CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY
MARINE ENGINEER OFFICER

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

040-33 - ELECTROTECHNOLOGY

THURSDAY, 17 OCTOBER 2019

0915 - 1215 hrs

Materials to be supplied by examination centres

Candidate's examination workbook
Graph paper

Examination Paper Inserts

Notes for the guidance of candidates:

1. Examinations administered by SQA on behalf of the Maritime & Coastguard Agency.
2. Candidates should note that 96 marks are allocated to this paper. To pass, candidates must achieve 48 marks.
3. Non-programmable calculators may be used.
4. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Maritime & Coastguard Agency

SQA

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

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 the 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 distributor cable; (6)

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

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

2. A 120 μF capacitor is charged through a 4.7 kΩ resistor from a 12 V d.c. power supply.

(a) Calculate the instantaneous charging current at switch on. (2)

(b) State the expression for the capacitor charging voltage, determining its value 2 seconds after switch on. (4)

(c) Calculate the energy stored in the capacitor 2 seconds after switch on. (2)

(d) After 2 seconds of charging the supply is switched off and the capacitor is discharged through a 1.2 kΩ resistor.

(i) Determine the time taken during discharge for the capacitor voltage to fall to 5 V. (4)

(ii) Sketch a clearly labelled graph with approximately scaled axes to show the capacitor voltage changes over its charge/discharge cycle. (4)

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3. A three phase, 4 wire, unbalanced load draws the following currents with reference to V_{RN} :

- $I_{RN} = 5\ A \angle 0°$
- $I_{SN} = 8\ A \angle -150°$
- $I_{TN} = 3\ A \angle 85°$

Calculate EACH of the following:

(a) the current in the neutral line; (7)

(b) the angular position of the neutral current with reference to V_{RN}; (2)

(c) the total power dissipated by the load if it is connected to a 415 V supply. (7)

4. A three-phase, 6 pole, 380 V, 60 Hz induction motor draws a line current of 80 A at a power factor of 0.8 lag with a shaft speed of 19 rev/s. The core losses are 2 kW, the stator winding loss is 1 kW and the windage and friction loss is 1.5 kW.

(a) Determine EACH of the following:

(i) the slip; (2)

(ii) the rotor winding loss; (4)

(iii) the shaft output power; (2)

(iv) the efficiency. (3)

(b) Sketch a clearly labelled power-flow diagram for the motor indicating power at each stage. (5)

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

- a star connected load of 33 kVA and power factor 0.9 leading
- a delta connected load of 40 kW and power factor 0.85 lagging
- miscellaneous loads of 23 kVA and power factor 0.8 lagging

Calculate EACH of the following:

(a) the kVA supplied by the generator; (10)

(b) the generator current; (2)

(c) the phase currents for the star and delta connected loads. (4)

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

Calculate EACH of the following:

(a) the magnetising current; (5)

(b) the primary current; (8)

(c) the primary power factor. (3)

7. With reference to shipboard three-phase generators:

(a) describe, with the aid of a clearly labelled sketch, EACH of the following:

(i) an insulated neutral distribution system; (3)

(ii) an earthed neutral distribution system. (3)

(b) explain the effect of a single earth fault on each of the systems in Q7(a). (6)

(c) state TWO causes of earth faults. (4)

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

(a) sketch a clearly labelled circuit diagram showing the essential features; (8)

(b) describe the system sketched in Q8(a). (8)