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 78 as amended MANAGEMENT ENGINEER REG. III/2 (UNLIMITED)

040-33 - ELECTROTECHNOLOGY

THURSDAY, 19 JULY 2018

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

   (a) the current in each battery; (10)

   (b) the load voltage; (3)

   (c) the load power. (3)

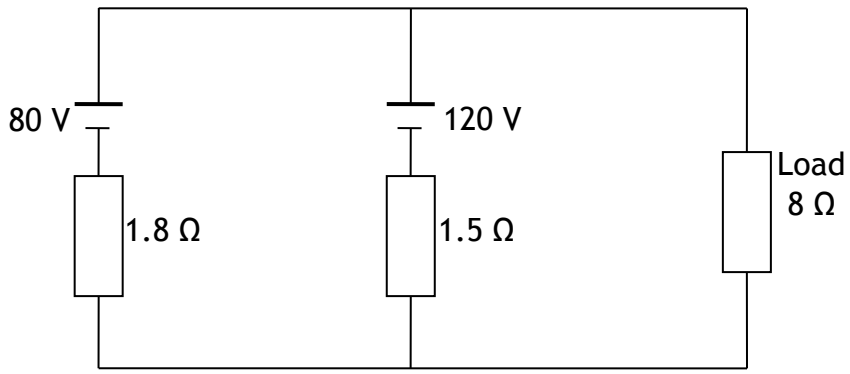

Fig Q1

2. When connected to a 20 V d.c. supply a relay starts to operate 0.52 ms after switching on the supply at which time the instantaneous current is 200 mA. The relay coil has a time constant of 5 ms.

   (a) Calculate EACH of the following:

      (i) the final steady state relay current; (6)

      (ii) the resistance and inductance of the relay coil. (4)

   (b) To increase the operating time a 40 Ω resistor is connected in series with the relay coil.

      Calculate the new operating time. (6)

3. A balanced, star connected, three phase load has a coil of inductance 0.2 H and resistance of 50 Ω in each phase. It is supplied at 415 V, 50 Hz.

Calculate EACH of the following:

(a) the line current; (5)

(b) the power factor; (2)

(c) the value of each of three identical delta connected capacitors to be connected to the same supply to raise the overall power factor to 0.9 lag; (7)

(d) the value of the new line current. (2)

4. A three phase, 440 V, 60 Hz, 8 pole induction motor runs at a power factor of 0.85 lag and drives a load of 8 kW at a speed of 14.4 rev/s. The stator loss is 1 kW and the rotational losses (windage and friction) amount to 0.8 kW.

Calculate EACH of the following:

(a) the synchronous speed; (3)

(b) the rotor copper loss; (5)

(c) the input power to the motor; (4)

(d) the motor current. (4)

5. A three phase, 440 V a.c. generator supplies the following loads:

- 400 kW at power factor 0.8 lagging
- 300 kW at unity power factor
- 250 kW at power factor 0.9 leading

Calculate EACH of the following:

(a) the total kW, kVA and kVAR supplied by the generator; (12)

(b) the generator current and power factor. (4)

6. A single phase, 50 Hz transformer has a turns ratio of 144:432 and a maximum flux of 7.5 mWb. The no load input is 0.24 kVA at 0.26 lagging. The transformer supplies a 1.2 kVA load at a power factor of 0.8 lagging.

Calculate EACH of the following:

(a) magnetising current; (5)

(b) primary current; (8)

(c) primary power factor. (3)

7. With reference to an automatic voltage regulator (AVR) for ship's a.c. generators:

(a) explain why it is needed; (3)

(b) state TWO minimum performance criteria; (2)

(c) sketch a labelled block diagram; (6)

(d) describe the operation of the block diagram sketched in Q7(c). (5)

8. (a) Sketch a labelled diagram of the power circuit for a star/delta starter. (8)

(b) Describe the sequence of operation of the circuit sketched in Q8(a). (6)

(c) State TWO limitations of the star/delta starting. (2)

9. An unstabilised d.c. supply voltage varies between 25 V and 35 V. A voltage stabiliser circuit comprising a 12 V zener diode and a series resistor R is connected across the unstabilised supply. The zener has a slope resistance of 14 Ω and requires a minimum operating current of 1 mA. A 0-80 mA variable load is to be supplied by the stabiliser circuit.

(a) When the supply voltage is minimum and the load current demand is maximum, calculate EACH of the following:

(i) the maximum value for R to give a stable load voltage; (4)

(ii) the load voltage. (2)

(b) Using the value of R determined in Q9(a), calculate EACH of the following:

(i) the load voltage when the supply voltage and load current are both at maximum values; (4)

(ii) the zener diode current when the supply voltage is minimum and the load is switched off; (3)

(iii) the load voltage when the supply voltage is 30 V and the load current is 30 mA. (3)