higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T520**(E)**(J31)T

NATIONAL CERTIFICATE

ELECTRICAL TRADE THEORY N3

(11041263)

31 July 2018 (X-Paper)
09:00–12:00

This question paper consists of 8 pages and 1 formula sheet.

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. 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. Answers must be given to TWO decimal places.
7. A FORMULA SHEET with the formulae used in Electrical Trade Theory N3 is attached to the question paper.
8. Write neatly and legibly.

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QUESTION 1: DOMESTIC APPLIANCES

1.1 The procedure below was followed during the replacement of a heating element (immersion type). Rearrange the steps by writing only the letters (A–I) in the correct order in the ANSWER BOOK.

A Reconnect the element.

B Close the cold-water supply to the geyser.

C Replace with the new element and gasket.

D Isolate the geyser from the supply.

E Open one hot-water tap and drain the water through the drain stopcock.

F Restore the supply.

G Disconnect and remove the element.

H Open the cold-water supply, let the geyser fill up, close the hot-water tap and check for leaks.

I Replace the cover plate.

(9 × 1) (9)

1.2 Name the alloy that is normally used for manufacturing heating elements. (1)

[10]

QUESTION 2: PROTECTION

2.1 Briefly describe the function of the following:

2.1.1 Circuit breaker

2.1.2 Earth leakage

(2 × 2) (4)

2.2 Name the components indicated in FIGURE 1 of a core-balanced earth leakage relay. Write only the name of the component next to the question number (2.2.1–2.2.6) in the ANSWER BOOK.

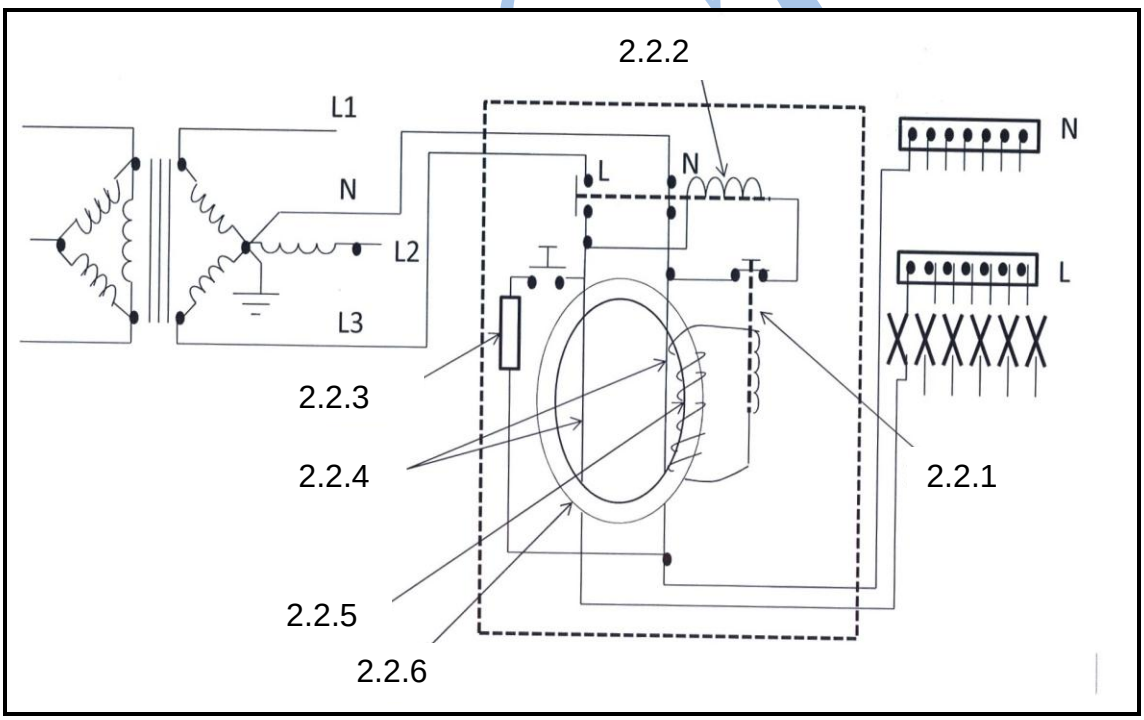


FIGURE 1: CORE-BALANCED EARTH LEAKAGE RELAY (6)

[10]

QUESTION 3: ILLUMINATION

3.1 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–E) next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1.1	Tungsten halogen lamps	A	used in households and offices
3.1.2	Cold cathode neon lamps	B	used for street lighting, floodlighting and lighting of industrial premises
3.1.3	High-pressure mercury-vapour discharge lamps	C	used on highways and airports runways
3.1.4	Compact fluorescent lamps	D	used for floodlighting, vehicle headlights and aircraft landing lights
3.1.5	Sodium-vapour discharge lamps	E	used for indicating lights on electrical appliances such as stoves, fridges and control panels where space is limited

(5 × 1) (5)

3.2 FIGURE 2 shows different types of lamps as used in an electrical field.

Name each type of lamp and write only the answer next to the letter (A–C) in the ANSWER BOOK.

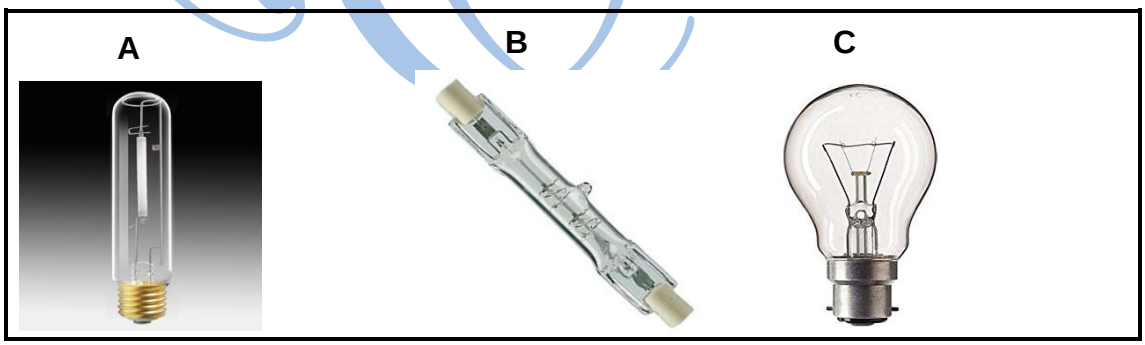


FIGURE 2: DIFFERENT LAMPS (3)

3.3 State TWO main components of a compact fluorescent lamp. (2)

[10]

QUESTION 4: ALTERNATING-CURRENT THEORY

The current equation of circuit is $i = 250 \sin 314t$.

Calculate:

4.1 The maximum current value (1)

4.2 The effective value of the current (3)

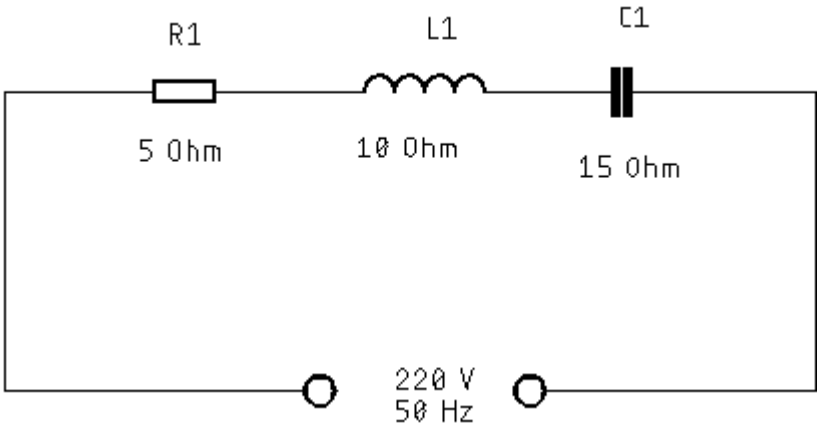
4.3 The frequency (3)

4.4 The instantaneous value 8 milliseconds after reaching zero while increasing positively (3)

[10]

QUESTION 5: SERIES RLC CIRCUIT

A series circuit comprises a resistor of 5 ohms, a coil of inductive reactance of 10 ohms and a capacitor of capacitive reactance of 15 ohms. The circuit is connected to a 220 V 50 Hz alternating supply.



Calculate:

5.1 The impedance of the circuit (3)

5.2 The total current flow (3)

5.3 The voltage drop across the resistor (3)

5.4 State the nature of current flow versus voltage applied in a capacitor connected to an alternating supply. (1)

[10]

QUESTION 6: THREE-PHASE AC SYSTEMS

6.1 A three-phase delta-connected motor draws a current of 12 A at full load from a 415 V supply at a power factor of 0,86.

Calculate:

6.1.1 The phase current flowing in the motor (3)

6.1.2 The phase voltage (1)

6.1.3 The power input to the motor (3)

6.2 Make a neat, labelled sketch to illustrate the delta connection of a three-phase system and indicate the line and phase voltages on your sketch. (3)

[10]

QUESTION 7: TRANSFORMERS

7.1 Explain the operation principle of a transformer. (2)

7.2 A 300 kVA 3-phase transformer has a star-connected primary and delta-connected secondary. The secondary line voltage is 2,2 kV and the primary phase voltage of 22 kV. The power factor of the transformer is 0.86.

Calculate:

7.2.1 The turns ratio of the transformer (3)

7.2.2 The primary line current (3)

7.3 Explain how overheating of the core of the transformer is avoided. (2)

[10]

QUESTION 8: DC MACHINES

8.1 Explain, with reference to a DC motor, the meaning of a separately excited machine. (2)

8.2 Draw a neat, labelled sketch which shows the basic principles of a motor. Include the relative directions of the flux, EMF, force and motion. (5)

8.3 Briefly explain the field coil connections of the following:

8.3.1 Shunt motor

8.3.2 Series motor

8.3.3 Compound motor

(3 × 1) (3)

[10]

QUESTION 9: AC MACHINES

9.1 Show, with a neat, labelled circuit diagram, how a single-phase capacitor starts, split-phase motor can be reversed. (5)

9.2 Answer the following questions with regard to a three-phase wound-rotor induction motor:

9.2.1 State how many connection terminals are on the stator of the motor. (1)

9.2.2 State in which formation the rotor normally would be connected. (1)

9.2.3 State which connection on the stator will produce a higher torque. (1)

9.2.4 Explain the significance of interlocking. (2)

[10]

QUESTION 10: MEASURING INSTRUMENTS AND ELECTRONICS

10.1 Draw a basic circuit diagram of the connections required for a voltmeter to be connected to a high-voltage AC supply. (3)

10.2 State the functions of the following components of measuring instruments:

10.2.1 Fixed iron

10.2.2 Hair springs

10.2.3 Permanent magnets

(3 × 1) (3)

10.3 Draw a neat, labelled circuit diagram to show how semi-conductor diodes can be used to give three-phase half-wave rectification when the supply is from a star-connected transformer secondary. (4)

[10]

TOTAL: 100

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ELECTRICAL TRADE THEORY N3

FORMULA SHEET

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

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

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

$X_l = 2\pi f L$

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

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

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

$V_R = I_T R$

$V_{XL} = I_T X_L$

$V_{XC} = I_T X_C$

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

$P = I^2 R$

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

$S = VI$

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

DELTA

$V_L = V_{PH/F}$

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

STAR

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

$I_L = I_{PH/F}$

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

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

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

$w = 2\pi f$

The next five formulae are also true for voltage.

$i = I_m \sin$

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

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

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

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

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

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

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