



# higher education & training

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

**T450(E)(A4)T  
APRIL EXAMINATION**

**NATIONAL CERTIFICATE**

**ELECTRICAL TRADE THEORY N2**

**(11041872)**

**4 April 2016 (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 N2  
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. Write neatly and legibly.
-

**QUESTION 1: CONDUCTORS AND CABLES**

- 1.1 Calculate the full load current which the cable must carry to deliver 380 V, 200 kW at a power factor of 0,9. (3)
- 1.2 Calculate the maximum fault current that a 30 mm<sup>2</sup> conductor insulated with PVC can carry for 2 seconds. The conductor and insulation factor for this type of cable is 62. (3)
- 1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.
- 1.3.1 Cables in the open air are more dangerous to human beings and animals than cables installed underground.
- 1.3.2 Lightning does not affect cables installed in the open.
- 1.3.3 An EMF of self-inductance is when a coil induces voltage in another coil close by.
- 1.3.4 In a purely inductive circuit, the phase angle between current and voltage is always above zero.
- 1.3.5 As the power factor increases, the current needed to supply the same amount of true power will be less.

(5 x 1)

(5)  
[11]

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

- 2.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (2.1.1–2.1.6) in the ANSWER BOOK. Correct the statement if it is false.
- 2.1.1 A disconnector differs from a switch-disconnector because the disconnector cannot carry the on-load current.
- 2.1.2 Switch-disconnectors are designed to open a highly inductive load at full voltage.
- 2.1.3 A switch-disconnector must be connected to the neutral point of the supply.
- 2.1.4 Overload current is defined as the current that flows when a short circuit occurs.
- 2.1.5 An abnormally low ambient temperature will delay the tripping of thermal magnetic circuit breakers on overload.
- 2.1.6 A circuit breaker may be used as a disconnector provided it complies with the standards of the relevant disconnectors. (6 x 1) (6)
- 2.2 Explain the operation of a relay. (3)
- 2.3 State the difference between *relays* and *contactors*. (2)
- 2.4 State what component of a relay is connected to the relay control circuitry (1)
- [12]**

**QUESTION 3: DC MOTORS AND STARTERS**

- 3.1 Briefly explain the purpose of the following parts of a DC motor:
- 3.1.1 The commutator
  - 3.1.2 The brushes
  - 3.1.3 The pole shoes
- (3 x 1) (3)
- 3.2 State the advantage of a compound motor above other DC motors. (1)
- 3.3 State how the speed of a shunt motor is affected by a varying load. (1)
- 3.4 Name the application for which a series motor is most suitable. (1)
- 3.5 Draw the load characteristics of the level-compounded motor. Label both axes. (3)
- 3.6 Draw a circuit diagram showing how the armature and field coils of a short shunt compound motor is connected to the supply. (3)
- [12]**

**QUESTION 4: AC MOTORS AND STARTERS**

- 4.1 Draw a circuit diagram of a capacitor start, induction run AC motor. (3)
- 4.2 Explain why an induction motor will not run at synchronous speed. (2)
- 4.3 The wound rotor induction motor is widely used for large AC applications.
- 4.3.1 Explain how it is connected at start-up.
  - 4.3.2 Explain how it is connected when running at full speed.
- (2 x 2) (4)
- 4.4 Large induction-motors need to be protected against electrical damage.
- 4.4.1 State what type of protection can be used to prevent the motor from being damaged. (1)
  - 4.4.2 Name TWO criteria that the regulations stipulate about single and multi-phase motor protection devices. (2 x 1) (2)
- 4.5 Describe, with the aid of drawings, how to test the insulation resistance of the windings to earth. Your explanation should include approximate values expected during the test. (3)
- [15]**

**QUESTION 5: EARTHING**

- 5.1 Name TWO appliances that need to be earthed in households. (2 x 1) (2)
- 5.2 State why electrical appliances should be earthed (2)
- 5.3 State what must be done with conductive cable sheaths and cable armouring (1)
- 5.4 Define *earth continuity conductor*. (2)
- 5.5 Explain how the following equipment is earthed:
- 5.5.1 A double insulated hand-drill
- 5.5.2 Metal roofs and gutters
- 5.5.3 The metal face-plate of the light switch, knowing that the conduit going to the switch is made of plastic. (3 x 1) (3)
- 5.6 Write why earth continuity conductors are erected above overhead lines. (1)
- 5.7 State where earth continuity conductors that are erected above overhead lines are earthed. (1)

**[12]****QUESTION 6: PROTECTION**

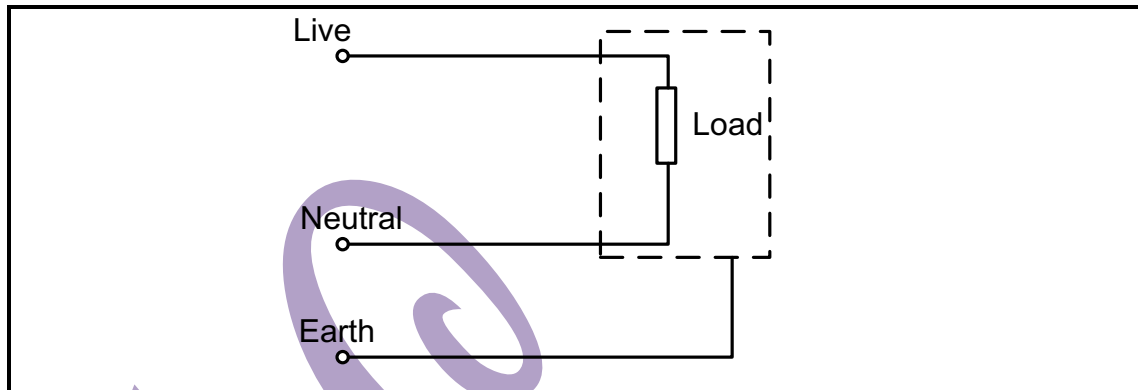
- 6.1 Describe the purpose of surge arrestors (2)
- 6.2 Explain how over-current-protection protects equipment and property. (2)
- 6.3 Explain how a current transformer around each phase conductor can be used to protect against single-phasing. (2)
- 6.4 State in which conductor miniature circuit breakers should be installed in circuit wiring (1)
- 6.5 Except for protection, state one other purpose of an MCB. (1)
- 6.6 Explain the following terms relating to circuit breakers:
- 6.6.1 Snap action
- 6.6.2 Manual reset

(2 x 1) (2)

**[10]**

## QUESTION 7: MEASURING INSTRUMENTS

Figure 7.1 shows a load connected to a supply. Draw a neatly labelled circuit diagram showing how the following instruments are connected in single phase circuits.



**FIGURE 7.1 – LOAD CONNECTED TO A SUPPLY**

- 7.1 A wattmeter
- 7.2 An ammeter
- 7.3 A frequency meter

(3 x 2)

**[6]**

## QUESTION 8: TRANSFORMERS

- 8.1 A single-phase 220/24 V step-down transformer supplies a secondary full-load current of 70 A at a power factor of 0,8.

Calculate the following:

- 8.1.1 The transformer rating (3)
- 8.1.2 The transformer ratio (3)
- 8.2 Show how three coils can be connected together to form a delta connection. Also show how a 3-phase supply is connected to these coils. (6)

**[12]**

**QUESTION 9: ELECTRONICS**

- 9.1 Draw a circuit showing a step down transformer 240/12 Volts AC that is connected to a full wave rectifier. (6)
- 9.2 Name TWO applications of transistors. (2 x 1) (2)
- 9.3 Draw and label the symbol of a thyristor. (2)

**[10]****TOTAL: 100**



## ELECTRICAL TRADE THEORY

### FORMULA SHEET

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

$$I_{ACTIVE/AKTIEWE} = I_T \cos \theta$$

$$I_{REACTIVE/REAKTIEWE} = I_T \sin \theta$$

$$X_L = 2\pi fL$$

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

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

$$\theta = \cos^{-1} \left[ \frac{R}{Z} \right]$$

$$V_R = I_T R$$

$$V_{X_L} = I_T X_L$$

$$V_{X_C} = I_T X_C$$

$$V = \sqrt{V_R^2 + (V_{X_L} - V_{X_C})^2}$$

$$P = I^2 R$$

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

$$S = VI$$

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

#### DELTA

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

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

#### STAR / STER

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

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

#### CABLES/KABELS

$$I_{fc} = \frac{CIFA}{\sqrt{E}}$$

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

$$\omega = 2\pi f$$

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

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

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

#### Series motor/ Seriemoor

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

#### Long shunt/Langsjunt

$$I_{se} = I_a$$

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

#### Short shunt / Kortsjunt

$$I_L = I_{se}$$

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

#### Series Resistors/Seriweerstande

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

#### Parallel Resistors/Paralleweerstande

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