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, 17 December 2015

0915 - 1215 hrs

Examination paper inserts:

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

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. Fig Q1 shows a circuit designed for measuring temperature.

   (a) Calculate the value of the sensing element 'R' so that the meter will read full scale deflection (F.S.D.) of 1 mA in the direction shown. (8)

   (b) Calculate the value to which the 200 Ω resistor will have to be changed if the meter becomes unserviceable and has to be replaced with one of the same resistance but of 2 mA F.S.D. if the meter is still to read full scale deflection. (8)

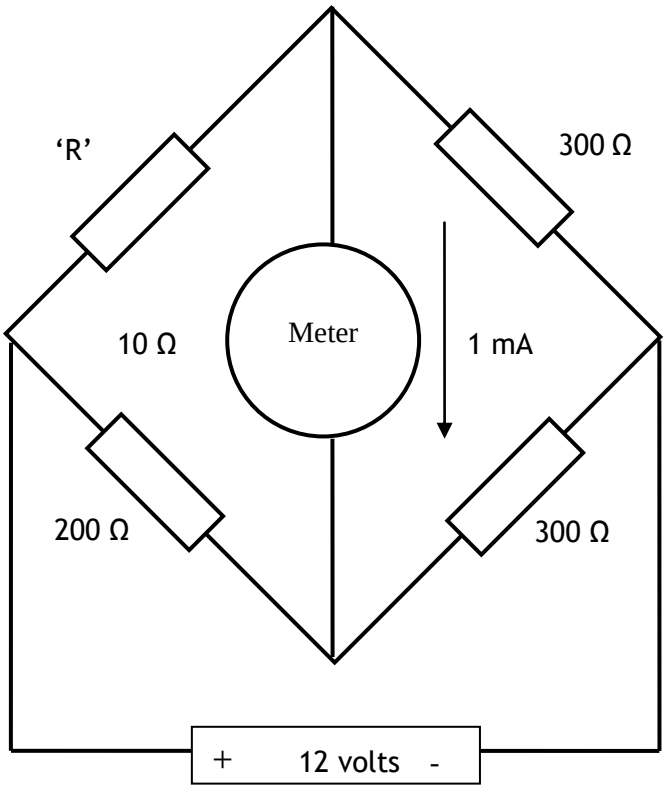

Fig Q1

2. A relay coil has resistance 24 Ω and inductance 2 H. It operates on 12 V d.c.

(a) Calculate the time after switching on the supply for the relay to close if it requires a current of 0.25 A to operate. (6)

(b) Calculate the energy stored in the coil at the time of operation. (4)

(c) Calculate the time delay before operation if a resistor of 6 Ω is connected in series with the relay coil and it is operated from 15 V supply. (6)

3. Fig Q3 shows a basic voltage stabiliser circuit intended to give a regulated output of 8 V d.c. from an unregulated input which can vary between 12 V and 20 V.

The Zener diode has a breakdown voltage of 8 V, a forward resistance after breakdown of 2 Ω and requires a minimum forward current of 2 mA. The Zener diode has a maximum power rating of 1 W.

Calculate EACH of the following:

(a) the minimum value of the series resistance 'R'; (6)

(b) the regulated output voltage when the input is 15 V and the load output current is 40 mA; (4)

(a) the maximum permissible output current for satisfactory regulation if the input voltage is 12 V. (6)

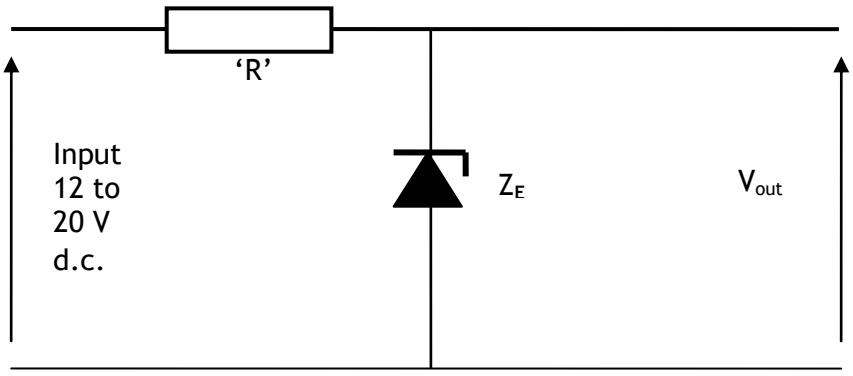

Fig Q3

4. A single phase circuit consists of a capacitor of 50 μF in parallel with a coil of unknown resistance and unknown inductance. When connected to 240 V, 50 Hz the circuit draws 7 A at power factor 0.8 lag.

Calculate EACH of the following:

(a) the resistance of the coil; (5)

(b) the inductance of the coil; (5)

(c) the power factor of the coil. (2)

(d) If the capacitor is now connected in series with the coil to the same supply, calculate the current drawn by this series circuit. (4)

5. A star connected three phase load has a coil of resistance 50 Ω and inductance 0.1 H in each phase. It is connected to a three-phase, three-wire supply of 415 V, 50 Hz.

Calculate EACH of the following:

(a) the line current; (5)

(b) the power factor of the load; (4)

(c) the value of EACH of three identical delta connected capacitors, which if connected in parallel with this load, will raise the overall power factor to unity. (7)

6. The load on a ship's distribution system comprises:

- motors totalling 1200 kW at a p.f. of 0.7 lag;
- lighting totalling 500 kW at u.p.f.;
- an over-excited synchronous motor taking 200 kW at a p.f. 0.5 lead.

This total load is shared by two identical alternators, one of which provides 1000 kVA at a p.f. of 0.85 lag.

Calculate EACH of the following:

(a) the kW provided by the second alternator; (5)

(b) the kVA supplied by this machine; (3)

(c) the power factor of the second alternator; (3)

(d) the power factor of the synchronous motor if the overall p.f. of the system is to be raised to unity. (5)

7. (a) Sketch a basic power circuit diagram for a star/delta starter for a squirrel cage motor. (8)

(b) Explain why the starting voltage and hence the starting current is reduced using a star/delta starter. (4)

(c) State by what factor the initial starting current is reduced using a star/delta starter compared to the direct on line starting current. (4)

8. (a) Explain the term *power factor correction*. (3)

(b) State two advantages of power factor correction. (4)

(c) Explain, with the aid of a suitable circuit diagram, how power factor correction can be effected in a three phase circuit using capacitors. (5)

(d) State one other method, other than the use of capacitors, of bringing about power factor correction. (4)

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 Q9(b) enables earth faults to be detected. (5)