



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

ELECTRICIAN'S THEORY EXAMINATION

21 June 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) Calculate the line current of a three phase 15kW deep fryer. The supply is 400 V, 50Hz. (2 marks)

- (b) (i) What test voltage is required when carrying out an insulation resistance test on a three-phase, 400 V, MEN supply cable? (1 mark)

- (ii) What is the minimum value of the permitted test result for the insulation resistance test on the cable? (1 mark)

- (c) Briefly explain the purpose of the interlocks in a star/delta starter. (2 marks)

- (d) State **TWO** advantages that HRC fuses have - other than cost - when compared to MCBs (2 marks)

(1) _____

(2) _____

(turn over)

Question 1 continued

- (e) State **TWO** disadvantages that MCBs have - other than cost - when compared to HRC fuses.

(2 marks)

(1) _____

(2) _____

- (f) What is the purpose of the capacitor in starting a single-phase a.c. capacitor-start induction motor?

(2 marks)

- (g) For what reason would you connect a resistor across a circuit after the electricity supply to that circuit has been isolated.

(2 marks)

- (h) (i) What is meant by the term "pullout torque" as it applies to an a.c. induction motor?

(1 mark)

- (ii) What is the synchronous speed of a three-phase, four-pole, 50 Hz motor?

(1 mark)

(turn over)

Question 1 continued

- (i) (i) State the main reason why it is important to consider prospective-short-circuit current when choosing a protection device.

(1 mark)

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

(1 mark)

- (j) A residual current device (RCD) has operated. The RCD protects a circuit and a fixed-wired Class I electrical appliance. What has the RCD detected that would cause it to operate?

(2 marks)

(turn over)

Question 2

(a) Draw and label a diagram to represent the supply arrangements for an MEN distribution system that includes:

- A delta-star-connected 11 kV/400 V supply transformer showing the neutral and earthing arrangements
- The conductors supplying a single-phase consumer installation and a three phase consumer installation
- The single-phase consumer switchboard that shows the main switch, neutral and earthing arrangements
- The three-phase consumer switchboard that shows the main switch, neutral and earthing arrangements
- Fuse protection for each installation

(4 marks)

(turn over)

Question 2 continued

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

(2 marks)

(1) _____

(2) _____

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

(2 marks)

(1) _____

(2) _____

(d) Describe **FOUR** electrical hazards that may occur in a low voltage installation if the impedance of the main neutral is higher than the impedance of main earth.

(2 marks)

(1) _____

(2) _____

(3) _____

(4) _____

(turn over)

Question 3

- (a) Describe the method by which a single-phase supply may be used to simulate a rotating magnetic field effect for a split-phase single phase induction motor.

(5 marks)

- (b) If an external starting relay is to be used to for a single-phase, split-phase induction motor, which winding will it switch?

(1 mark)

(turn over)

Question 3 continued

(c) In a single-phase, capacitor start induction motor, what would be the effect on the performance of the motor if the run winding was open-circuited:

(i) And the motor was switched on whilst on load?

(1 mark)

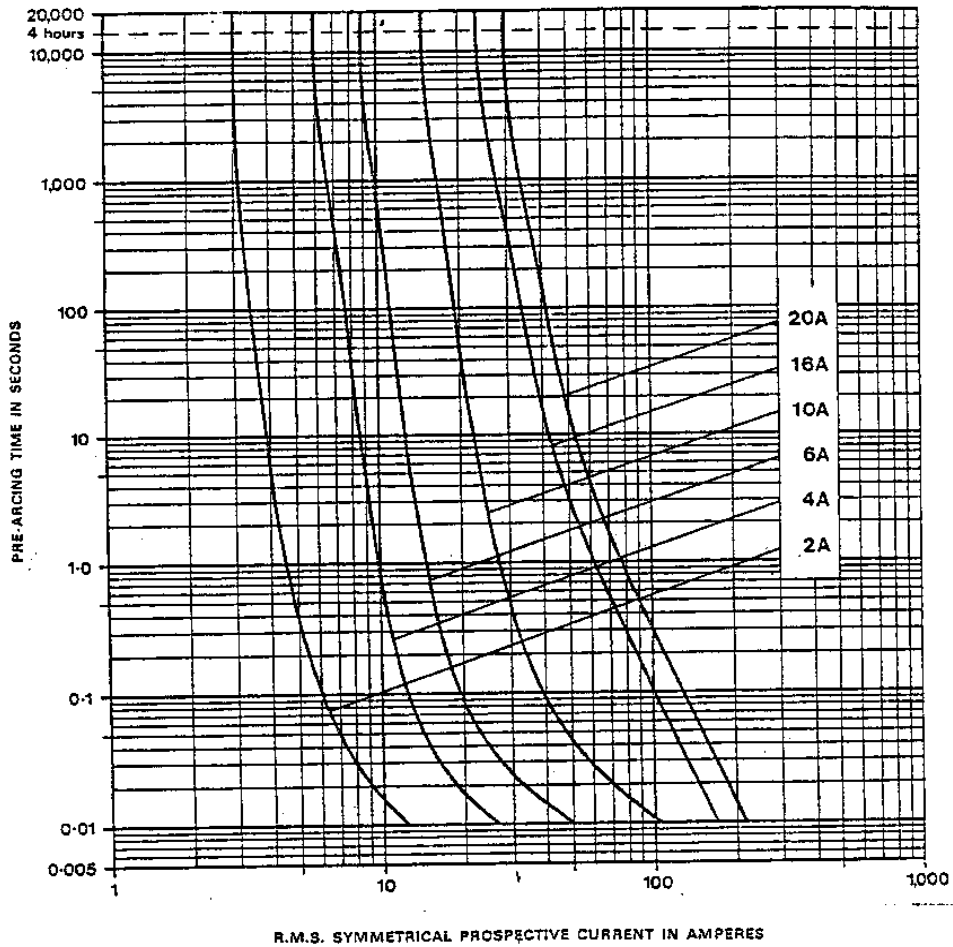
(ii) While the motor was running whilst on load?

(3 marks)

(turn over)

Question 4

- (a) The following graph shows the time/current characteristics of six HRC fuses.



- (i) Why is the graph referred to as an inverse time current characteristic graph?

(2 marks)

(turn over)

Question 4 continued

- (ii) Which fuse would trip when a current of 27A flows with a pre-arcing time of 1.0 second?

(1 mark)

- (b) (i) What is the gG utilisation category (fusing factor) of a 6A rated fuse?

(1 mark)

- (ii) What value of current will operate the 6A fuse?

(1 mark)

- (c) Describe what happens in an electrical installation when a fault occurs and there is "discrimination" between protective devices.

(2 marks)

- (d) Under what circumstances must back-up protection be installed in a motor circuit?

(2 marks)

- (e) What is meant by the term "current rating" when applied to fuses.

(1 mark)

(turn over)

Question 5

(a) The circuit supplying a 230V, single-phase wash-down pump has both RCCB and MCB protection. The pump isolating switch has been replaced.

(i) What would be the effect if the phase and neutral were accidentally interchanged at the supply side of the isolating switch?

(3 marks)

(ii) What would be the effect if the neutral and earth were accidentally interchanged at the supply side of the isolating switch?

(1 mark)

(b) State **ONE** test that would detect the interchange of the phase and neutral conductors before the electricity supply is livened.

(1 mark)

(turn over)

Question 5 continued

- (c) A three-phase, 400V, four-wire distribution board has a load of 32A on the red phase, 12A on the white phase and 40A on the blue phase. Determine the neutral current using a graphical method.

(5 marks)

(turn over)

Question 6

- (a) You need to take a three-phase, 10 kW pump motor away for repair. You have isolated the motor and have disconnected the motor cables. The motor cables are still connected to the DOL starter.

State **TWO** precautions which must be taken to ensure the safety of persons and property after you have completed the isolation and disconnection

(2 marks)

(1) _____

(2) _____

- (b) How is "isolating" a three-phase machine different from just "switching off" the machine?

(3 marks)

turn over)

Question 6 continued

(c) Describe **THREE** different methods of safely ensuring the continued isolation of a fixed-wired, three-phase machine. (3 marks)

(1) _____

(2) _____

(3) _____

(d) State the **TWO** reasons why the prove-test-prove method of testing for isolation is used. (2 marks)

(1) _____

(2) _____

(turn over)

Question 7

A 400V, three-phase star-connected bakery oven is rated at 25 kW. The circuit is protected by 45A, gG type, HRC fuses with utilisation category (fusing factor) of 1.5.

- (a) A fault of negligible impedance has developed between one line and the oven frame while the oven is operating. The protective earth conductor resistance is 0.75Ω . Calculate the total current in the faulty line
(1½ marks)

- (b) If fault was 15Ω impedance and the protective earth conductor resistance is 5Ω .

- (i) Calculate the total current in the faulty line
(5 marks)

(turn over)

Question 7 continued

(ii) Calculate whether the fuse will operate.

(1½ marks)

(iii) Calculate the touch voltage that would appear on the frame of the oven.

(2 marks)

(turn over)

Question 8

A three-phase three-wire 11 000V supply is available for the primary connection of the delta connected transformer to a commercial site.

You have taken the current measurements at the three-phase, four-wire secondary side of the transformer and have recorded the following maximum demands:

- Red = 145A
- White = 130A
- Blue = 120A

The line voltage on the secondary side is 400V.

(a) Using the information above, determine:

- (i) The load in kVA of the heaviest loaded phase.

(4 marks)

- (ii) The minimum sized kVA rating of the three phase distribution transformer required to supply load for this site.

(1½ marks)

(turn over)

Question 8 continued

- (b) Using the information given above and from your calculations in (a), determine the maximum line current in the three-phase 11 000V system
(4½ marks)

(turn over)

Question 9

You have been requested to wire a DOL forward and reverse starter that controls a three-phase delta connected motor.

- (a) Draw and label the power circuit for the DOL starter. The drawing must show the contactors and conductors that enables the motor to be operated in the forward and reverse directions.

(3 ½ marks)

(turn over)

Question 9 continued

- (b) Draw and label the 230V control circuit for the DOL forward and reverse starter.

(6½ marks)

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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		
3		
4		
5		
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7		
8		
9		
TOTAL		