



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

ELECTRICAL WORKERS REGISTRATION BOARD

ELECTRICIAN'S THEORY EXAMINATION

20 November 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) VAr is “volts amps reactive”. Explain what the term VAr means.

- (b) What is the synchronous speed of a three-phase, four-pole motor?

- (c) What is the specified voltage for testing the insulation resistance of a 230 V circuit?

- (d) State the relationships between line and phase currents for a 3-phase load when it is -

(1) Star connected: _____

(2) Delta connected: _____

- (e) A three-phase induction motor produces 150% of full-load torque when started direct-on-line. What proportion of the full load torque is produced if the motor is started with a start-delta starter?

- (f) How many capacitors are there in the circuit of a permanently split capacitor motor?

(turn over)

Question 1 continued

(g) What type of fuse would you install where the prospective short-circuited current is calculated to be 20,000 A?

(h) Identify the main colours emitted by the following lamps:

(i) Sodium (high pressure) _____

(ii) Mercury vapour (high pressure) _____

(i) Sketch a typical inverse time-current characteristic as applied to fuses.

(j) Why is it important to consider prospective-short-circuit current when choosing a fuse or circuit breaker?

(k) State the formula for calculating power in a balanced resistive three-phase 400 V star-connected circuit.

(l) State **ONE** aspect that must be taken into consideration when installing additional cables in a conduit, tube or pipe?

(turn over)

Question 1 continued

(m) If a capacitor across the starter of a fluorescent light fitting short-circuits, what effect does this have on the operation of the lamp?

(n) State **ONE** factor that limits the prospective short-circuit current in an installation.

(o) What device is used to provide starting torque in a shaded pole motor?

(p) Define the term Transducer.

(q) With reference to polyphase systems of supply, briefly explain the term phase sequence.

(r) What is meant by the term "Testing" as applied to electrical work?

(turn over)

Question 1 continued

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

- (t) Briefly describe how earthing the metal frame of a Class I electrical appliance prevents electric shock hazards under fault conditions.

(turn over)

Question 2

A 2 kW, Class I, single-phase heater has a 230 V supply and a circuit-breaker providing close protection. A phase-to-frame fault of $100\ \Omega$ 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.

(2 marks)

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

(2 marks)

(turn over)

Question 2 continued

- (c) Explain in detail how effective earthing of exposed metal on the heater will provide protection against electric shock when it is used in an earthed situation. (3 marks)

- (d) Explain in detail how a high-resistance earth connection increases the risk of electric shock when using this heater in an earthed situation. (3 marks)

(turn over)

Question 3

- (a) (i) Define power factor. (Stating only a formula will gain no marks) (1 mark)

- (ii) What term is normally used for power factor in a formula? (1 mark)

- (b) A factory supplied from a 230 V single-phase a.c. system, draws a current of 215 A and operates at a power factor of 0.65 lagging.

kVAr per kW required for power factor correction			
	New pf		
Existing pf	0.800	0.850	0.900
0.55	0.769	0.899	1.035
0.60	0.584	0.714	0.849
0.65	0.419	0.549	0.685
0.70	0.270	0.400	0.536

- (i) Using the information from the table, calculate the kVAr rating of the capacitor required to improve the power factor of the load to 0.85. (3 marks)

(turn over)

Question 3 continued

- (ii) Calculate the new line current if the power factor is increased to 0.9
(2 marks)

- (c) Capacitors have been connected to the terminals of a motor to improve the power factor. The thermal motor overloads are installed in the motor control centre.

- (i) What action would you take to ensure the integrity of the motor protection?
(1 mark)

- (ii) State ONE reason why you would take the action stated in (c)(i).
(2 marks)

(turn over)

Question 4

(a) In New Zealand, the standard distribution system has the neutral conductor connected to the earth at the main switchboard on all low voltage installations. What name is given to this type of system?

(1 mark)

(b) Give **TWO** reasons why the neutral conductor is earthed.

(2 marks)

(1) _____

(2) _____

(c) Describe **THREE** hazardous conditions that could occur in an installation with a high-prospective short-circuit current level.

(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 4 continued

(d) A 250kVA, 400V 3 phase transformer has a 5% impedance.

- (i) Determine the fault level which could be produced by the transformer
(2 marks)

- (ii) Determine the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.

(2 marks)


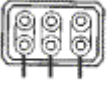
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SECTION 2

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

Question 5

Use the information given on this name plate in to answer the questions below.

Type	MOT 112M	No	042657	Year	1296
kW	4.0 kW	H.P.		Hz	50
R.P.M	1440	Ph.	3-	Ins. Class	F
Amb. Temp		Cos θ	0.82	$\eta\%$	
Duty	S1	Protection	IP 55		
V	415			V	
A	8.52			A	

(a) Calculate the following:

(i) Motor efficiency

(3 marks)

(ii) Slip at full load

(1 mark)

(turn over)

Question 5 continued

- (b) The motor is rated IP55. The letters "IP" mean International Protection or Ingress Protection. Explain what is meant by Ingress Protection (2 marks)

- (c) The motor is to be started direct on-line and protected by a thermal overload unit and HRC fuses. Briefly explain why both of the protection devices are required.

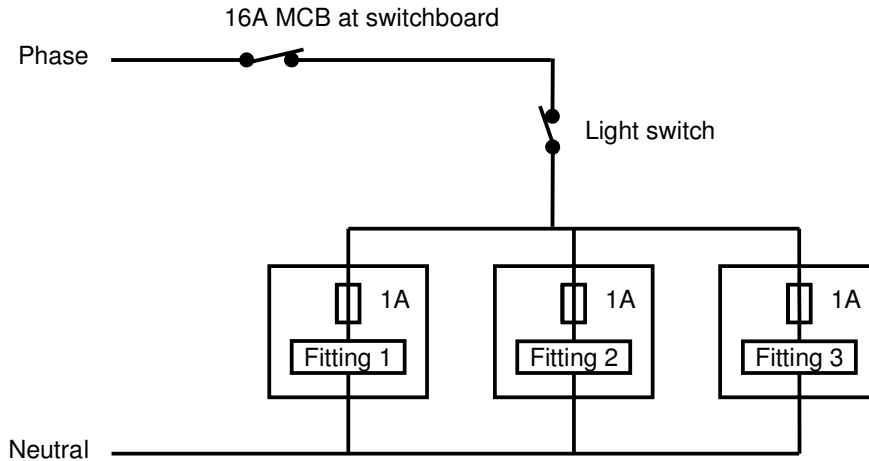
- (i) Thermal overload (2 marks)

- (ii) HRC fuses (2 marks)

(turn over)

Question 6

The figure below represents 3 fluorescent lights supplied from a 230V MEN supply.



(a) If a voltmeter were connected across the terminals of the circuit breaker what voltage would it read when:

(i) The circuit is working normally? (1 mark)

(ii) The circuit breaker has operated? (1 mark)

(b) The fuses in the light fittings are HRC fuses.

(i) What protection is afforded by the MCB. (3 marks)

(turn over)

Question 6 continued

- (ii) What protection is afforded by one of the 1A HRC fuses? (2 marks)

- (iii) How is discrimination achieved in the circuit in the figure? (2 marks)

- (c) State **ONE** reason why the fuses in the fittings must not be shorted out or increased in current rating. (1 mark)

(turn over)

Question 7

- (a) Explain the principal difference in operation between an electronic speed controller and an electronic soft starter as used with a.c. induction motors.
(2 marks)

- (b) (i) Draw and label a block diagram of an inverter type a.c. speed controller as used with a.c. induction motors.
(2 marks)

- (ii) State **THREE** operational principles of the inverter type a.c. speed controller you have drawn in (b)(i)
(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 7 continued

- (c) State **THREE** advantages of electronic starters over electromechanical type starters, such as auto-transformer types.

(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 8

- (a) Explain why the secondary terminal voltage of a transformer is less at full load than it is with no load.

(3 marks)

- (b) What precaution must be taken with current transformers before the associated instruments are disconnected?

(1 mark)

- (c) A three-phase 2 MVA transformer is star-delta connected, and has a turn ratio of 173:50. The primary line voltage is 66 kV. Calculate:

- (i) Primary phase voltage

(1 mark)

- (ii) Secondary line voltage

(1 mark)

(turn over)

QUESTION 8 continued

(iii) Full load secondary line current

(3 marks)

(iv) The current in each secondary winding on full load

(1 mark)

(turn over)

Question 9

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

(2 marks)

- (ii) State **ONE** advantage that a single-phase capacitor start - induction run motor has over other single-phase induction motors.

(1 mark)

- (iii) Describe how to change the direction of rotation of a single-phase capacitor start - induction run motor.

(1 mark)

- (b) (i) Sketch a circuit diagram of a single-phase permanently-split capacitor motor.

(2 marks)

(turn over)

Question 9 continued

- (ii) State **ONE** advantage that a single-phase permanently-split capacitor motor has over other single-phase induction motors.

(1 mark)

- (iii) Describe how to change the direction of rotation of a single-phase permanently-split capacitor motor.

(1 mark)

- (c) State **ONE** advantage that a single-phase split phase motor has over other single-phase induction motors.

(1 mark)

- (d) Describe how to change the direction of rotation of a single-phase shaded pole motor.

(1 mark)

(turn over)

Question 10 continued

(b) State **TWO** precautions to be taken when installing halogen lamps. (2 marks)

(1) _____

(2) _____

(c) Describe, with the aid of a diagram, direct light distribution from a light fitting. (2 marks)

(i) Diagram

(ii) Description

(d) Describe the lighting term - luminous intensity, (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		