

**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 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)**

**041-33 - ELECTROTECHNOLOGY**

**THURSDAY, 17 OCTOBER 2013**

**0915 - 1215 hrs**

Examination paper inserts:

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Notes for the guidance of candidates:

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| <ol style="list-style-type: none"><li>1. Non-programmable calculators may be used.</li><li>2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.</li></ol> |
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Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper
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## ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A relay coil is connected across 10 V d.c. supply and starts to operate after 0.55 ms when the instantaneous current is 100 mA. The relay coil has a time constant of 5 ms.

Calculate EACH of the following:

- (a) the final relay current; (4)
- (b) the resistance and inductance of the relay coil; (4)
- (c) in order to increase the operating time a resistance of 40  $\Omega$  is connected in series with the relay coil. Calculate the new operating time assuming that the relay starts to operate when the instantaneous current is 100 mA. (8)
2. The V/I characteristic of a non-linear element is given by the Table Q2.

V (volts)	40	60	80	100	120
I (mA)	0.65	1.1	1.5	2.2	3.3

Table Q2

The non-linear element is connected in series with a pair of paralleled resistors of 35 k $\Omega$  and 55 k $\Omega$  and the overall circuit is connected to a 120 V d.c. supply.

Determine EACH of the following:

- (a) the supply current; (8)
- (b) the effective resistance of the non-linear element; (6)
- (c) the current in each of the two paralleled resistors. (2)

3. An unregulated d.c power supply whose voltage varies between 15 V and 50 V is connected to a stabiliser circuit comprising a 400  $\Omega$  resistor in series with a 8.2 V Zener diode. The Zener diode has a slope resistance of 10  $\Omega$  and requires a minimum operating current of 1 mA. The arrangement supplies a load whose current can vary between zero and 30 mA.
- (a) Sketch a circuit diagram for the arrangement. (2)
- (b) Calculate EACH of the following:
- (i) the load voltage when the load current is zero and the supply voltage is 15 V; (4)
- (ii) the load voltage when the load current is 30mA and the supply voltage is 40 V; (3)
- (iii) the minimum value of input voltage to give a stabilised load voltage when the load current is 30 mA; (3)
- (iv) the power dissipated in the Zener diode when the supply voltage is 50V and the output load current is 20 mA. (4)

4. The series circuit shown in Fig Q4 is connected to 120V 50Hz. It draws a current of 2.4 A at a power factor of 0.8 lagging. The resistor  $R_2$  dissipates 57.6 W and the volt drops across the various parts of the circuit are as shown.

Calculate EACH of the following:

- (a) the values of  $R_1$  L and C; (10)
- (b) the power factor of the coil ( $R_1$  and L); (3)
- (c) the power factor of the combination  $R_2$  and C. (3)

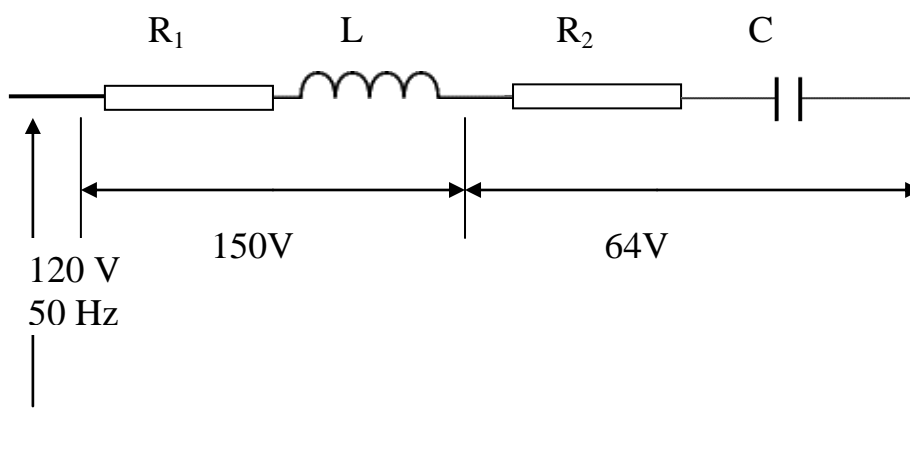


Fig Q4

5. A three phase star connected load has a coil of inductance 0.1 H and resistance 25  $\Omega$  in each phase. It is connected to 440 V 50 Hz supply.

Determine EACH of the following:

- (a) the line current drawn by the load; (5)
  - (b) the power factor; (3)
  - (c) the power taken by the load; (3)
  - (d) the values of three identical capacitors which when connected in delta to the same supply will raise the overall power factor to unity. (5)
6. A ship's electrical load is made up as follows:
- motors totalling 2100 kW at a p.f of 0.7 lag
  - lighting and heating totalling 1200 kW at U.P.F.
  - an overexcited synchronous motor drawing 600 kW at p.f 0.5 lead.

It is supplied by two alternators one of which provides 2000 kW at p.f. 0.95 lag.

Determine EACH of the following:

- (a) the kVA supplied by the second alternator; (6)
- (b) the power factor of the second alternator; (4)
- (c) the overall power factor of the system if the synchronous motor is not connected. (6)

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7. Fig Q7 shows a *soft start* circuit for a delta connected induction motor using six thyristors (silicon controlled rectifiers).
- (a) Explain how the circuit arrangement reduces the current drawn by the motor during the starting sequence. (7)
- (b) Sketch the voltage waveform supplied to any one phase of the motor at the following points in the starting operation:
- (i) the commencement of starting; (3)
- (ii) part way through the starting operation; (3)
- (iii) the completion of starting. (3)

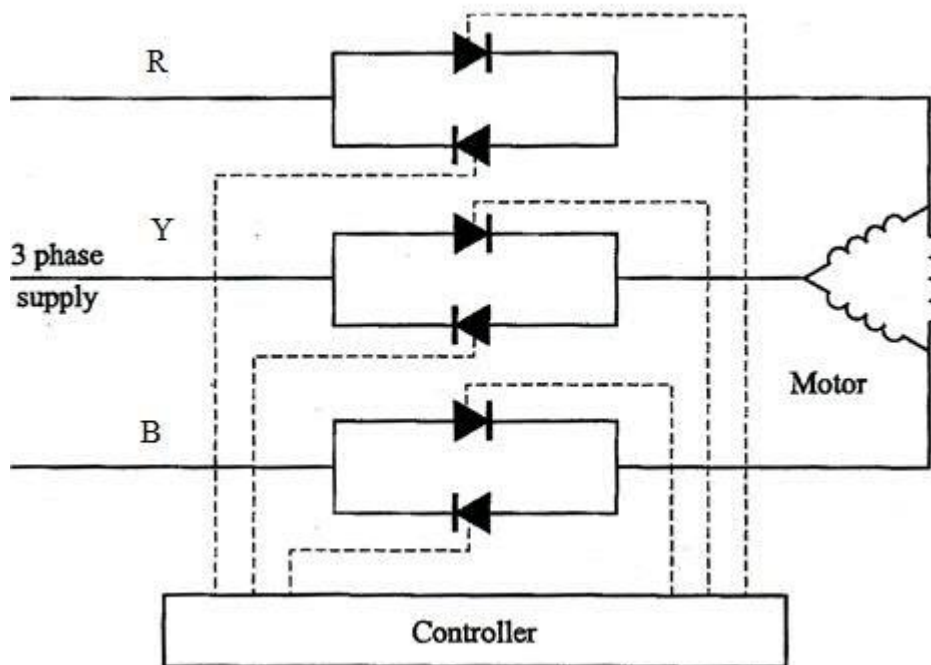


Fig Q7

8. (a) Explain the meaning of the term *power factor correction*. (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 effected 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 effected. (4)

9. (a) List the various losses which occur in a squirrel cage induction motor on load. (4)
- (b) State which of these losses is:
- (i) independent of load current and speed; (4)
  - (ii) dependent on load current; (4)
  - (iii) dependent on speed. (4)