



<b>Candidate Code No.</b>	
<b>For Board Use Only</b>	
Result	Result
Date	Date
Int	Int

## **ELECTRICIAN'S THEORY EXAMINATION**

**15 November 2008**

### **QUESTION AND ANSWER BOOKLET**

Time Allowed: Three hours

#### **INSTRUCTIONS – READ CAREFULLY**

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

**Answer all questions.**

**The pass mark for this examination is 60 marks.**

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

**Do not** use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Non-programmable calculators may be used.

**Warning** – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

**Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.**

**PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.**

(turn over)

## Question 1

- (a) (i) Describe the characteristics of a thermistor. (1 mark)

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- (ii) Where in a motor circuit would a thermistor be located? (1 mark)

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- (b) Some fittings in an electrical installation have a fault duty lower than the prospective short circuit rating of the installation. State **TWO** hazards that could occur when a high prospective short-circuit fault current occurs in the electrical installation. (2 marks)

(1) \_\_\_\_\_

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(2) \_\_\_\_\_

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**(turn over)**

## Question 1 continued

(c) When taking measurements in a single phase a.c. inductive circuit, the following readings were obtained

- 235V
- 12A
- 2115W

Calculate the power factor of the circuit.

(2 marks)

(d) An RCD is used for personal protection. What is the maximum time permitted for the RCD to trip at 5 times its residual current rating?

(2 marks)

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(e) (i) What device is used to provide starting torque in a shaded pole motor?  
(1 mark)

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(ii) Describe how a shaded pole motor can be reversed.

(1 mark)

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## Question 1 continued

(f) Define the term "slip speed" as it applies to a.c. induction motor.

(2 marks)

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(g) (i) What is meant by the term "current rating" when applied to an HRC fuse?

(1 mark)

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(ii) What is meant by the term "breaking (or rupturing) capacity" when applied to an HRC fuse?

(1 mark)

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(h) State **TWO** reasons why a run capacitor would be fitted to a single-phase split-phase induction motor.

(2 marks)

(1) \_\_\_\_\_  
\_\_\_\_\_

(2) \_\_\_\_\_  
\_\_\_\_\_

**(turn over)**

## Question 1 continued

- (i) State **TWO** advantages electronic starters have when compared to electromechanical type starters, such as auto-transformer types. (2 marks)

(1) \_\_\_\_\_

\_\_\_\_\_

(2) \_\_\_\_\_

\_\_\_\_\_

- (j) A heater draws 2000W at 230V. What power will the heater draw if the voltage drops 5%? (2 marks)

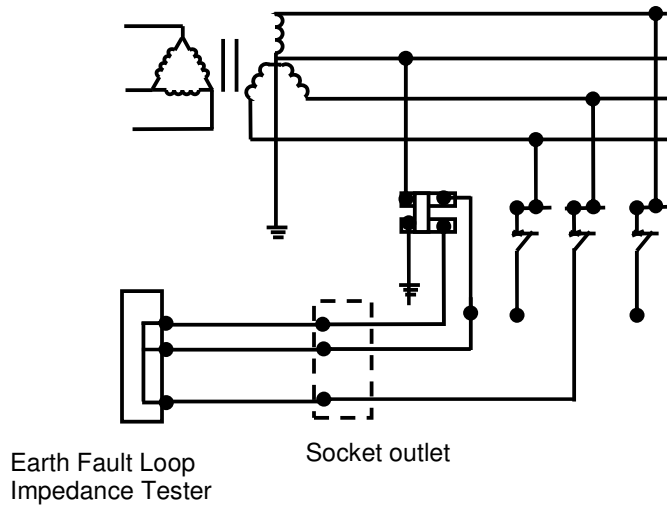
**(turn over)**

## Question 2

- (a) The figure below represents an earth fault loop impedance test on a single phase socket outlet in a low voltage electrical installation.

Commencing at the earth fault loop impedance tester, describe the circuit that is being tested by the tester.

(7 marks)



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There is more space for your answer on the next page.

(turn over)

## Question 2 continued

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- \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(b) State **TWO** uses for the information gained from an earth fault loop impedance test carried out in (a) above.

(2 marks)

- (1) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (2) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(c) Why is the earth fault loop path between the earth and neutral bars and MEN link and the star point via the main neutral considered more important than the path between the earth and neutral bars and MEN link and the star point via the mass of earth

(1 mark)

\_\_\_\_\_  
\_\_\_\_\_

**(turn over)**

### **Question 3**

- (a) Draw and label a circuit diagram of a three-phase RCD used for personal protection that protects a 5-pin socket outlet in a workshop.

(5 marks)

**(turn over)**

### Question 3 continued

- (b) Describe the operation of an RCD when there is an active (phase) to earth fault occurs on the circuit the RCD protects.

(4 marks)

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- (c) Define the term "RCBO"

(1 mark)

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## Question 4

(a) A small 400V, three-phase, 4-wire commercial installation has the following resistive loads on each phase:-

- Red 30kW
- White 20kW
- Blue 10kW

(i) Calculate the line current in each of the three phases.

(5 marks)

(ii) Calculate the total power of the installation

(1 mark)

**(turn over)**

## Question 4 continued

(iii) Determine the neutral current by resolution of vectors

(3 marks)

(b) State **ONE** technical reason why it is important to balance the load across the three phases of the installation?

(1 mark)

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**(turn over)**

## Question 5

- (a) You have been requested to wire an automatic star/delta starter for a 15kW motor in a workshop. The motor starts in star and runs in delta.

Draw and label the power circuit for the automatic star/delta starter showing all components necessary to make it work correctly and safely.

(5 marks)

**(turn over)**

## Question 5 continued

- (b) You have been requested to wire an automatic Star/Delta starter for a 15kW motor in a workshop. The motor starts in Star and runs in Delta.

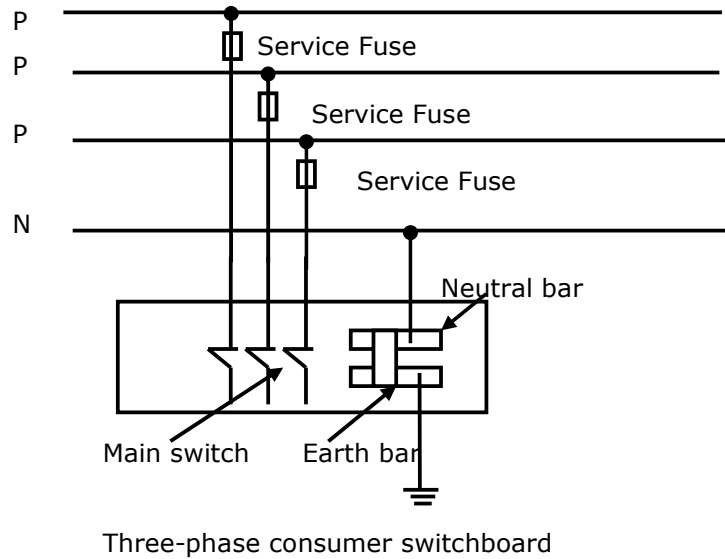
Draw and label the 230V control circuit for the automatic star/delta starter showing all the components to enable it to run correctly and safely.

(5 marks)

**(turn over)**

## Question 6

- (a) The figure below represents a low voltage, three-phase 400V supply to an electrical installation. The installation is live.



State **THREE** hazards that will occur if any one of the three phases and the neutral are transposed at a point between the distribution line and the switchboard.

(3 marks)

- (1) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (2) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (3) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**turn over)**

## Question 6 continued

(b) From the figure in (a) above:

- (i) Describe how you would carry out an instrument test to establish whether a phase/neutral transposition has taken place. Include in your description the type of instrument and equipment used.

(2 marks)

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- (ii) State the expected instrument readings when no transposition has taken place.

(2 marks)

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- (iii) State the expected instrument readings when a transposition has taken place.

(3 marks)

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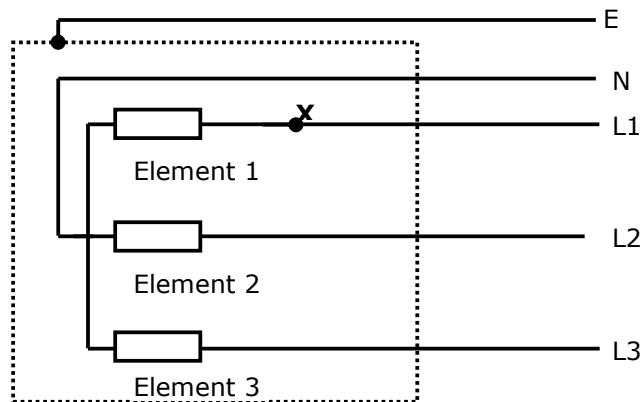
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## Question 7

The figure below represents a three-phase, star-connected 400V, 18 kW commercial oven. The oven is protected by 40A HRC fuses with a fusing factor (gG Utilisation Category) of 1.5.

An earth fault of  $6\Omega$  has developed between L1 and the oven frame while the oven is operating. The fault occurred at point X.

The protective earthing conductor resistance is  $9.75\Omega$  due to a high resistance termination.



- (a) (i) Calculate the total current that will flow in L1 under the fault conditions. (5 marks)

**(turn over)**

## Question 7 continued

(ii) Explain by calculations:

(1) Whether the fuse protecting L1 will operate.

(1 mark)

(2) Whether any hazard exists to the operator of the oven.

(2 marks)

(b) If the fault at point X was of negligible impedance, calculate the maximum resistance in the protective earthing conductor that would ensure the fault current exceeded the fusing current of the fuse by a margin of 1A.

(2 marks)

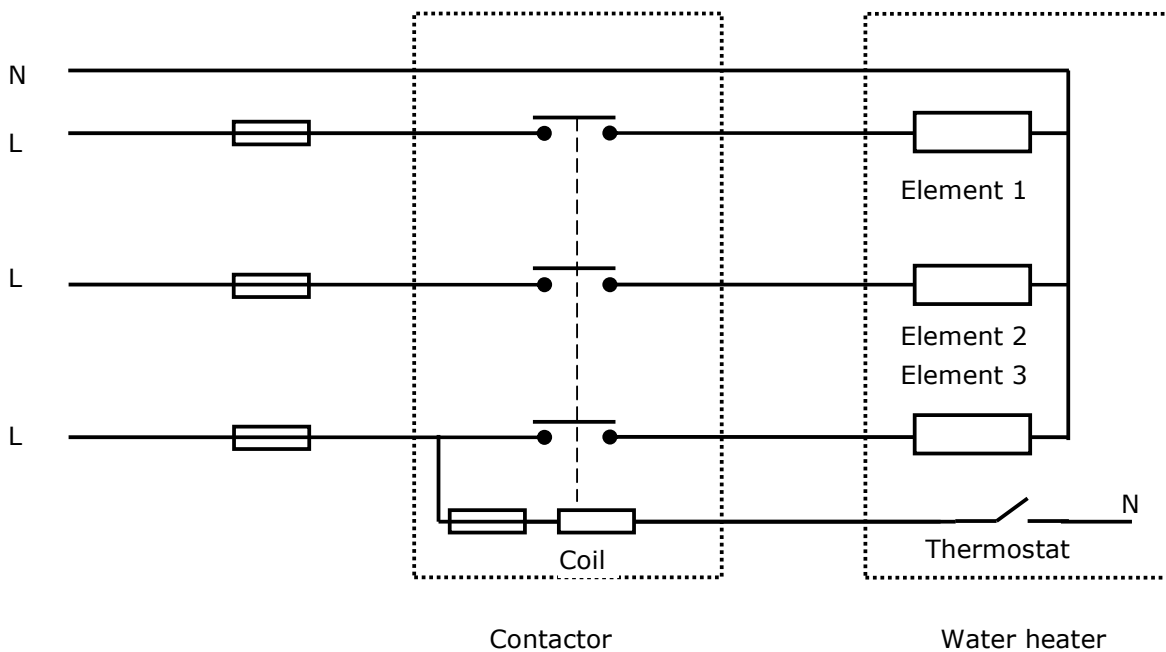
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## Question 8

**Note: Read the entire question before commencing.**

The figure below represents a three-phase electric hot-water cylinder in an industrial plant. It comprises 3 single-phase 2 kW elements controlled by a contactor. The 230V contactor control circuit comprises a coil controlled by the water heater thermostat.

The cylinder is controlled by an adjacent isolating switch (not shown) and is connected via flexible conduit and cables from the contactor. The circuit supplying the cylinder is protected by HRC fuses at the switchboard.



The cylinder is faulty and the isolating switch cannot be operated because the handle is broken. You have been requested to make the necessary repairs to the cylinder and replace the isolating switch.

**(turn over)**



## Question 8 continued

(b) The following faults on the cylinder have been reported:

- The fuse to element 1 has blown. When it was replaced, it blew immediately.
- The fuse to element 2 blows at intermittent intervals.

Before you isolated the cylinder you found that:

- The cylinder is still operating on one element.
- No fault exists between the switchboard and the supply side of the isolator.
- The contactor is not faulty.

(i) Why does the cylinder operate on one element with two fuses blown?  
(1 mark)

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(ii) Describe the likely causes of the fault to element 1.  
(2 marks)

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(iii) Describe the likely causes of the fault to element 2.  
(1 mark)

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**(turn over)**

## Question 8 continued

- (iv) State the type of test you would carry out to determine the location of the fault on element 1.

(1 mark)

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- (v) State the type of test you would carry out to determine the location of the fault on element 2.

(1 mark)

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**(turn over)**

## Question 9

A three phase, delta-star connected transformer has a turns ratio of 956:20. The primary is connected to an 11kV three phase supply and the transformer is fully loaded.

(a) Calculate the secondary phase voltage.

(2 marks)

(b) Calculate the secondary line voltage.

(2 marks)

**(turn over)**

### Question 9 continued

- (c) If the full load primary line current is 13.12A, calculate the full load kVA rating of the transformer.

(2 marks)

- (d) Calculate the full load secondary line current.

(2 marks)

- (e) When the transformer was tested on full load the single- phase terminal  $V_{PH}$  dropped to 222 volts. Calculate the percentage regulation on the transformer

(2 marks)

### For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only		
Questions Answered	Marks	
1		
2		
3		
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8		
9		
<b>TOTAL</b>		