higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ELECTRICAL TRADE THEORY N3

(11041263)

12 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators and drawing instruments may be used.

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

124Q1A2112

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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. Answers must be in accordance with the SABS (SANS) Code of Practice SANS 10142-1:2003 for the Wiring of Premises where applicable.
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: DOMESTIC APPLIANCES

1.1 1.1.1 Explain how the temperature of a laundry iron can be controlled. (2)

1.1.2 Give TWO possible fault conditions that could lead to an iron tripping the main earth-leakage relay. (2 × 2) (4)

1.1.3 Which type of thermostat is used in this appliance? (1)

1.2 Draw a neat, labelled circuit diagram to show how the two elements of a stove plate are connected to a three-heat switch to give high heat. Clearly indicate the two elements, three-heat switch and the supply (live and neutral). (3)

[10]

QUESTION 2: PROTECTION

2.1 Indicate whether each of the following must be earthed, must not be earthed or must be bonded together and earthed:

2.1.1 Portable drilling machine

2.1.2 PVC conduits

2.1.3 Metallic working surfaces in kitchens and laundries

2.1.4 Hot-water and cold-water pipe systems

2.1.5 Fixings such as cleats, clips, saddles and clamps

(5 × 1) (5)

2.2 Give the components of a magnetic circuit breaker/overload relay (not thermal-magnetic type) responsible for each of the following:

2.2.1 Quick tripping in case of a short circuit (2)

2.2.2 Time delay before tripping (3)

[10]

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QUESTION 3: ILLUMINATION

3.1 FIGURE 1 shows two discharge lamps connected to an electrical supply.

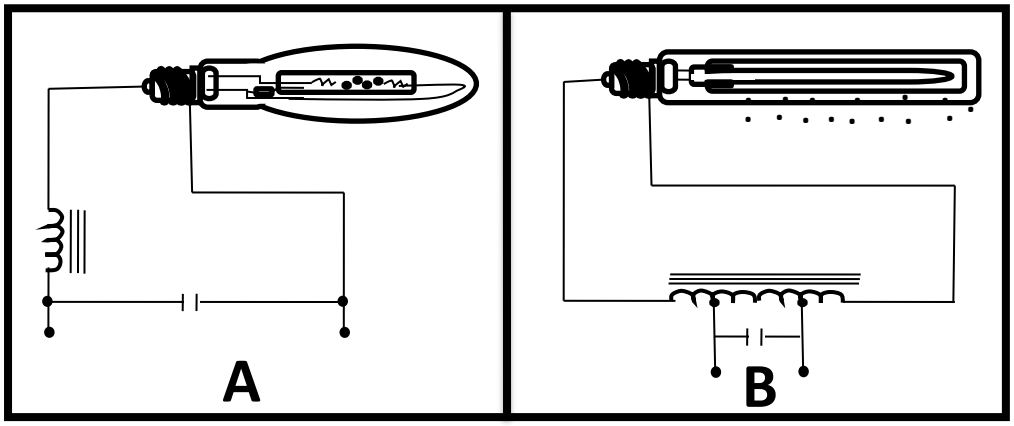

FIGURE 1

3.1.1 Name the discharge lamps labelled A and B. (2 x 1) (2)

3.1.2 Give TWO uses of each lamp. (2 x 2) (4)

3.1.3 Give ONE advantage of lamp B. (1)

3.2 Redraw lamp B and indicate each of the following on the sketch:

- Electrodes
- Neon and argon gas
- Metallic sodium

(3)
[10]

QUESTION 4: ALTERNATING CURRENT THEORY

An alternating voltage is represented by the equation $e = 250\sin 314t$ with the angle in radians.

Determine:

4.1 The maximum value of the emf (1)

4.2 The frequency of the supply (3)

4.3 The effective value of the voltage (2)

4.4 The period of the waveform (1)

4.5 The instantaneous value 0,008 seconds from the start of the cycle (3)
[10]

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QUESTION 5: SERIES RLC CIRCUITS

A series circuit consisting of a 100 mH inductor, 15 ohm-resistor and a variable capacitor is connected across a 150 V, 50 Hz supply.

5.1 Calculate the following for a resonant condition:

5.1.1 The capacitance of the capacitor (2)

5.1.2 The current through the circuit (2)

5.1.3 The voltage drop across the inductor (2)

5.1.4 The voltage drop across the capacitor (1)

5.1.5 The voltage drop across the resistor (1)

5.2 Prove that the vector sum of the three voltage drops is 150 V. (2)
[10]

QUESTION 6: THREE-PHASE AC SYSTEMS

6.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (6.1.1–6.1.5) in the ANSWER BOOK.

6.1.1 The colours representing the three phases of a phase system are red, white and black.

6.1.2 The phase displacement between the three voltages of a three-phase alternator is 120°.

6.1.3 Three-phase alternator windings are usually connected in star.

6.1.4 The line voltage of a star-connected system is 1,73 times the phase voltage.

6.1.5 If the phase voltage of a three-phase star-connected system is 240 V the line voltage is 415,692 V.

(5 × 1) (5)

6.2 Three loads, each with a resistance of 12 Ω, are connected in star to a 415 V three-phase supply system.

Calculate:

6.2.1 The system's phase voltage (2)

6.2.2 The phase current (2)

6.2.3 The line current (1)
[10]

QUESTION 7: TRANSFORMERS

7.1 Electrical transformers are machines that transfer electricity from one circuit to another.

7.1.1 State how electrical energy is transferred from the primary of the transformer to its secondary winding.

7.1.2 What type of voltage is applied to the primary winding of a transformer?

(2 × 1) (2)

7.2 A three-phase transformer has a rating of 30 kVA and is connected in delta-star. The primary line voltage is 11 kV and the secondary line voltage is 400 V.

Ignore losses and calculate:

7.2.1 The transformer ratio (3)

7.2.2 The secondary phase current (3)

7.2.3 The primary line current (2)

[10]

QUESTION 8: DC MACHINES

8.1 Name TWO protective devices found in a face plate starter used to start large DC motors. (2)

8.2 Briefly explain armature reaction with reference to DC motors. (2)

8.3 Draw a neat, fully labelled circuit diagram of a face-plate starter used to start a shunt motor. (6)

[10]

QUESTION 9: AC MACHINES

9.1 Name the type of three-phase motor starter used in each of the following starting methods:

9.1.1 Resistance starting

9.1.2 Reduced voltage starting

(2 × 1) (2)

9.2 Explain how the direction of rotation of a three-phase induction motor may be reversed. (2)

9.3 Draw a neat, labelled circuit diagram of a capacitor-start split-phase motor. (4)

9.4 What is the purpose of a centrifugal switch in single-phase motors? (2)

[10]

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QUESTION 10: MEASURING INSTRUMENTS AND ELECTRONICS

10.1 Draw a basic circuit diagram of the connections required for a wattmeter to be connected to a high-current and high-voltage AC supply. (5)

10.2 Name ONE semi-conductor material used to manufacture diodes and transistors. (1)

10.3 FIGURE 2 shows a configuration of a transistor.

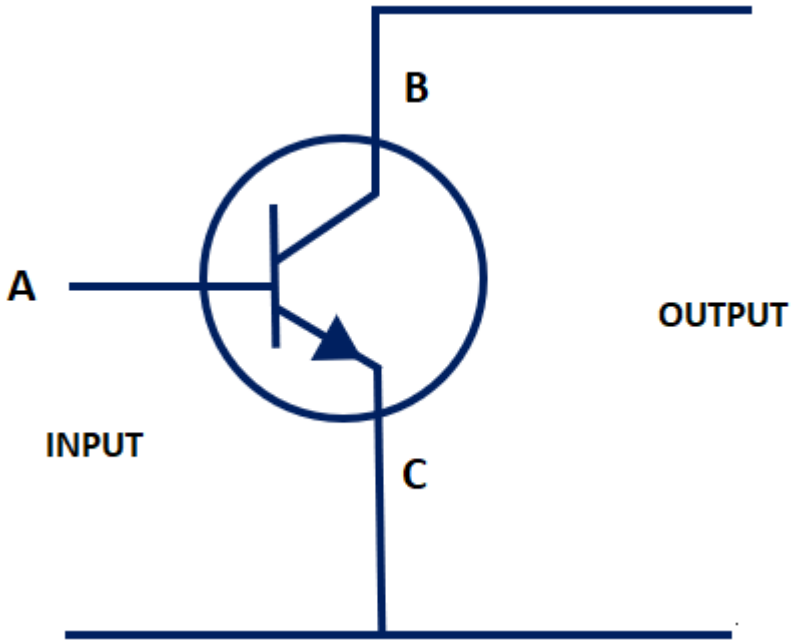

FIGURE 2

10.3.1 Identify the configuration. (1)

10.3.2 Label the terminals by writing only the answer next to letter (A–C) in the ANSWER BOOK. (3 × 1) (3)

[10]

TOTAL: 100

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ELECTRICAL TRADE THEORY N3

FORMULA SHEET

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

$S = VI$

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

$s = \sqrt{3}\ V_L\ I_L$

$i = I_m \sin \emptyset$

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

<u>DELTA</u>

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

$X_L = 2\pi f L$

$V_L = V_{PH/F}$

$I_{ave} = 0{,}637\ I_m$

$X_C = \frac{1}{2\pi f C}$

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

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

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

<u>STAR</u>

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

$\emptyset = Cos^{-1}(\frac{R}{Z})$

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

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

$V_R = I_T R$

$I_L = I_{PH/F}$

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

$V_{XL} = I_T X_L$

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

<u>SERIES</u>

$V_{XC} = I_T X_C$

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

$R_T = R_1 + R_2 + \cdots R_n$

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

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

<u>PARALLEL</u>

$P = I^2 R$

$\omega = 2\pi f$

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

$P = \sqrt{3}\ V_L\ I_L \cos \emptyset$

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