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, 24 JULY 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. In the network shown in Fig Q1, the meter indicates 2mA in the direction shown.

   Determine EACH of the following:

   (a) the resistance of the meter; (8)

   (b) the reading on the meter if the 1.5 kΩ and the 2 kΩ resistors are interchanged. (8)

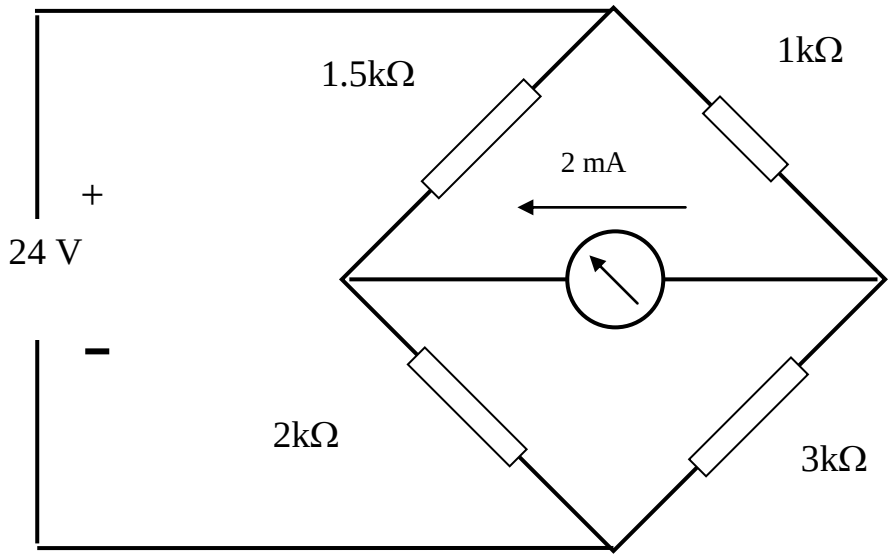

Fig Q1

2. The V/I characteristic of a non-linear circuit element is shown in Table Q2.

This non-linear element is connected in series with a paralleled pair of resistors of 40 kΩ and 80 kΩ and the overall circuit is connected to 110V d.c.

Determine EACH of the following:

(a) the current in the non-linear resistor; (8)

(b) the effective resistance of the non-linear resistor; (3)

(c) the current in the 80 kΩ resistor. (5)

V (volts)	40	60	80	100	120	140
I (mA)	0.65	1.05	1.55	2.20	3.20	4.70

Table Q2

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) If the transistor is used in a common emitter configuration and is biased at a base current of 60 μA and an alternating signal of +/- 40 μA 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) A coil having resistance and inductance is connected to a 240 V, 50 Hz supply and draws a current of 4A at power factor 0.8 lag.

Determine EACH of the following:

(i) the resistance of the coil; (4)

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

(b) A capacitor is now joined in series with the coil and the current rises to 5A.

Determine EACH of the following:

(i) the value of the capacitor; (4)

(ii) the new power factor. (4)

5. A three phase star connected load has three identical legs each comprising a 40 Ω resistor in series with a 100 μF capacitor. It is supplied at 415 V, 50 Hz from a three wire supply.

Calculate EACH of the following:

(a) the current in each phase; (4)

(b) the current in each phase if due to a fault the red phase lead becomes detached; (6)

(c) the current in each phase if the red phase short circuits to the star point. (6)

6. A 440 V/ 110 V single phase transformer takes a no load current of 5 A at power factor 0.25 lag. On load the transformer supplies 7.5 kVA at power factor 0.8 lag.

Calculate EACH of the following:

(a) the transformer secondary current; (2)

(b) the transformer primary current; (8)

(c) the primary power factor; (3)

(d) the efficiency of the transformer at this load. (3)

7. (a) Describe, with the aid of a sketch, the construction of a double wound, single phase transformer and explain the principle of its operation. (4)

(b) Explain why a transformer is rated in KVA rather than KW. (4)

(c) State why the iron loss in a transformer is not load dependent. (4)

(d) State how the copper losses in the two windings of a transformer vary with the loading of the transformer. (4)

8. (a) State the conditions necessary to *turn on* and *turn off* a thyristor ('SCR'). (4)

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

(c) Sketch the voltage waveform across the load for EACH of the following trigger delay angles:

(i) 60^{o}; (2)

(ii) 120^{o}. (2)

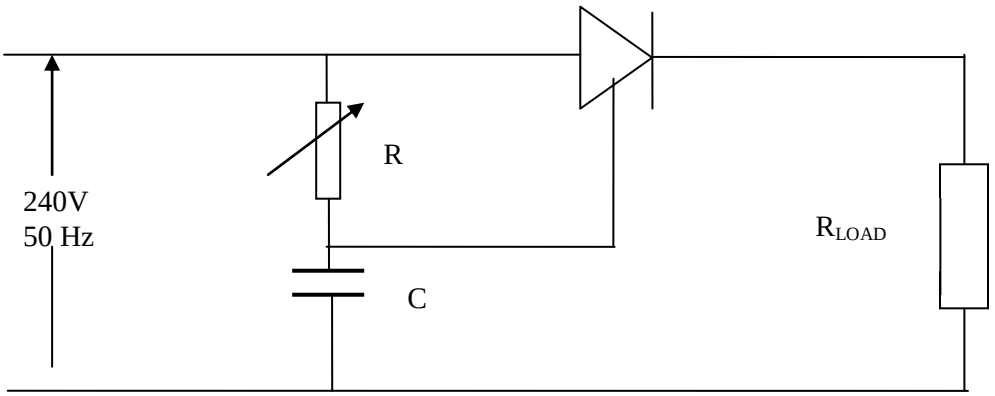

Fig Q8

9. (a) Sketch a circuit diagram showing the essential features of a star/ delta starter for a three phase induction motor, showing the connections to the stator windings. (8)

(b) Explain why the starting current is reduced by the use of such a starter. (4)

(c) Explain what happens to the current drawn on switching from star to delta. (4)