



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

ELECTRICAL WORKERS REGISTRATION BOARD

ELECTRICIAN'S THEORY EXAMINATION

19 June 2004

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.

The pass mark for this examination is 60 marks.

Answer **All questions in section 1**
Any FIVE questions in section 2. (If you answer all questions in Section 2 strike out the question you do not want marked)

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)

SECTION 1

(Answer all questions in this section)

Question 1

Each part of Question 1 is worth 1 mark

- (a) Why is it important that an RCD is tripped before every use?

- (b) State **TWO** types of operation employed by most miniature circuit-breakers.

(1) _____

(2) _____

- (c) Describe what would happen if a multi-meter were connected in parallel to a live circuit when set on the amps scale.

- (d) List **TWO** types of prime movers used to drive alternators.

(1) _____

(2) _____

- (e) List **TWO** reasons why shaded pole motors are used to power fans in portable fan heaters.

(1) _____

(2) _____

- (f) How is the output frequency of a stand-alone a.c. generator increased?

(turn over)

Question 1 continued

(g) How is the direction of rotation changed in a universal motor?

(h) Describe an acceptable method of discharging a large capacitor before disconnection from a circuit that has already been isolated.

(i) State the purpose of a phase failure relay.

(j) State the angle of displacement between the phase windings in a two-pole, three-phase alternator.

(k) Define the term **slip speed** as applied to an induction motor.

(l) List **TWO** safety rules that should be observed when using a **stepladder**.

(1) _____

(2) _____

(turn over)

Question 1 continued

(m) How is the direction of rotation changed in a single-phase capacitor-start motor?

(n) What precaution must be taken before disconnecting metering from a CT in a live circuit that cannot be isolated.

(o) List **TWO** advantages of balancing a load over three phases in an installation.

(1) _____

(2) _____

(p) What is meant by the term **peak inverse voltage** as applied to semiconductor devices?

(q) State the standard low voltages available from the NZ MEN three-phase and neutral electricity supply.

(r) In a single-phase split-phase motor, how is the start winding automatically disconnected after starting.

(turn over)

Question 1 continued

(s) List **TWO** common types of earth electrode used to connect the MEN system to the mass of earth.

(1) _____

(2) _____

(t) Give a reason why reduced-voltage starting of a large three-phase induction motor may be required.

(turn over)

Question 2

A three-phase star connected pottery kiln draws 20A from a 400V supply and is protected by 32A fuses. A fault of 8Ω has developed between one line and the kiln frame while the kiln is operating. Assume that the protective earth conductor resistance is 0Ω and the fuse has a fusing factor (gG Utilisation Category) of 1.5.

- (a) (i) Calculate the total current in the faulty line.

(3 marks)

- (ii) Determine by calculation and state the effect if any, that this fault will have on the circuit protection.

(2 marks)

(turn over)

Question 2 continued

(b) If the earth continuity conductor resistance to the kiln was 12Ω and the same 8Ω fault occurred between line and the kiln frame:

(i) Calculate the total current in the faulty line (3 marks)

(ii) Explain by calculations, what electrical hazard this presents to the user. Assume the fuse has a fusing factor (gG Utilisation Category) of 1.5. (2 marks)

(turn over)

Question 3 continued

(c) Explain the internal operation of a miniature circuit breaker when the following situations occur.

(i) Sustained small overload

(2 marks)

(ii) Short circuit

(2 marks)

(turn over)

Question 4

- (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)

(turn over)

Question 4 continued

- (c) Identify which of the tests in (a) and (b) above are carried out on live circuits. (1 mark)

- (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)

SECTION 2

(Answer any **FIVE** questions in this section. If you answer all questions, please strike out the question you do not want marked)

Question 5

A 150 kVA three phase, delta-star connected transformer has a phase ratio of 47.8 to 1. The primary is connected to an 11kV three phase supply and the transformer is fully loaded.

(a) Sketch and label a circuit diagram of the circuit.

(2 marks)

(bi) Calculate the secondary phase voltage.

(2 marks)

(turn over)

Question 5 continued

(c) Calculate the secondary line voltage.

(2 marks)

(d) Calculate the primary line current.

(2 marks)

(e) Calculate the secondary line current.

(2 marks)

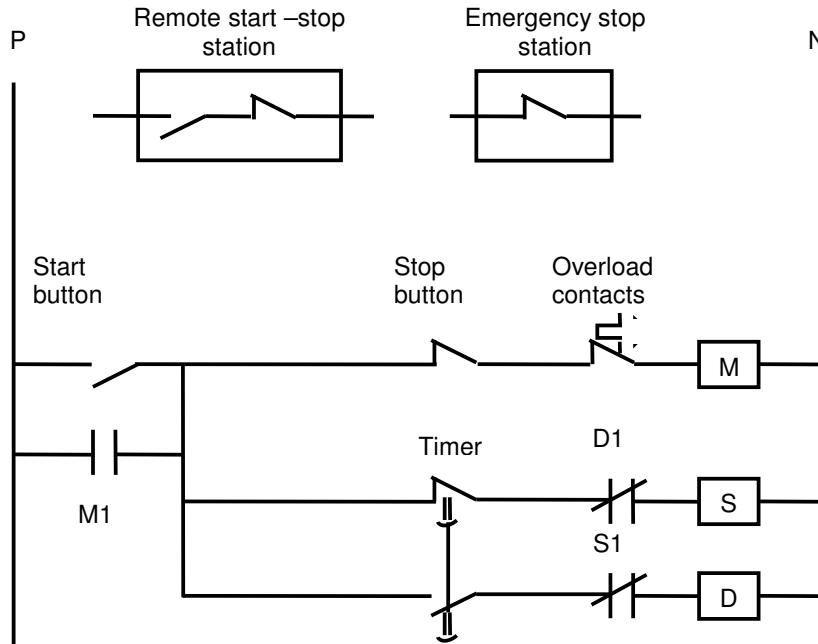
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Question 6

- (a) The figure below shows a motor control circuit. On the diagram, make the appropriate wiring alterations to connect the remote stop-start and emergency stop stations.

(3 marks)

Note: Indicate the removal of any part of the circuit like this - ~~XXXXX~~



- (b) A three-phase, 6 kW induction motor connected to a 400 V, 50 Hz, three-phase supply has a power factor of 0.75 and an efficiency of 80% when fully loaded.

Calculate:

- (i) The input power

(1 mark)

(turn over)

Question 6 continued

(ii) The input kVA (1 mark)

(iii) The input kVAr (2 marks)

(iv) The phase angle (1 mark)

(v) line current (2 marks)

(turn over)

Question 7

(a) A 400V, 7.5kW, 50Hz four pole induction motor, has a slip of 5% when operating at full load.

(i) State the frequency of the rotor currents at start. (1 mark)

(ii) Calculate the synchronous speed of the motor (2 marks)

(iii) Calculate the rotor frequency at full-load speed. (2 marks)

(turn over)

Question 7 continued

- (iv) If the motor has a power factor of 0.8 and draws a full load current of 18A, calculate the efficiency of the motor at full load.

(2 marks)

- (b) A delta connected fully loaded induction motor draws 90A from a 400V supply when started direct online. Show by calculation the current at start up that the motor would draw when connected to a star delta starter in the star position.

(3 marks)

(turn over)

Question 8

- (a) (i) Sketch and label a circuit diagram for a half-controlled, single-phase, full wave bridge rectifier supplying a resistive load.

Include in your diagram the following components:

- Single-phase transformer
- SCRs
- Diodes
- Load
- Control circuit (block only)

(4 marks)

- (ii) Sketch the output waveform at half output (90°).

(2 marks)

(turn over)

QUESTION 8 continued

(b) State **TWO** components that may be used as part of a circuit to filter a rectifier output.

(2 marks)

(1) _____

(2) _____

(c) State **TWO** factors that will cause an SCR to be turned off once it has been triggered (turned on).

(2 marks)

(1) _____

(2) _____

(turn over)

Question 9

(a) List the **FOUR** essential requirements for good lighting. (2 marks)

- (1) _____
- (2) _____
- (3) _____
- (4) _____

(b) State a typical application for EACH of the following lamps and give a reason for your choice.

(i) Sodium Vapour (Low Pressure) (2 marks)

- _____
- _____
- _____
- _____
- _____
- _____

(ii) Metal halide (2 marks)

- _____
- _____
- _____
- _____
- _____
- _____

(turn over)

Question 9 continued

- (c) State **TWO** precautions that must be taken when handling and installing halogen lamps.

(2 marks)

(1) _____

(2) _____

- (d) Explain why single-tube fluorescent fittings should not be installed in a machine shop?

(2 marks)

(turn over)

Question 10

(a) Sketch and label a simple diagram to represent an MEN distribution system showing:

- A delta-star-connected 11 kV/400 V supply transformer including output lines
- A single-phase consumer including main switch, and neutral and earth bar connections
- A three-phase consumer including main switch, and neutral and earth bar connections
- All earthing arrangements.

(5 marks)

(b) List **THREE** advantages of a three-phase MEN system.

(3 marks)

- (1) _____

- (2) _____

- (3) _____

(turn over)

Question 10 continued

- (c) What is the main difference between an MEN switchboard and a distribution switchboard?

(1 mark)

- (d) What type of switchboard must be the first switchboard (closest to the point of supply) in an MEN electrical installation?

(1 mark)

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		
3		
4		
5		
6		
7		
8		
9		
10		
TOTAL		