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| For Board Use Only | |
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ELECTRICAL WORKERS REGISTRATION BOARD

ELECTRICIAN'S THEORY EXAMINATION

19 November 2005

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. 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)

SECTION 1

Answer all questions in this section

Question 1

(a) State:

(i) A typical transmission voltage used in New Zealand.

(½ mark)

(ii) A typical distribution voltage used in New Zealand.

(½ mark)

(b) State the formula for determining the percentage slip in a three-phase induction motor?

(1 mark)

(c) Why is a Thermistor used in a motor protection circuit?

(1 mark)

(d) Give **ONE** application where a three-phase motor would require phase reversal protection.

(1 mark)

(e) What are the **TWO** main functions of a choke in a fluorescent light fitting?

(1 mark)

(1) _____

(2) _____

(turn over)

Question 1 continued

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

(1 mark)

- (g) The power of a balanced 3-phase star-connected load is 9kW. What is the single-phase power?

(1 mark)

- (h) What are the **TWO** main functions of the capacitor in starting a single-phase a.c. capacitor-start induction motor?

(1 mark)

(1) _____

(2) _____

- (i) State **ONE** reason why the neutral conductor is earthed in an MEN system.

(1 mark)

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

(1 mark)

(turn over)

Question 1 continued

- (k) What type of three-phase a.c. motor is most likely to have a wound rotor and an external resistance bank?

(1 mark)

- (l) One end of a main earthing conductor in an MEN electrical installation is connected to an earth electrode. To where must the other end be connected?

(1 mark)

- (m) Does a fluorescent tube strike when the contacts of the glow-starter switch close, or open?

(1 mark)

- (n) State **TWO** reasons why induction motor rotor bars normally skewed?

(1 mark)

(1) _____

(2) _____

- (o) State the ripple frequency of a three-phase, full wave rectifier with an input of 50 Hz.

(1 mark)

- (p) State **ONE** hazard that could be present where high prospective short-circuit fault currents occur.

(1 mark)

(turn over)

Question 1 continued

- (q) 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 star-delta starter?

(1 mark)

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

(1 mark)

- (s) Why must the secondary terminals of a current transformer be short-circuited before disconnecting the burden?

(1 mark)

- (t) State **TWO** reasons why rectified three-phase a.c. is easier to smooth with filters, than rectified single-phase a.c.?

(1 mark)

(1) _____

(2) _____

(turn over)

Question 2

- (a) A three-phase star-connected bakery oven kiln draws 40A from a 400V supply and is protected by 45A HRC fuses. A fault of 11Ω has developed between one line and the kiln frame while the kiln is operating and the protective earth conductor resistance to the kiln is 5.7Ω .

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

(2 marks)

- (ii) Explain, using calculations, the effect on the operation of the fuse. Assume that the fuse has a fusing factor (gG Utilisation Category) of 1.5.

(2 marks)

(turn over)

Question 2 continued

(iii) What electrical hazard may be presented to the user of the appliance?

(2 marks)

(b) Explain in detail how effective earthing of the exposed metal on the kiln frame will provide protection against electric shock.

(4 marks)

(turn over)

Question 3

- (a) Explain the meaning of the term **discrimination** as applied to protective devices. (2 marks)

- (b) An HRC fuse is marked 60A - 440V - AC40. What is the meaning of these **THREE** sets of figures and letters? (3 marks)

60A _____

440V _____

AC40 _____

- (c) Under what circumstance must back-up protection be installed in addition to normal circuit protection? (2 marks)

(turn over)

Question 3 continued

- (d) What is meant by the term inverse time-current characteristic in relation to fuses and circuit breakers?

(2 marks)

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

(1 mark)

(turn over)

Question 4 continued

- (d) If a Residual Current Circuit Breaker (RCCB) is installed in a single-phase circuit, why is it necessary to also have overcurrent protection?

(1 mark)

- (e) Are Portable Residual Current Devices (PRCDs) used in New Zealand required to be voltage dependent? State a reason for your answer.

(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) A balanced load comprising three impedances of 94.4Ω each are delta-connected to a 400V three-phase a.c. 50 Hz supply.

(i) Draw a circuit diagram to illustrate the above arrangement. (2 marks)

(ii) Calculate the phase current in the load. (2 marks)

(iii) Calculate the line current. (2 marks)

(turn over)

Question 5 continued

(iv) Calculate the power consumption of the arrangement.

(2 marks)

(b) What would be the effect on the power dissipated if the system described in (a) above, was inadvertently connected in Star?

(2 marks)

(turn over)

Question 6

(a) A three-phase induction 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 the **TWO** forms of protection that will be incorporated in the starter's circuitry.

(2 marks)

(1) _____

(2) _____

- (iii) Briefly explain the purpose of the interlocks.

(2 marks)

(b) The same motor could be started by an auto-transformer starter.

- (i) What would be the main advantage of this starter over the star/delta starter?

(1 mark)

(turn over)

Question 6 continued

- (ii) If the auto-transformer has tapplings of 40%, 60% and 80%, which tapping should be chosen first? State a reason for your answer.

(2 marks)

- (iii) If the motor fails to start satisfactorily on the initial choice of tapping, what action should be taken and why?

(2 marks)

(turn over)

Question 7

(a) A 250 kVA three phase, delta-star connected transformer has 4780 primary turns to 100 secondary turns. The primary is connected to an 11kV three-phase supply and the transformer is fully loaded.

(i) Calculate the secondary phase voltage.

(2 marks)

(ii) Calculate the secondary line voltage.

(2 marks)

(iii) Calculate the primary line current.

(2 marks)

(iv) Calculate the secondary line current.

(2 marks)

(turn over)

Question 7 continued

- (b) State the **TWO** reasons why the secondary terminal voltage of a transformer is less at full load than it is with no load.

(2 marks)

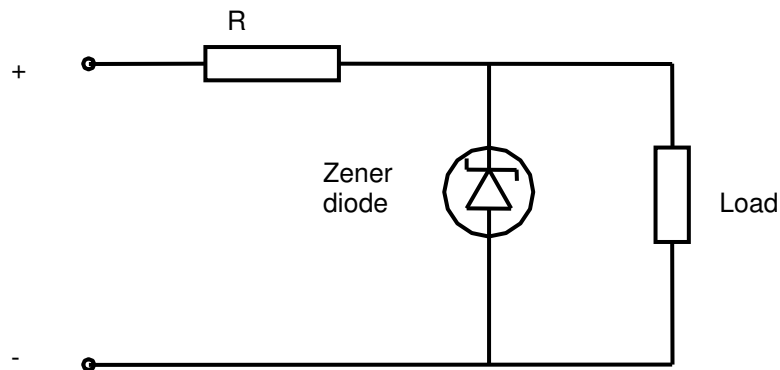
(1) _____

(2) _____

(turn over)

Question 8

(a) The figure below shows a shunt regulator supplied by a rectified d.c. supply.



(i) What is the purpose of the Zener diode?

(1 mark)

(ii) What main advantage does a Zener diode have over a normal rectifier diode?

(1 mark)

(turn over)

Question 9

(a) Sketch the speed/torque characteristic graph of a squirrel cage induction motor, and show the location of:

- The starting torque.
- The pull-out torque.
- The full-load torque.
- The full-load (normal) speed.

(4 marks)

(b) What do the following terms mean?

(i) Starting torque

(1 mark)

(ii) Pull-out torque

(1 mark)

(turn over)

Question 9 continued

(iii) Full-load torque

(1 mark)

(iv) Full-load (normal) speed

(1 mark)

(c) Briefly explain why the starting torque is only twice full-load torque, when the starting current can be 7 times full-load current.

(2 marks)

(turn over)

Question 10 continued

(c) Overall kVA

(2 marks)

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 | |
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