



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

ELECTRICIAN'S THEORY EXAMINATION

18 November 2006

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 TWO decimal 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.

(turn over)

Question 1

Each part in this question is worth 2 marks.

- (a) In a low voltage MEN electrical installation, one end of the main earthing conductor is connected to an earth electrode. To where must the other end of the main earthing conductor be connected.

- (b) Sketch a circuit diagram of a single-phase, capacitor-start, induction-run motor.

- (c) State **TWO** differences between an MEN switchboard and a distribution switchboard.

(1) _____

(2) _____

(turn over)

Question 1 continued

(d) AS/NZS 3000 states:

The output circuit of an autotransformer shall be insulated for the highest input or output voltage of the autotransformer.

State **ONE** reason for this requirement.

(e) The adjacent isolating switch for a three-phase, fixed-wired appliance has been turned off. When testing the appliance for isolation, it is found that some terminals on the appliance are still live. State **TWO** possible causes for this situation.

(1) _____

(2) _____

(f) State **TWO** factors which affect the severity of electric shock upon the human body.

(1) _____

(2) _____

(g) A three-phase motor has windings rated at 230V and is to be connected in Star to a 400V three-phase supply. How many terminals must there be on the terminal block?

(turn over)

Question 1 continued

(h) State **TWO** factors that limit the prospective short-circuit current in an electrical installation.

(1) _____

(2) _____

(i) (i) How is the direction of rotation reversed in a delta-connected, three-phase, squirrel-cage motor?

(ii) How is the direction of rotation reversed in a single-phase, split-phase induction motor?

(j) An ohmmeter gives a reading of 24 ohms when used to measure the resistance of a plug-in heater designed for use on 230V/240V a.c. supply. If the heater draws 10 amps when plugged into a 240 V supply:

(i) Will the current increase or decrease when the heater is plugged into a 230 V supply?

(1 mark)

(ii) Will the power dissipated increase or decrease when the heater is plugged into a 230 V supply?

(1 mark)

(turn over)

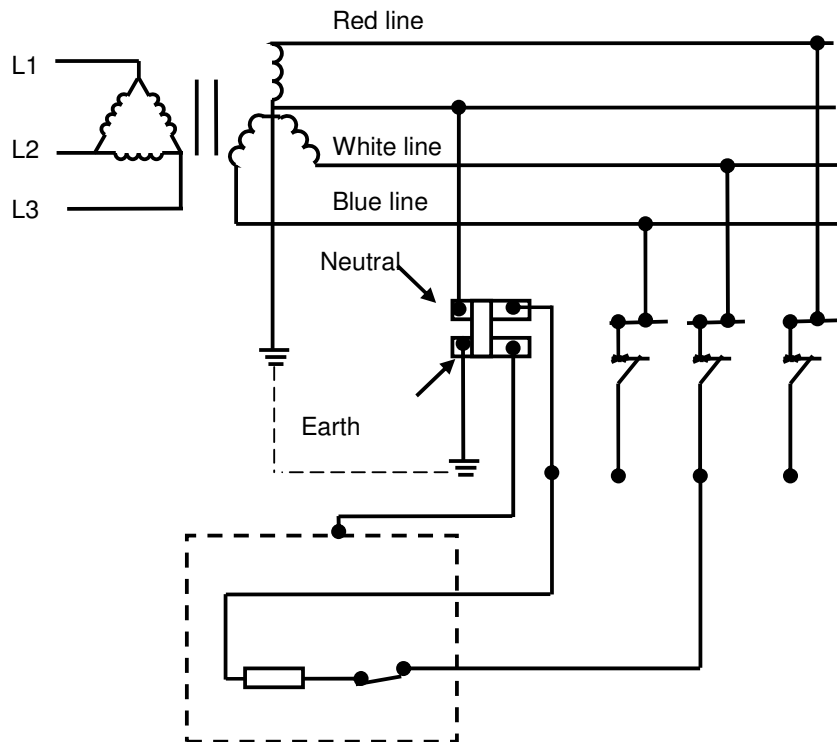
Question 2

A 230V, 2 kW, Class I, single-phase heater is plugged in to a circuit protected by a 20A MCB. The MCB has a utilisation category (fusing factor) of 1.5. A phase-to-frame fault of $60\ \Omega$ has occurred on the load side of the heater control switch.

(a) On the diagram below:

- Indicate the fault on the heater.
- Draw in the earth fault loop

(2 marks)



Class 1 heater

(turn over)

Question 2 continued

(b) If the resistance of the appliance protective earthing conductor is 0.5 and the fault-loop impedance of the circuit is 0.67 ohms:

(i) Calculate the total current in the phase conductor.

(5 marks)

(ii) Determine by calculation whether the MCB will operate.

(1 mark)

(turn over)

Question 2 continued

- (c) State the **TWO** reasons why the high-resistance earth fault in the appliance increases the risk of electric shock when using the appliance in an earthed situation.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 3

- (a) (i) State **ONE** reason for carrying out an earth fault loop impedance test on a single-phase socket outlet circuit.

(1 mark)

- (ii) Describe how the earth fault loop impedance tester is connected.

(1 mark)

- (b) (i) State the reason for carrying out an RCD test on a single-phase portable RCD.

(1 mark)

- (ii) Describe how the RCD tester is connected.

(1 mark)

- (c) Identify which of the tests in (a) and (b) above are carried out on live circuits.

(1 mark)

(turn over)

Question 3 continued

- (d) (i) Describe how the **prove test prove** method of testing for isolation is carried out

(3 marks)

- (ii) Why is it important to use the **prove test prove** method before working on electrical equipment?

(2 marks)

(turn over)

Question 4

A three-phase motor is controlled by DOL starter that contains thermal overloads. The starter control circuit operates at 230V. The motor circuit is protected by HRC fuses.

- (a) Draw and label a circuit diagram to show how the components listed below would be connected in the 230V control circuit. Your diagram is to include:
- A fuse
 - Stop button
 - Start button
 - Hold in contact (maintaining contact)
 - Thermal overload relay contact
 - A 230V coil

You do not need to show the main contacts or the motor

(4 marks)

(turn over)

Question 4 continued

(b) Briefly explain why:

(i) Thermal overload protection is required.

(2 marks)

(ii) HRC fuse protection is required.

(2 marks)

(c) The thermal overload protection is replaced with thermistor protection. Describe how the thermistor would provide protection to the motor

(2 marks)

(turn over)

Question 5

(a) A 150 kVA, three-phase, delta-star-connected step-down transformer has a phase- turns ratio of 287 to 1. The primary is connected to a 66 kV, three-phase supply, and the transformer is fully loaded.

(i) Calculate the secondary phase voltage.

(1½ marks)

(ii) Calculate the secondary line voltage.

(1½ marks)

(iii) Calculate the primary line current.

(2 marks)

(turn over)

Question 5 continued

(iv) Calculate the secondary line current.

(1 mark)

(b) State **ONE** reason why a current transformer is dangerous when its secondary winding is left in the open circuit condition.

(2 marks)

(c) State **ONE** practical method used to reduce the iron loss of a transformer when it is constructed.

(2 marks)

(turn over)

Question 6

- (a) (i) What is meant by the term "inverse time-current characteristic" in relation to protective devices?

(1 mark)

- (ii) Sketch a typical inverse time-current characteristic as applied to fuses.
(1 mark)

- (b) Under what circumstance must back-up protection (for example, HRC fuses) be installed in addition to normal circuit protection?

(2 marks)

turn over)

Question 6 continued

- (c) Explain how "discrimination" applies to protective devices in an electrical installation.

(4 marks)

- (d) The current rating of a fuse relates to the maximum current the circuit, which is protected by the fuse, can carry safely. What would be the overall effect on the circuit:

- (i) If the fuse operated but was under-rated for the circuit?

(1 mark)

- (ii) If the fuse operated but was over-rated for the circuit?

(1 mark)

(turn over)

Question 7

Note: Read this entire question before attempting to answer it.

A single-phase 20A circuit consists of two socket outlets and is protected by a MCB. The socket outlets supply one electrical appliance each.

The MCB has tripped out. The supply was switched off and the MCB reset. When supply was restored to the circuit with all of the appliances plugged in and switched on, the MCB tripped out again.

You have been requested by the Supervisor to locate the cause of the fault and, if possible make repairs. You have established:

- From the nameplate data on each appliance, that the combined load current did not overload the MCB.
- That the MCB is not faulty and is correctly rated for the circuit it protects.

You do not need to contact the Supervisor before starting the work or after finishing.

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

- (a) Describe how you would ensure that the circuit is safely isolated. (4 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 7 continued

- (b) There are **TWO** possible types of fault. What tests would you make to establish the cause of the fault.

(3 marks)

(1) _____

(2) _____

- (c) Describe the action you would take for each of the possible faults.

(3 marks)

(1) _____

(2) _____

(turn over)

Question 8

The circuit supplying a 230V single-phase kiln has both RCCB and MCB protection. The kiln isolator has been replaced.

What would be the effect if:

- (a) The phase and neutral were accidentally interchanged at the supply side of the isolating switch.

(3 marks)

- (b) The neutral and earth were accidentally interchanged at the supply side of the isolating switch.

(1 mark)

- (c) The phase and earth were accidentally interchanged at the supply side of the isolating switch and the RCCB failed to operate.

(4 marks)

(turn over)

Question 8 continued

- (d) State **TWO** tests that would detect the interchange of the phase and earth conductors?

(2 marks)

(1) _____

(2) _____

(turn over)

Question 9

A three phase 400V induction motor has been removed from an industrial machine for cleaning and checking. It is supplied by a neutral-screened cable and controlled by a star/delta starter. The disconnection occurred at the starter so the cable is still connected to the motor. Checks must be carried out to ensure the motor is safe to reconnect.

- (a) Describe how the insulation resistance test should be carried out on the motor. Identify the type of instrument used, and state any minimum or maximum test values that are applicable.

(4 marks)

- (b) Describe how a circuit continuity test should be carried out on the motor. Identify the type of instrument used, and describe the expected test results.

(3 marks)

(turn over)

Question 9 continued

- (c) List **THREE** other checks or tests you would carry out on the motor before returning it to service.

(3 marks)

(1) _____

(2) _____

(3) _____

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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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TOTAL		