

**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, 14 DECEMBER 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:

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. Fig Q1 shows a ring main of total length 1000 m and resistance (go + return) of $0.002 \Omega/\text{m}$. The ring main is supplied with 240 V d.c. and the following loads are connected to the ring at distances measured clockwise from the supply point:

- 60 A at 200 m
- 90 A at 500 m
- 150 A at 700 m

Calculate EACH of the following:

- (a) the currents fed into the ring main in each direction;
(b) the lowest voltage across any of the three loads;
(c) the total power loss in the ring main.

(5)

(5)

(6)

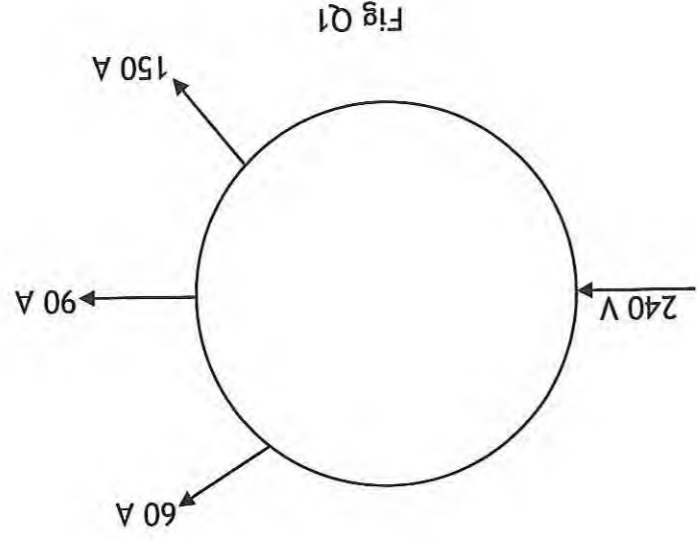


Fig Q1

2. A $100 \mu\text{F}$ capacitor is charged from 120 V d.c. supply via a $10 \text{ k}\Omega$ resistor.
- (a) Calculate EACH of the following:
- (i) the time taken for the capacitor voltage to reach 80 V ;
- (ii) the energy stored in the capacitor when its voltage has reached 80 V .
- (3) (b) If the supply is now removed and replaced by a second $10 \text{ k}\Omega$ resistor, calculate EACH of the following:
- (i) the time taken for the capacitor voltage to fall to 50 V ;
- (ii) the circuit current when the capacitor voltage has fallen to 50 V .
- (2) (5)
3. Three identical coils each of inductance 0.1 H and resistance 30Ω are connected in delta to a three phase, 440 V , 50 Hz supply. Three identical star connected capacitors are connected in parallel with the delta load to raise the power factor to 0.9 lagging.
- Calculate EACH of the following:
- (a) the value of each capacitor;
- (b) the percentage reduction in line current;
- (c) the kVAR taken by the three capacitors.
- (3) (3) (10)
4. A three phase, 440 V , 60 Hz , 8 pole induction motor drives a load of 7 kW and runs at 14.4 rev/sec . The power factor is 0.8 lag. The stator loss is 0.6 kW and the rotational losses (windage + friction) are 0.4 kW .
- Calculate EACH of the following:
- (a) the slip;
- (b) the frequency of rotor e.m.f.;
- (c) the input power to the motor;
- (d) the line current.
- (3) (8) (2) (3)

5. Two three phase, 3.3 kV alternators operating in parallel supply the following three loads:

- a lighting load of 600 kW at unity power factor
- motors totalling 2500 kW at p.f. 0.7 lag
- a synchronous motor driving a bow thruster

One alternator supplies 350 A at p.f. 0.9 lag and the other supplies 330 A at p.f. 0.95 lag.

Determine EACH of the following:

- (11) (a) the kW supplied to the synchronous motor;
- (3) (b) the p.f. of the synchronous motor;
- (2) (c) the overall p.f. of the system.

6. A 50 kVA transformer has an efficiency of 98% at full load, 0.8 p.f. and 97% at half load, 0.8 p.f. lag.

Calculate EACH of the following:

- (8) (a) the full load copper loss;
- (4) (b) load at which maximum efficiency occurs;
- (4) (c) the maximum efficiency for 0.8 p.f. load.

7. With reference to shipboard electrical distribution systems:

- (2) (a) describe the meaning of the term *earth fault*;
- (3) (b) explain why *insulated neutral* is preferred for low voltage systems;
- (6) (c) sketch a circuit diagram of one arrangement for detecting phase to earth faults for a star connected alternator with neutral earthing resistor (NER);
- (5) (d) calculate the ohmic value of a 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 neutral earthed a.c. generator.

8. (a) State the main reasons why switchboard instruments are supplied via instrument transformers from the power circuits which they monitor. (3)
- (b) Explain why it is hazardous to open circuit a current transformer whilst its primary is still energised. (4)
- (c) Sketch a circuit diagram showing an ammeter, a voltmeter and a wattmeter fed from a single phase supply via current and voltage transformers. (5)
- (d) An ammeter, a voltmeter and a wattmeter monitoring a single phase supply read 40 A, 240 V and 8 kW respectively. Calculate the power factor of the circuit. (4)
9. With reference to a full wave bridge rectifier using diodes:
- (a) sketch a labelled circuit diagram; (4)
- (b) explain the circuit operation; (4)
- (c) sketch waveforms to show the relationships between the following:
- (i) the bridge input voltage; (2)
- (ii) the current through each diode; (4)
- (iii) the load current; (2)