give FOUR reasons why the neutral is earthed on the supply side of an installation. (4) **[10]**

QUESTION 9: POWER MANAGEMENT

9.1 Industrial consumers pay a two parts tariff. State the two parts. (2)

9.2 Mention THREE methods employed by consumers to keep their maximum demand low. (3)

9.3 List TWO devices that can be used by energy utilities to switch off certain heating appliances during peak periods. (2) **[7]**

QUESTION 10: RENEWABLE ENERGY

10.1 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–D) next to the question number (10.1.1–10.1.3) in the ANSWER BOOK.

COLUMN A		COLUMN B
10.1.1	It uses an automatic voltage regulator to correct abnormal voltages without switching to the battery.	A Offline UPS B Cloud UPS
10.1.2	It converts the AC supply into DC by using a rectifier circuit and charges the battery using a charge controller circuit.	C Online double conversion UPS D Line interactive UPS
10.1.3	It supplies power directly to an AC load from the AC supply of a home during normal operation.	

(3 × 1) (3)

10.2 List any TWO sources of direct current. (2) **[5]**

TOTAL: 100

Copyright reserved

(11041263)

ELECTRICAL TRADE THEORY N3

FORMULA SHEET

$I_T = \frac{V}{Z}$

$I_{ACTIVE} = I_T \cos \emptyset$

$I_{REACTIVE} = I_T \sin \emptyset$

$X_l = 2\pi f L$

$Xc = \frac{1}{2\pi fC}$

$\boldsymbol{Z = \sqrt{R^2 + (X_L - X_C)^2}}$

$\cos\theta = \frac{R}{Z}$

$V_R = I_T R$

$V_{XL} = I_T X_L$

$V_{XC} = I_T X_C$

$V = \sqrt{V_R{}^2 + (V_{XL} - V_{XC})^2}$

$P = I^2 R$

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

$E = V + I_a R_a$

Efficiency = $\frac{VI}{VI + I_a{}^2 R_a + I_s V + C} \times 100\%$

Efficiency = $\frac{VI - (I_a{}^2 R_a + I_s V + C)}{VI} \times 100\%$

Efficiency = $\frac{2\pi N(W - S)r}{60VI} \times 100\%$

$S = VI$

$S = \sqrt{3}\, V_L I_L$

DELTA

$V_L = V_{PH/F}$

$I_L = \sqrt{3}\, I_{PH}$

STAR

$V_L = \sqrt{3}\, V_{PH}$

$I_L = I_{PH}$

$\frac{V_P}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$

$N = \frac{f.60}{P}$

$s = \frac{n - n_r}{n}$

$w = 2\pi f$

$P = VI \cos\theta$

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

$T = \frac{0{,}318 I_a Zp\Phi}{C}$

$i = I_m \sin$

$I_{ms} = 0{,}707\, I_m$

$I_{ave} = 0{,}632\, I_m$

$I_{rms} = \sqrt{\frac{i1^2 + i2^2 + \cdots in^2}{n}}$

$I_{ave} = \frac{i_1 + i_2 + .. i_n}{n}$

Form factor = $\frac{RMS - Value}{AVE - Value}$

Crest factor = $\frac{MAX - Value}{RMS - Value}$

SERIES

$R_T = R_1 + R_2 + \cdots R_n$

PARALLEL

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}$

$N = \frac{V}{K\Phi}$

$Efficiency = \frac{output\ power}{input\ power}$

Copyright reserved