



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

REFRIGERATION AND AIR CONDITIONING

SUBJECT: Electro Technology

PAPER NO: 359/21/S03

DURATION: 3 Hours

NOVEMBER/DECEMBER 2025 EXAMINATION

REQUIREMENTS

Serialised HEXCO answer booklet and non-programmable scientific calculator.

INSTRUCTIONS TO CANDIDATE

1. Answer all questions in Section A. 50 marks.
2. Answer any three questions from Section B: 30 marks
3. Answer any two questions from Section C: 20 marks
4. Use large, clearly labelled diagrams to explain your answer
5. Do not write your name inside or outside the answer script.
6. Do not write anything on the question paper.
7. Take $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$
 $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

This paper consists of 5 printed pages.

SECTION A

50 MARKS

Answer all questions from this Section.

QUESTION 1

- 1.1 State any two (2) effects of an electric current and give a practical application for each. (4 marks)
- 1.2 The following conditions exist on a hermetically sealed refrigeration system. On each case indicate one (1) malfunction.
- (a) the motor only hums when switched on. (1 mark)
 - (b) the motor runs but draws an abnormally high current. (1 mark)
 - (c) the supply is interrupted by the motor overload protection cutting out. (1 mark)
 - (d) the ammeter reading was 8A at starting and 1.5A running. Now the meter consistently reads 8A. (1 mark)
- 1.3 The maximum working flux density of a lifting electromagnet is 1.9T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 611mWb, determine the radius of the pole face. (4 marks)
- 1.4 An ideal transformer, connected to a 240V mains, supplies a 12V, 150W lamps. Calculate: -
- (a) Transformer turns ratio. (2 marks)
 - (b) Current taken from the supply. (2 marks)
- 1.5 A current magnetic relay is an electromechanical control switch used in refrigeration trade. Outline any two (2) faults mostly associated with this switch under the following: -
- (a) mechanical (2 marks)
 - (b) electrical (2 marks)
- 1.6 Outline any four (4) electrical regulations that govern the installation of a domestic air conditioner. (4 marks)
- 1.7 Identify any four (4) advantages of 3-phase induction motors used in the trade of refrigeration. (4 marks)

1.8 Determine the value and tolerance of a resistor having the following colour coding:

- (i) brown - black-brown (1 mark)
- (ii) orange – green – red-yellow – brown (1 mark)
- (iii) blue – grey – orange-red (1 mark)
- (iv) brown - black-brown – silver (1 mark)

1.9 With reference to electronic resistors, define the following:-

- (a) power rating (2 marks)
- (b) power dissipation (2 marks)

1.10 Describe conduction in semi-conductors with reference to temperature rise. (4 marks)

QUESTION 2

- (a) Two parallel plates having a potential difference of 250V between them are spaced 1mm apart and the electric field strength is 250KV/m. Calculate the electric flux density when the dielectric between the plates is :-
 - (i) air (2 marks)
 - (ii) mica of relative permittivity of 5. (3 marks)
- (b) Describe the effect minority carriers have on the reverse current of an N-P-N junction or semi-conductor diode. (5 marks)

SECTION B

30 MARKS

Answer any three (3) questions for this Section.

QUESTION 3

- (a) A current of 12A flows in the element of an electric fire of resistance 25Ω . Determine the power dissipated by the element. (3 marks)
- (b) If the power calculated above is on for 5 hours every day, calculate for one week period:-
- (i) the energy used (4 marks)
- (ii) cost of using the fire if electricity cost 7 cents per unit. (3 marks)

QUESTION 4

- (a) Define the following terms:-
- (i) static electricity (1 mark)
- (ii) current electricity (1 mark)
- (iii) direct current (1 mark)
- (iv) alternating current (1 mark)
- (b) Briefly explain the following terms:-
- (i) 2 – phase (2 marks)
- (ii) 3 – phase (2 marks)
- (c) Outline two (2) factors that determine the electrical displacement between the windings. (2 marks)

QUESTION 5

Explain the operating principle of a voltmeter with the aid of a diagram. Clearly show how the voltmeter can be incorporated in the circuit.

(10 marks)

QUESTION 6

- (a) Draw an alternating / sinusoidal waveform and indicate the following quantities
- (i) peak value (2 marks)
 - (ii) period (1 mark)
 - (iii) instantaneous value (1 mark)
- (b) A supply voltage has a mean value of 150V.
Determine:-
- (i) the maximum value (3 marks)
 - (ii) RMS value (3 marks)

SECTION C

20 MARKS

Answer any two (2) questions from this section.

QUESTION 7

Using symbols and sketches, describe the principle of operation of bipolar junction transistors. (10 marks)

QUESTION 8

- (a) Define the term inductor. (2 marks)
- (b) Briefly explain any four (4) inductor uses in refrigeration and air conditioning. (8 marks)

QUESTION 9

Explain any five (5) reasons for doping of semi-conductor materials, n-type and p-type semi-conductors. (10 marks)