higher education & training

Department:
Higher Education and Training
**REPUBLIC OF SOUTH AFRICA**

T582**(E)**(N16)T
**NOVEMBER 2010**

NATIONAL CERTIFICATE

# ELECTRICAL TRADE THEORY N2

(11041872)

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

**This question paper consists of 8 pages and a 1-page formula sheet.**

# 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. Where applicable, answers must *be* in accordance with the SABS (SANS) Code of Practice SANS 10142-1:2003 for the Wiring of Premises.
4. Sketches must be neat, labelled and large enough to show the required detail.
5. Formulae used in Electrical Trade Theory N2 can be found at the end of the question paper.
6. Answers must be given to TWO decimal places.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Write neatly and legibly.

**QUESTION 1: CONDUCTORS AND CABLES**

1.1 State THREE disadvantages of installing high voltage cables by suspending them in open air. (3)

1.2 What causes inductance in a circuit? (1)

1.3 Is self-induced emf and back-emf the same thing? (1)

1.4 Name a load which has inductance when coupled to an AC supply. (1)

1.5 Name a load which has no inductance when coupled to an AC supply. (1)

1.6 Cables can carry fault currents that are much higher than their rated current. Name TWO factors that affect the permissible fault current that a cable can carry. (2)

1.7 What would be the reason for insulating conductors in a particular application with the following materials?

1.7.1 Mica or magnesium oxide (1)
1.7.2 PVC or glass (1)
**[11]**

**QUESTION 2: SWITCHGEAR, CONTACTORS AND RELAYS**

2.1 With reference to the sketch FIGURE 4 below, explain the operation of a relay:

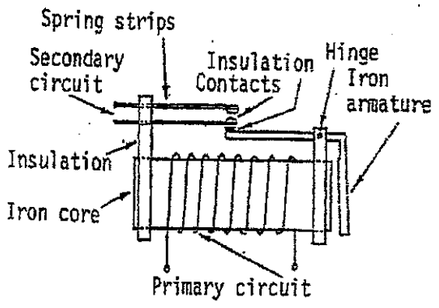


**FIGURE 1** (4)

2.2 In which TWO house wiring sub-circuits will you use a switch disconnector? (1)

2.3 Separate circuits in house wiring each have an (MCB) miniature circuit breaker. With reference to the sketch FIGURE 2 below, explain the operation of a thermal magnetic (MCB):

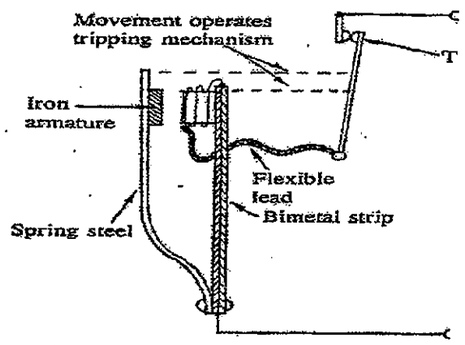


**FIGURE 2** (4)

2.4 Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (2.4.1 – 2.4.3) in the ANSWER BOOK.

2.4.1 The overcurrent protection device protecting a 3-phase motor must allow the motor to continue running, if single phasing occurs. (1)

2.4.2 The tungsten in silver-tungsten that is used for circuit breaker contacts is the best conductor of electricity. (1)

2.4.3 A circuit breaker may be used as a local switch disconnector, provided that it complies with the standards of a disconnector. (1)
**[12]**

**QUESTION 3: D.C. MOTORS AND STARTERS**

3.1 With reference to the sketch FIGURE 3, explain the following:

3.1.1 What prevents the motor from starting up with the starting resistors out of the circuit? (1)

3.1.2 What influence will the NVR have in the circuit's operation if the starting arm is at stud number three? (1)

3.1.3 What influence will the O/L relay have in the circuit's operation, if the starting arm is at stud number three? (1)

3.1.4 How can the current be limited when the starting arm is manually switched to the next stud? (1)

3.1.5 What independent variable is represented by the X-axis of the graph in FIGURE 3 below? (1)

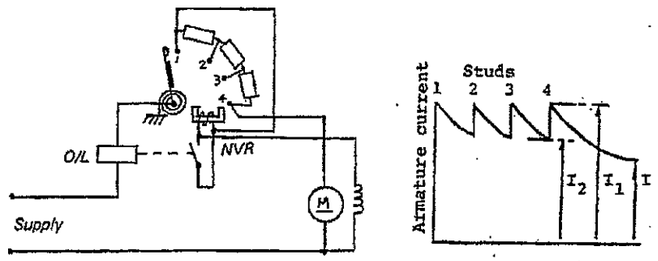





**FIGURE 3**

3.2 What is the main disadvantage of a shunt motor? (1)

3.3 What is the main disadvantage of a series motor? (1)

3.4 What type of motor overcomes the two disadvantages in QUESTION 3.2 and QUESTION 3.3? (1)

3.5 Draw the load characteristic of the motor you stated in QUESTION 3.4. (2)

3.6 Draw a fully labelled circuit diagram showing how the armature and field coils of a shunt motor are connected to the supply. Show, on your diagram, the direction of current flow. (2)
**[12]**

**QUESTION 4: AC MOTORS AND STARTERS**

4.1 Explain the construction of the following types of rotors:

4.1.1 Squirrel cage rotor (3)
4.1.2 Wound rotor (3)

4.2 Explain how the rotating magnetic field is produced in a three-phase motor. (3)

4.3 At what speed does this resultant magnetic field rotate around the stator? (1)

4.4 Explain why the rotor of an induction motor cannot rotate at synchronous speed. (1)

4.5 The universal series motor is widely used for small AC applications.

4.5.1 Explain how a universal series motor operates with an AC supply. (2)

4.5.2 Name ONE appliance that you are familiar with that consists of a universal motor. (1)

4.6 Large induction motors need starters to limit the starting current. What type of starter can be used to start a large squirrel cage induction motor? (1)
**[15]**

**QUESTION 5: EARTHING**

5.1 Name THREE protective measures that can be used to protect people, animals and property from harmful earth fault currents. (3)

5.2 A floating earth on a portable appliance is a zero volt connection point. What should be connected to this point? (1)

5.3 If this floating earth accidentally becomes live, what protection would prevent a dangerous electric shock? (1)

5.4 What must be done with electrical equipment that have metallic frames and/or metallic enclosures, so that a dangerous electric shock is prevented? (1)

5.5 A distribution system consists of overhead lines and an outdoor substation. The outdoor substation contains switch disconnectors, surge arrestors, overload protection and star-delta transformers. Explain how each of the following are earthed in this system:

5.5.1 The overhead lines (2)
5.5.2 The whole substation (2)
5.5.3 The transformers (2)
**[12]**

**QUESTION 6: PROTECTION**

6.1 Explain the purpose of the following:

| | | |
|---|---|---|
| 6.1.1 | An earth leakage relay | (2) |
| 6.1.2 | Surge protection | (2) |
| 6.1.3 | Phase imbalance protection | (1) |
| 6.1.4 | An overload relay | (1) |
| 6.1.5 | A fuse | (1) |

6.2 Where should the fuse be installed when wiring a circuit? (1)

6.3 Name TWO places where surge arrestors can be installed to protect your television set. (2)
**[10]**

**QUESTION 7: MEASURING INSTRUMENTS**

Measuring instruments are important for circuit diagnostics and recording. Name the instrument that you would use to determine the following:

| | | |
|---|---|---|
| 7.1 | The amount of electric energy consumed by a load | (1) |
| 7.2 | Why an AC-operated alarm clock loses time or an electric grinder seems to be turning slower | (1) |
| 7.3 | Whether the earthing in a domestic installation is continuous and within acceptable limits, as stipulated in the code of practice | (1) |
| 7.4 | If the voltage at a certain point is within the permissible 5% volt-drop | (1) |
| 7.5 | Whether this month's billing from the supplier would be high because of excessive power usage for long periods | (1) |
| 7.6 | If the current rating of the supply cable is being exceeded | (1) |
| | | **[6]** |

**QUESTION 8: TRANSFORMERS**

A three-phase transformer has a delta-connected primary and a star-connected secondary. The transformer is connected to a 2,2 kV supply. The secondary phase voltage is found to be 220 V.

Calculate the following:

8.1 The primary phase voltage (2)

8.2 The secondary line voltage (2)

8.3 The primary phase current when the transformer draws its full load current of 120 A from the supply (2)

8.4 The transformer rating in kVA (2)

8.5 The turns ratio of the transformer (2)

8.6 The number of turns on the secondary if the phases on the primary each contain 250 turns (2)
**[12]**

**QUESTION 9: ELECTRONICS**

9.1 Draw a neat, fully labeled circuit diagram of a regulator circuit that makes use of a zener diode. (2)

9.2 With reference to your answer for QUESTION 9.1, explain how the zener diode is used to give a constant output voltage from a source that has a varying voltage. (2)

9.3 Draw the input (unregulated DC) and output (regulated DC) waveforms for the circuit diagram in QUESTION 9.1. (4)

9.4 Name TWO applications that transistors can be used for. (2)
**[10]**

**TOTAL: 100**

# ELECTRICAL TRADE THEORY N2

## FORMULA SHEET

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

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

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

$$X_L = 2\pi f L$$

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

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

$$\phi = \cos^{-1}\left(\frac{R}{Z}\right)$$

$$V_R = I_T R$$

$$V_{XL} = I_T X_L$$

$$V_{XC} = I_T X_C$$

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

$$P = I^2 R$$

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

$$S = VI$$

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

***DELTA***

$$V_L = V_{PH/F}$$

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

***STER***

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

$$I_L = I_{PH/F}$$

***CABLES***

$$I_{fe} = \frac{CIF \times A}{\sqrt{F}} \;/\; I_{fs} = \frac{CIF \times A}{\sqrt{F}}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$$

$$\omega = 2\pi f$$

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

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

$$I = \frac{V - E}{R_a}$$

***Serie motor***

$$I_L = I_{se} = I_a$$

***Long shunt***

$$I_{se} = I_a$$

$$I_L = I_a = I_{sh/sj}$$

***Short shunt***

$$I_L = I_{se}$$

$$I_L = I_a = I_{sh/sj}$$

***Series Resistors***

$$R_T = R_1 + R_2 + \ldots R_n$$

***Parallel Resistors***

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