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, 21 JULY 2011

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

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. For the circuit shown in Fig Q1, determine EACH of the following:

   (a) the current supplied by each battery; (10)

   (b) the voltage across the 8 Ω load resistor; (3)

   (c) the power dissipated in the 8 Ω resistor. (3)

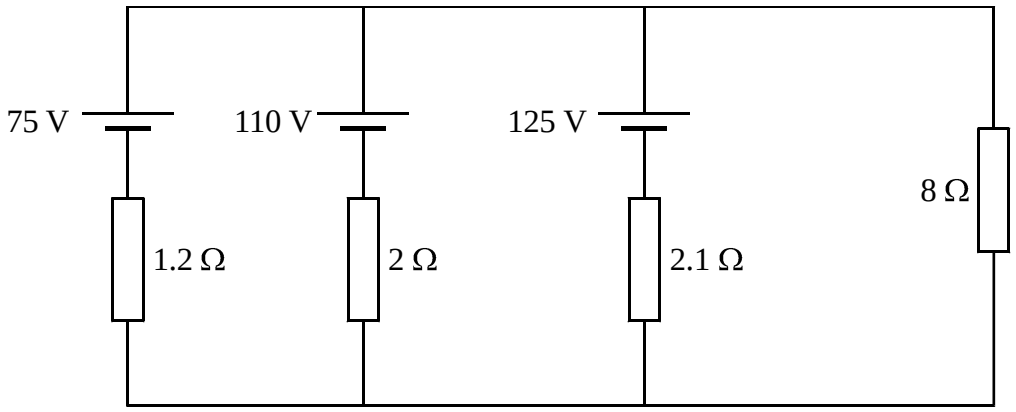

Fig Q1

2. A relay coil has resistance of 200 Ω and the current required to operate the relay is 150 mA. When the relay is connected to a 50 V d.c. supply the time between switch on and the operation of the relay is 40 ms.

   (a) Calculate EACH of the following:

      (i) the steady state relay current; (3)

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

      (iii) the inductance of the coil. (3)

   (b) To increase the operating time delay for the relay a 50 Ω resistor is connected in series with the coil.

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

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 volt d.c. supply.

(a) Plot the maximum 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 EACH of the following:

(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 series circuit comprising a 50 Ω resistor, a capacitor and a coil having resistance and inductance is connected across a 50 V variable frequency supply.

When the frequency is 400 Hz the current reaches its maximum value of 0.6 A and the voltage across the capacitor is 200 V.

Calculate EACH of the following:

(a) the value of the capacitance; (5)

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

(c) the power taken; (3)

(d) the circuit power factor. (3)

5. A balanced three phase delta connected load comprises a coil of resistance 50 Ω and inductance 0.1 H in each phase. It is connected to a 440 V 50 Hz supply.

Calculate EACH of the following:

(a) the line current for the load; (5)

(b) the power factor of the load; (3)

(c) the power dissipated by the load; (3)

(d) the component values in each leg of a star connected load which would draw the same line current at a leading power factor numerically equal to that found in Q5(b). (5)

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

- motors totalling 1200 kW at a p.f. of 0.7 lag
- lighting totalling 500 kW at unity p.f.
- an over excited synchronous motor taking 200 kW at 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 supplied by the second alternator; (3)

(b) the kVA supplied by the second alternator; (5)

(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. With reference to a 3 phase *double cage* induction motor:

(a) sketch a cross section through part of the rotor; (4)

(b) explain the operation of the motor from starting to operating speed; (8)

(c) sketch a torque/speed curve for each cage on the same pair of axes. (4)

8. (a) Sketch a circuit diagram for an auto-transformer starter for a 3 phase induction motor, showing the connections to the stator windings. (8)

(b) Explain the advantage of such a starter over the star/delta starter. (4)

(c) State the disadvantage that the basic auto-transformer starter shares with the star/delta starter. (4)

9. (a) Sketch the circuit diagram for a full wave three phase rectifier, indicating on the sketch the direction of current flow when the red phase is positive and the yellow and blue phases are negative. (8)

(b) Sketch the output voltage waveform for the circuit shown in Q9(a). (4)

(c) Add a smoothing capacitor to the rectifier circuit shown in Q9(a) and explain why less capacitance is needed for a three phase rectifier set than a single phase rectifier for the same acceptable level of *ripple* voltage at the output. (4)