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, 16 OCTOBER 2014

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
Graph Paper

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. The network shown in Fig Q1 is for sensing temperature.

   (a) Calculate the value of the sensing element 'R' so that the meter will read full scale deflection (FSD) 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 replaced by one of the same resistance but of 2 mA FSD and the meter is still to read full scale deflection. (8)

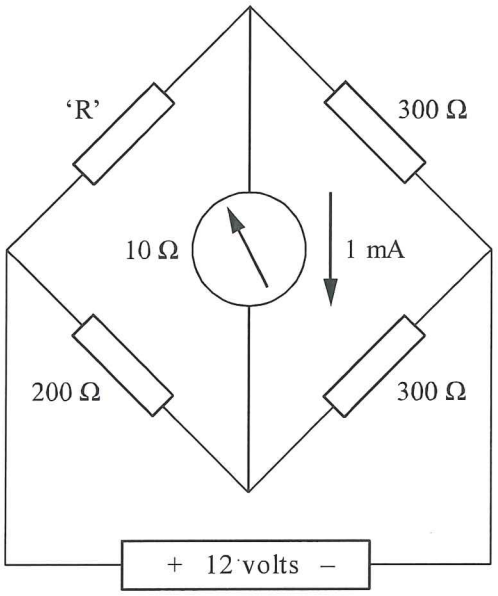

Fig Q1

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2. A relay coil has a resistance of 200 Ω and the current required to operate the relay is 150 mA.

When the coil is connected to 50 V d.c. it takes 40 ms to operate.

Calculate EACH of the following:

(a) the steady state relay current; (2)

(b) the time constant for the coil; (4)

(c) the inductance of the coil. (4)

(d) To increase the operating time of the relay, a 50 Ω resistor is connected in series with the coil.

Calculate the new operating time for the relay. (6)

3. The p.d. across the base emitter junction of the silicon transistor shown in Fig Q3 is 0.6 V and the output voltage V_C is 4 V.

Assuming that the base current is negligible, calculate EACH of the following:

(a) the p.d. across each of the base bias resistors; (4)

(b) the p.d between collector and emitter; (4)

(c) the value of the load resistor R_L; (4)

(d) the power dissipated in the load resistor R_L; (2)

(e) the power dissipated by the transistor. (2)

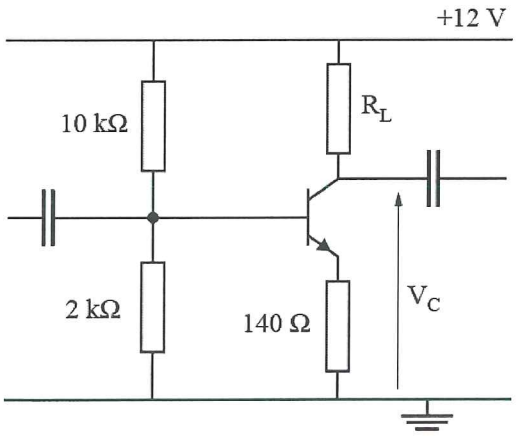

Fig Q3

4. A coil of resistance **R** and inductance **L** is connected to a 50 Hz supply and draws a current at a power factor of 0.8 lag. If a capacitor of 100 μF is now connected in series with the coil the circuit draws the same current but at a power factor of 0.8 lead.

Calculate EACH of the following:

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

(b) the resistance of the coil. (5)

If the voltage measured across the capacitor is 36 V, determine EACH of the following:

(c) the current in the circuit; (2)

(d) the supply voltage. (4)

5. A three phase load connected to a 415 V 50 Hz supply takes a current of 40 A at a lagging power factor of 0.7.

(a) Calculate EACH of the following:

(i) the power taken by the load; (3)

(ii) the KVAR taken by the load. (3)

(b) Three capacitors, each of 100 μF, are now connected in delta to the same supply.

(i) Calculate the new power factor of the whole circuit. (3)

(ii) If the capacitors had been connected in star, calculate the new power factor for the whole circuit. (3)

6. A 440/110 volt 10 kVA single phase transformer gives its maximum efficiency at 80% full load. The iron loss is 0.4 kW.

Calculate EACH of the following:

(a) the efficiency at full load and power factor 0.9; (8)

(b) the efficiency at 60% full load and unity power factor. (8)

7. (a) State TWO advantages and TWO disadvantages of the wound rotor induction motor starting method. (4)

(b) Sketch a circuit diagram showing the rotor/slip rings/starting resistor connection for a 3 ph wound rotor induction motor. (6)

(c) A 3 ph 4 pole wound rotor induction motor has a rotor induced e.m.f. of 230 V 60 Hz between the slip rings at standstill.

Calculate EACH of the following:

(i) the rotor phase e.m.f. and frequency at a slip 0.04 p.u.; (4)

(ii) the synchronous speed. (2)

8. (a) State the conditions necessary to *turn on* and *turn off* a thyristor (silicon controlled rectifier). (4)

(b) Describe the operation of the circuit shown in Fig Q8. (8)

(c) Sketch the output waveform across the load for switching delay angles of:

(i) 45°; (2)

(ii) 120°. (2)

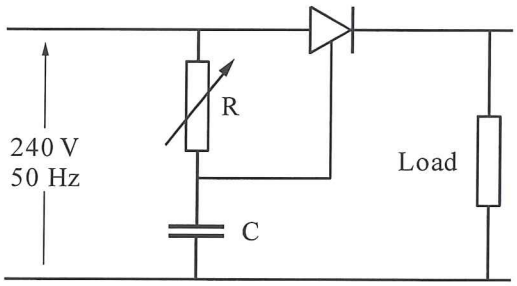

Fig Q8

9. (a) Explain, with the aid of a sketch, the principle of the *auto transformer.* (8)

(b) Explain why the auto transformer is not a suitable choice of transformer for applications where the transformation ratios differs widely from 1:2 or 2:1. (4)

(c) Explain why it is possible, with an auto transformer of ratio 1:2, to use the same gauge of conductor throughout the windings. (4)