ELECTRICAL WORKERS REGISTRATION BOARD

Safety • Competency

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

16 June 2007 - 019

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. Show answers to THREE significant places.

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.

Question 1

Each part of this question is worth 2 marks

(a) One end of a main earthing conductor must be connected to the main earthing terminal in the main switchboard. State **ONE** point at which the other end of the main earthing conductor can be connected.

_____

_____

_____

(b) If three-phase motor has six terminals and windings rated at 230V how should it be connected to a 400V three-phase supply?

_____

(c) What is the purpose of a residual current device (RCD)?

_____

_____

(d) What is the purpose of an on-load tap-changer in a transformer?

_____

_____

(e) What is the minimum acceptable insulation resistance of an entire low voltage electrical installation:

(i) **<u>That does not</u>** contain a heating appliance?

(1 mark)

_____

(ii) **<u>That contains</u>** a heating appliance?

(1 mark)

_____

(turn over)

Question 1 continued

(f) Describe **TWO** different ways of safely ensuring the continued isolation of a fixed-wired electrical appliance.

(1) _____

_____

(2) _____

_____

(g) Most appliances sold in New Zealand are designed to operate at 230V or 240V. An electric heater with a 26.45Ω element is rated at 2 kW when operated at 230V. Calculate the power output when supplied at 240V

(h) Why is a centrifugal switch used in a single phase split-phase (resistance-start) motor?

_____

_____

(turn over)

Question 1 continued

(i) A two core Mineral-Insulated Metal-Sheathed (MIMS) permanently installed supply cable has been carefully disconnected from a single phase fuel pump motor on an oil-fired furnace.

State **TWO** important **mechanical** precautions that must be observed when reconnecting this particular cable to the motor.

(1) _____

_____

(2) _____

_____

(j) A miniature circuit breaker has both thermal and electromagnetic current-sensor functions. Briefly explain the internal operation of the circuit breaker when **ONE** of these functions detects a fault.

_____

_____

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_____

(turn over)

Question 2

(a) State **TWO** reasons why a neutral conductor is required in the cable supplying a three-phase final subcircuit that has heating loads that draw different values of current on each of the phases.

(4 marks)

(1) _____

_____

_____

(2) _____

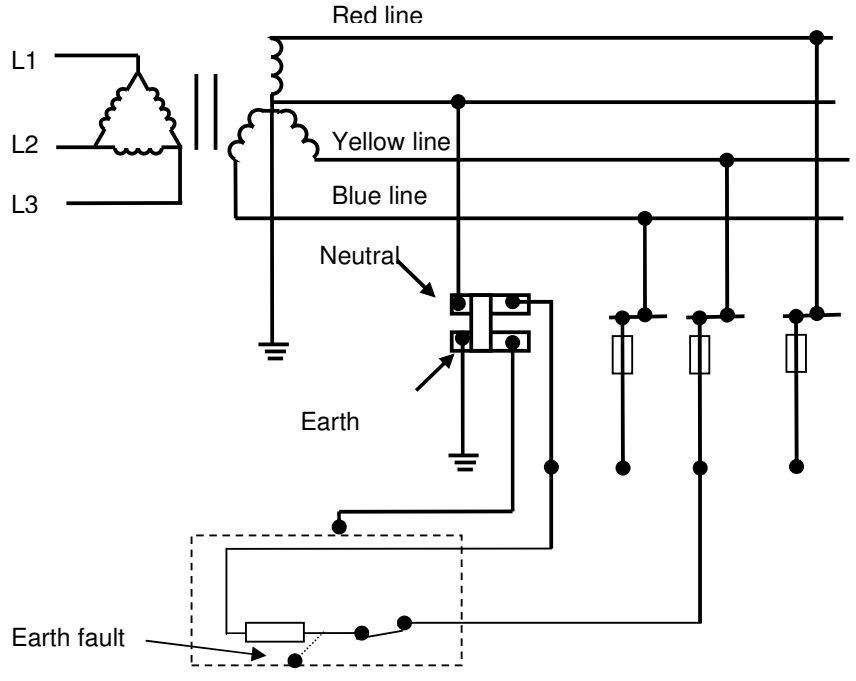
_____

_____

(b) The figure below shows a three-phase supply, consumers' neutral and earth bars, and protective fuses. It also shows a single-phase Class I appliance with a phase - to - frame fault on the load side of the appliance switch.

Clearly draw on the figure the fault loop impedance path for this circuit.

(4 marks)



(turn over)

Question 2 continued

(c) State **TWO** reasons why the neutral conductor is earthed in an MEN system.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(turn over)

Question 3

(a) Describe the operation of the RCD circuit when there is a phase to earth fault

(4 marks)

_____

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_____

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(b) What is the residual current rating of an RCD used for personal protection?

(1 mark)

_____

(c) An RCD is a safeguard designed to operate if current from a faulty appliance flows through a person's body to earth. Why, then, doesn't that person receive a severe shock from the faulty appliance?

(2 marks)

_____

_____

(d) A Residual Current Circuit Breaker (RCCB) is installed in a single phase circuit. Why is it necessary to have additional electrical protection in that circuit?

(1 mark)

_____

_____

(turn over)

Question 3 continued

(e) Briefly explain why Portable Residual Current Devices (PRCDs) used in New Zealand are required to be voltage dependent.

(2 marks)

_____

_____

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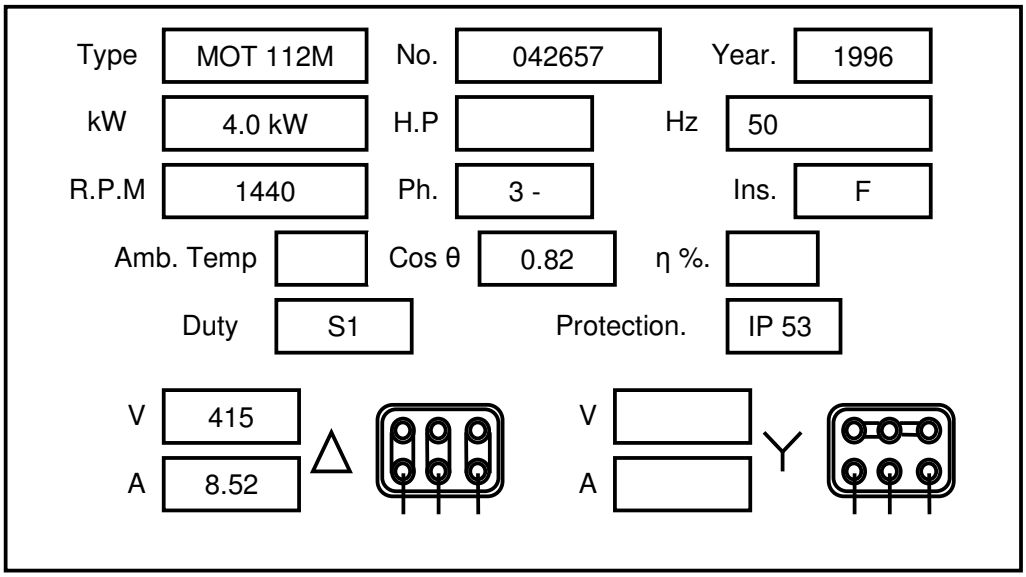
_____

(turn over)

Question 4

(a) The following name plate for a three-phase induction motor.



Use the information given on the name plate in to calculate the following:

(i) Motor efficiency

(3 marks)

(ii) Slip at full load

(2 marks)

(turn over)

Question 4 continued

(b) The motor is started by a star/delta starter.

(i) State the percentage of the direct-on-line starting torque in the start (star) position.

(1 mark)

_____

(ii) State **TWO** forms of protection incorporated in the starter's circuitry.

(2 marks)

(1) _____

_____

(2) _____

_____

(iii) Briefly explain the purpose of the interlocks in the starter.

(2 marks)

_____

_____

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_____

(turn over)

Question 5

Note: Read the entire question before answering (a), (b) and (c).

A three-phase fixed-wired induction motor running an industrial refrigeration plant is protected by HRC fuses mounted on a switchboard. The motor requires new bearings.

The motor is controlled by an adjacent isolating switch. However, the switch has a broken operating handle and cannot be used.

You have been requested to:

- Remove the three-phase motor, by disconnecting the cable at the motor
- Replace the isolating switch.

Warning: If any part of your answer is dangerous or hazardous, you will get no marks for this question.

(a) Describe how you would safely isolate the motor and its isolating switch. (6 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

(3) _____

_____

_____

_____

(4) _____

_____

_____

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(turn over)

Question 5 continued

(b) After you have done the isolation and the work, what would you do to ensure that the work area is safe to be left unattended?

(3 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

(c) State the first action the other electrician should take before attempting to re-install the motor.

(1 mark)

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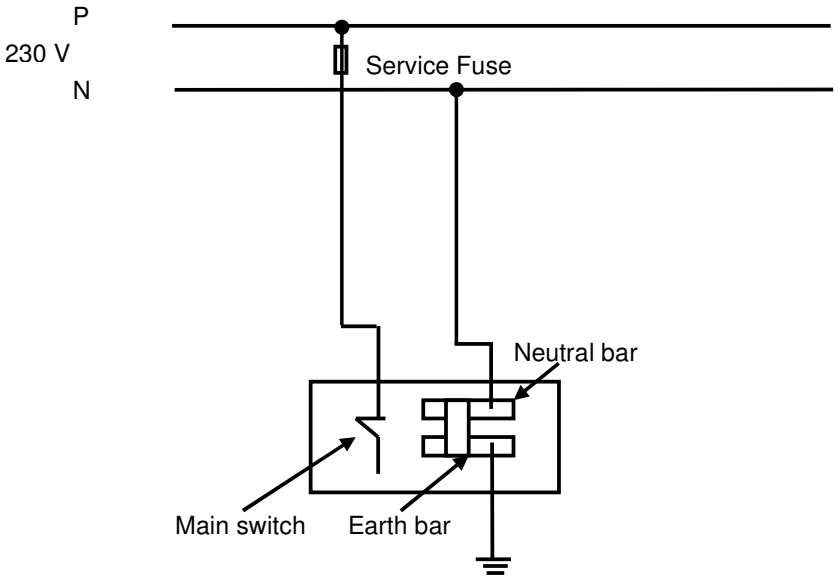
(turn over)

Question 6

(a) The figure below represents a low voltage single-phase supply to a domestic installation. **The installation is live.**



Single-phase consumer

State **THREE** hazards that will occur if the phase and neutral are transposed.

(3 marks)

(1) _____

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_____

(2) _____

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_____

(3) _____

_____

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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.

(3 marks)

_____

_____

_____

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_____

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

(2 marks)

_____

_____

_____

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

(2 marks)

_____

_____

_____

(turn over)

Question 7

(a) A three-phase delta-star connected transformer, steps down voltage from 33 000V to 11 000V at the output terminal; when fully loaded a current of 13.8 flows in its primary windings. Assuming no losses, calculate:

(i) Full-load primary line current.

(1 mark)

(ii) Full-load secondary line current.

(5 marks)

(turn over)

Question 7 continued

(iii) Total kVA rating

(2 marks)

(b) State **ONE** reason why there are no fuses on the secondary circuit of a CT

(2 marks)

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_____

_____

(turn over)

Question 8

A 2 kW, Class I, single-phase heater has a 230 V supply and is supplied from a circuit protected by an MCB. A phase-to-frame fault of 100 Ω has occurred on the load side of the heater control switch.

(a) Sketch a circuit diagram of this heater, showing:
- The supply
- The heater with a control switch
- The fault.
- The circuit breaker

(2 marks)

(b) Explain in detail how effective earthing of exposed metal on the heater provides protection against electric shock.

(3 marks)

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(turn over)

Question 8 continued

(c) Explain in detail how a high-resistance earth connection increases the risk of electric shock.

(3 marks)

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_____

_____

_____

(d) The MCB did not operate when the fault occurred. Calculate the power dissipated in the protective earthing conductor under the fault conditions. Assume the resistance of the protective earthing conductor to be 1Ω

(2 marks)

(turn over)

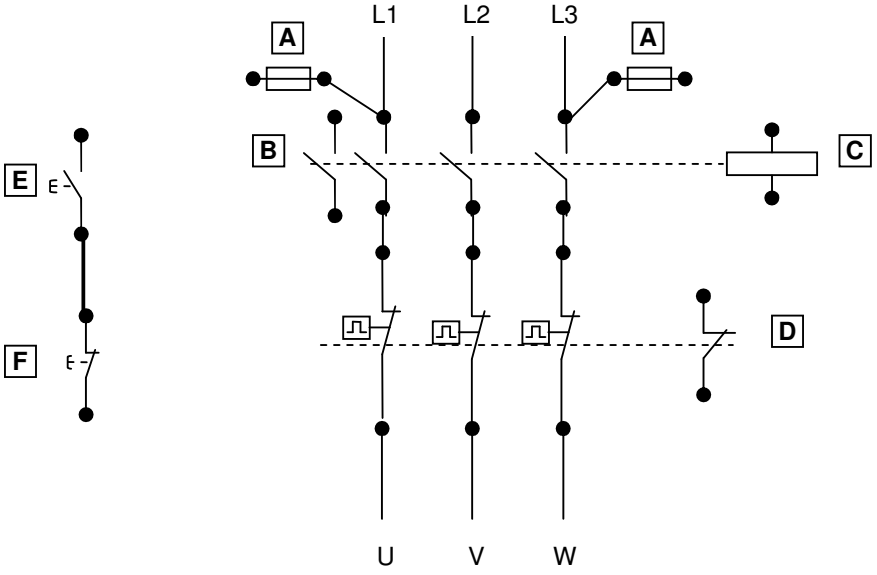
Question 9

(a) The figure below represents the components of a direct-on-line (DOL) starter with a 400V control circuit and a remote stop/start station:

- L1, L2, and L3 represent the three-phases connected to the main contacts.
- U, V and W represent the three conductors from the thermal overloads to the motor
- A are the control circuit fuses
- B is the hold-in contact
- C is the 400V coil
- D is the auxiliary overload contact
- E is the start button
- F is the stop button

Draw the conductors on the figure to complete a working 400V control circuit

(4 marks)



(turn over)

Question 9 continued

(b) Explain the principal difference in operation between an a.c. variable speed controller and an electronic soft starter as used with three-phase, a.c. induction motors.

(2 marks)

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_____

_____

(c) In addition to the thermal overload unit a motor is also protected by HRC fuses. Briefly explain why both of the protection devices are required.

(i) Thermal overload

(2 marks)

_____

_____

_____

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_____

(ii) HRC fuses

(2 marks)

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For Candidate's Use

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

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Questions Answered	**Marks**	
1		
2		
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