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 OCTOBER 2017

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. A 525 m, two core distributor cable is fed at one end with 240 V d.c. and at the other end with 250 V d.c.

   The following loads are applied at distances measured from 240 V end:

   - Load 1 10 A at 100 m
   - Load 2 100 A at 250 m
   - Load 3 70 A at 450 m
   - Load 4 25 A at 500 m

   The cable resistance (go and return) is 0.08 Ω per 100 m.

   Calculate EACH of the following:

   (a) the current supplied at each end of the cable distributor; (6)

   (b) the voltage at each load point; (8)

   (c) the power delivered at each end of the cable distributor. (2)

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 a 50 V d.c. it takes 40 ms for the relay to operate.

   (a) Calculate EACH of the following:

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

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

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

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

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

3. A star connected three phase load has a coil of resistance 50 Ω and inductance 0.1 H in each phase. The load is connected to a three phase, 440 V, 60 Hz supply.

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)

4. A three phase, four pole induction motor runs on a 440 V, 50 Hz supply. It delivers a shaft output power of 50 kW. The rotational losses (windage and friction) amount to 4 kW and the speed is 24 rev/s.

If the input current is 120 A at a lagging power factor of 0.7 and the stator copper loss is 3 kW, calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the stator iron loss; (6)

(c) the efficiency. (4)

5. Two, six pole, three phase a.c. generators operating in parallel supply a total load of 2000 kVA at a power factor of 0.8 lagging.

Their load characteristics are linear with the test results given in Table Q5.

Generator	Speed/kW	Voltage/kVAR
No. 1	1440 rev/min on No-load 1200 rev/min on 1200 kW	500 V on No-load 415 V on 1000 kVAR
No. 2	1360 rev/min on No-load 1180 rev/min on 900 kW	490 V on No-load 425 V on 800 kVAR

Table Q5

Determine EACH of the following:

(a) the supply frequency; (6)

(b) the bus-bar voltage; (6)

(c) the kVA output of each generator; (2)

(d) the operating power factor of each generator. (2)

6. A 60 kVA, 440 V/110 V single phase transformer has iron loss of 4 kW, and a full load copper loss of 6 kW.

Calculate EACH of the following:

(a) the kVA output at which maximum efficiency will be achieved; (8)

(b) the efficiency at 50 kW output and 0.85 power factor. (8)

7. (a) Explain the meaning of the term *power factor*. (3)

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

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

(d) Explain ONE method other than the use of capacitors by means of which power factor correction may be achieved. (4)

8. With reference to a three phase brushless generator system:

(a) sketch a labelled diagram showing the essential features; (7)

(b) describe the system sketched in Q8(a); (7)

(c) state ONE advantage and ONE disadvantage. (2)

9. A single phase, 230 V, 50 Hz, 3:1 transformer has a secondary winding resistance of 1 Ω and supplies a half wave rectifier circuit. The rectifier circuit has a resistive load of 680 Ω and the diode has a forward resistance of 14 Ω.

(a) Sketch EACH of the following:

(i) a labelled circuit diagram; (3)

(ii) the load voltage waveform indicating maximum and average voltage levels. (3)

(b) Calculate EACH of the following load values:

(i) the maximum current; (5)

(ii) the average current; (3)

(iii) the average voltage. (2)