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, 28 MARCH 2019

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. Fig Q1 shows a d.c. ring main supplied by two 230 V generators. The cable section resistances are for go and return.

   Calculate EACH of the following:

   (a) the current in each cable section; **(8)**

   (b) the power loss in each cable section; **(5)**

   (c) the p.d. at each load. **(3)**

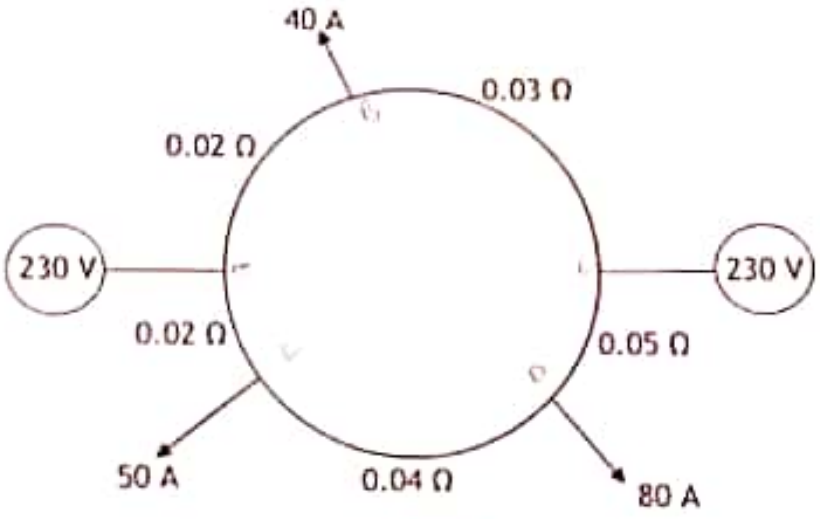

Fig Q1

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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. supply 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. Three identical coils are star-connected across a three-phase, 440 V, 60 Hz, power supply and consume a total power of 3 kW at a power factor of 0.8 lagging.

(a) Determine the resistance and inductance of each coil. (8)

(b) Calculate the current in each line if one coil is:

(i) short-circuited; (4)

(ii) open-circuited. (4)

4. A three-phase electrical load of 800 kW is operating at a power factor of 0.7 lagging. It is desired to improve the supply power factor to 0.92 lagging by connecting a synchronous motor driving a load of 200 kW with an efficiency of 91%.

Determine EACH of the following:

(a) the kVA of the synchronous motor; (12)

(b) the power factor of the synchronous motor. (4)

5. Two, three-phase, four-pole, generators operating in parallel supply a total load of 900 kW at a power factor of 0.75 lagging.

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

Generator	Speed/kW	Voltage/kVAR
No. 1	1960 rev/min at no-load	475 V at no-load
	1720 rev/min at 450 kW	430 V at 420 kVAR
No. 2	1850 rev/min at no-load	450 V at no-load
	1750 rev/min at 450 kW	435 V at 420 kVAR

Table Q5

Determine EACH of the following:

(a) the bus-bar frequency; (5)

(b) the bus-bar voltage; (5)

(c) the operating power factor of each generator. (6)

6. With reference to a single-phase a.c. power transformer with natural air cooling:

(a) sketch a labelled diagram of the basic construction; (4)

(b) describe the principle of operation; (4)

(c) explain why it is rated in kVA; (3)

(d) explain why it may overheat if supplied below its rated frequency; (3)

(e) state how operation at a reduced frequency may be compensated to avoid overheating. (2)

7. (a) State the *function* of an AVR. (2)

(b) State FOUR conditions external to an alternator that cause its terminal voltage to drop. (4)

(c) Sketch and label a typical AVR response curve, identifying the application of load, recovery time, maximum acceptable voltage dip, and the permissible steady-state voltage regulation. (6)

(d) State the function of an AVR trimming potentiometer for EACH of the following cases:

(i) when a generator operates in standalone mode; (2)

(ii) when a generator operates in parallel. (2)

8. With reference to shipboard electrical distribution systems:

(a) describe the meaning of the term *earth fault*; (2)

(b) explain the meaning of the term *earth-bonding* and why it is required; (3)

(c) sketch a circuit diagram of one arrangement for detecting phase to earth faults in an earthed neutral system; (6)

(d) calculate the value of a neutral earthing resistor (NER) to limit the earth fault current to the full load rating of a 2 MW, 0.8 p.f., 3.3 kV, three-phase generator. (5)

9. (a) Sketch a labelled circuit diagram of a half-wave rectifier with a capacitor filter and resistive load. (4)

(b) Describe the operation of the circuit sketched in Q9(a). (8)

(c) Sketch the load voltage waveform for the circuit sketched in Q9(a), and identify the *peak-peak ripple voltage*. (4)