CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 10 APRIL 2014

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

1. Non-programmable calculators may be used. 2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A two core cable is 400 metres long and is fed at each end with 240 V d.c. Three loads are connected to the distributor:

   - 120 A at 80 metres
   - 80 A at 160 metres
   - 100 A at 280 metres

   All distances are measured from the same end of the distributor.

   The resistance of the twin cable ('go and return') is 0.001 Ω/metre.

   Calculate EACH of the following:

   (a) the current supplied at each end of the distributor; (6)

   (b) the p.d. at each load point; (6)

   (c) the total power lost in the distributor cable. (4)

2. A capacitor of 100 μF is charged for 5 secs from a 100 volt d.c. supply via a resistor of 100 kΩ.

   Calculate EACH of the following:

   (a) the voltage across the capacitor at the end of this period; (4)

   (b) the energy stored in the capacitor; (4)

   (c) the capacitor is now disconnected and a second capacitor of 100 μF already charged to 70 volts is connected in parallel with it.

   Calculate EACH of the following:

   (i) the final steady state voltage across the pair; (4)

   (ii) the energy stored by the pair of capacitors. (4)

3. A small silicon transistor with the characteristics given in Worksheet Q3 has a maximum safe power dissipation of 18 mW and it is to be operated on a 12 V d.c. supply.

(a) Plot this power dissipation curve on the characteristics. (5)

(b) Determine the minimum value of collector load resistance for the transistor if this dissipation is not to be exceeded. (5)

(c) The transistor is used in a common emitter configuration and is biased at a base current of 60 μA and an alternating signal of +/- 40μA is applied to the base.

Determine:

(i) the r.m.s. voltage variation between collector and emitter; (3)

(ii) the r.m.s. value of the variation in collector current. (3)

4. A capacitor connected in series with a resistor is tested on 240 V 50 Hz and the current is found to be 3.6 A. When the frequency is raised to 100 Hz, the current increases to 4.8 A.

Determine EACH of the following:

(a) the values of the resistor and the capacitor; (6)

(b) the power factor of the circuit at 50 Hz; (4)

(c) the value of an inductor which, when connected in series with the pair, will give the same current of 3.6 A at 50 Hz but with a lagging power factor equal to the value obtained in part (b). (6)

5. A 440 V 400 kVA three- phase transformer is designed to operate at maximum efficiency at ¾ full load and 0.8 power factor. The iron losses total 8 kW.

Determine EACH of the following:

(a) the efficiency at ¾ full load and 0.8 p.f.; (6)

(b) the total losses at full load; (6)

(c) the full load efficiency at 0.7 p.f. (4)

6. An unbalanced three phase load is supplied from a 440 V 50Hz four wire supply. The current in the red line is 6 A lagging by 30°, the current in the yellow line is 5A in phase and the current in the blue line is 7 A leading by 15°.

Determine EACH of the following:

(a) the current in the neutral line; (6)

(b) the phase angle of the neutral current relative to the voltage between the red line and the neutral line; (5)

(c) the total power dissipated by the circuit. (5)

7. (a) Explain, with the aid of a circuit diagram, the *auto transformer* method of starting a squirrel cage induction motor. (8)

(b) State two advantages and two disadvantages of the auto transformer method of starting over the star delta method of starting. (4)

(c) Explain why it is desirable to disconnect the auto transformer when the starting sequence is completed. (4)

8. (a) Sketch the reverse current/voltage characteristic for a low power Zener diode with a breakdown voltage of 10 V. (5)

(b) Sketch a simple voltage regulator circuit using a Zener diode. (5)

(c) State which factors determine the value of the series resistor used in the circuit described in part (b). (3)

(d) State which factors determine the power rating of the Zener diode in the circuit described in part (b). (3)

9. (a) Explain why it is necessary to monitor and detect faults between the phase windings and earth of a star connected alternator with an earthed neutral point. (4)

(b) Sketch a circuit diagram of one arrangement for detecting phase to earth faults within a star connected alternator with earthed neutral. (7)

(c) Explain how the circuit given in part (b) enables earth faults to be detected. (5)