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, 18 OCTOBER 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
Graph paper

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)

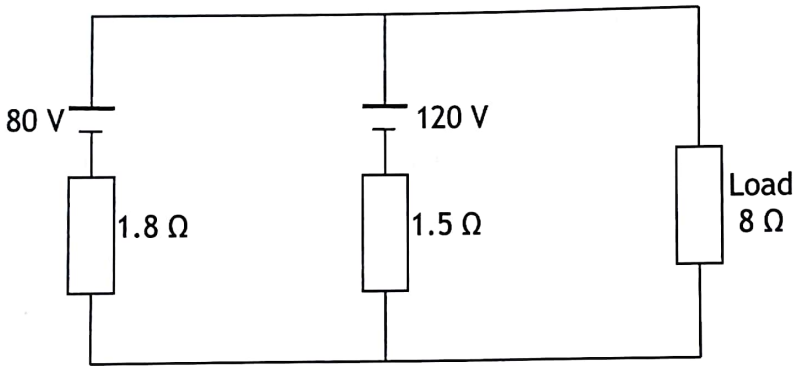

Fig Q1

2. A d.c. relay coil has an inductance of 400 mH and a time-constant of 1.6 ms. The current rises to 86.5 mA after 3.2 ms from switch on.

Calculate EACH of the following:

(a) the coil resistance; (2)

(b) the maximum current; (3)

(c) the supply voltage; (2)

(d) the current 4 ms after switch on; (3)

(e) the time take for the current to reach 70 mA; (4)

(f) the final value of the stored energy. (2)

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3. A three-phase, 415 V, 4-wire power supply has the following unity power factor loads:

- R-N: 24 kW
- S-N: 18 kW
- T-N: 12 kW

Calculate EACH of the following:

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

(b) the current in the neutral conductor; (10)

(c) the phase angle of the current in the neutral conductor relative to the red phase voltage. (2)

4. A three-phase, star-connected, eight-pole induction motor runs on a 415 V, 50 Hz power supply. The stator resistance is 0.1 Ω per phase, the rotational losses (windage and friction) are 1 kW, the speed is 12 rev/s and the shaft output power is 24 kW.

If the input current is 57 A at a lagging power factor of 0.707, calculate EACH of the following:

(a) the output torque; (2)

(b) the rotor copper losses; (5)

(c) the stator copper losses; (2)

(d) the stator iron losses; (5)

(e) the efficiency. (2)

5. A three-phase, 440 V, shaft-driven generator shares the total electrical load of a ship with an auxiliary diesel generator. An over-excited synchronous motor is used in the supply system for kVAr compensation.

The ship's total consumer load is 1 MW at 0.83 power factor lagging and the synchronous motor takes 40 kW.

(a) Sketch a single-line diagram of the power system. (3)

(b) The shaft-generator is loaded to its rated output of 650 kW at unity power factor; the diesel generator is operated at a power factor of 0.9 lagging.

Determine EACH of the following:

(i) the kW and kVAr loading of the diesel generator; (5)

(ii) the load current supplied by the diesel generator; (2)

(iii) power factor of the synchronous motor. (6)

6. (a) With reference to three-phase transformers, sketch labelled diagrams for EACH of the following connection types indicating line and phase voltages and line currents:

(i) star-star; (4)

(ii) delta-star. (4)

(b) A three-phase, step down transformer has a turns ratio of 12 and takes 10 A when it is connected to a 6600 V supply. If the transformer is star-delta connected, calculate EACH of the following:

(i) the secondary line voltage; (3)

(ii) the secondary line current; (3)

(iii) the output kVA. (2)

7. With reference to shipboard three-phase generators:

(a) describe, with the aid of a 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. (a) With reference to principle of operation of a synchronous motor, explain how it differs from that of an induction motor. (4)

(b) Explain why a synchronous motor is unable to produce starting torque. (6)

(c) State how an electronic converter is used to start a synchronous motor. (3)

(d) State THREE shipboard applications of synchronous motors. (3)

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 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)(i), 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)