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, 7 April 2016

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

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 determine EACH of the following:

   (a) the current supplied by each battery; (10)

   (b) the voltage across the 8 Ω load resistor; (3)

   (c) the power dissipated in the 8 Ω resistor. (3)

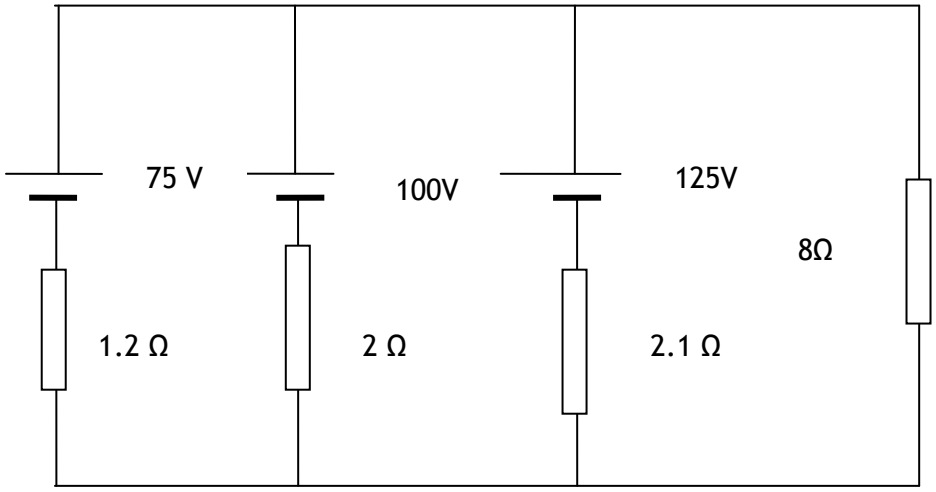

Fig Q1

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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 kΩ and 55 kΩ 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. A small silicon transistor with the characteristics given in Worksheet Q3 has a maximum safe power dissipation of 18 mW and it is to be operated on a 12 V d.c. supply.

(a) Plot this power dissipation curve on the characteristics. (5)

(b) Determine the minimum value of collector load resistance for the transistor if this dissipation is not to be exceeded. (5)

(c) If the transistor is used in a common emitter configuration and is biased at a base current of 60 μA and an alternating signal of +/- 40 μA is applied to the base, determine the r.m.s. value of:

(i) the voltage variation between collector and emitter; (3)

(ii) the variation in collector current. (3)

4. A series circuit comprising a 50 Ω resistor, a coil having resistance and inductance and a capacitor is connected across a 50 V variable frequency supply.

When the frequency is 400 Hz the current reaches its maximum value of 0.6 A and the voltage across the capacitor is 200 V.

Calculate EACH of the following:

(a) the value of the capacitance; (4)

(b) the resistance and inductance of the coil; (6)

(c) the power taken from the supply; (3)

(d) the circuit power factor. (3)

5. A three phase, 240 V, 4 wire unbalanced system has a current in the red phase of 5A at unity power factor and a current in the yellow phase of 8A lagging by 30°.

If the current in the neutral line is 1.93 A in phase with the red line voltage, calculate EACH of the following:

(a) the magnitude of the current in the blue line; (6)

(b) its angular relationship to the blue line voltage; (6)

(c) the total power drawn by this unbalanced circuit. (4)

6. A 3 ph, 440 V, 60 Hz 8 pole induction motor runs at a power factor of 0.85 lag and drives a load of 8 kW at a speed of 14.4 rev/sec. The stator loss is 1 kW and the rotational losses (windage and friction) amount to 0.8 kW.

Calculate EACH of the following:

(a) the synchronous speed; (3)

(b) the rotor copper loss; (5)

(c) the input power to the motor; (5)

(d) the motor current. (3)

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)

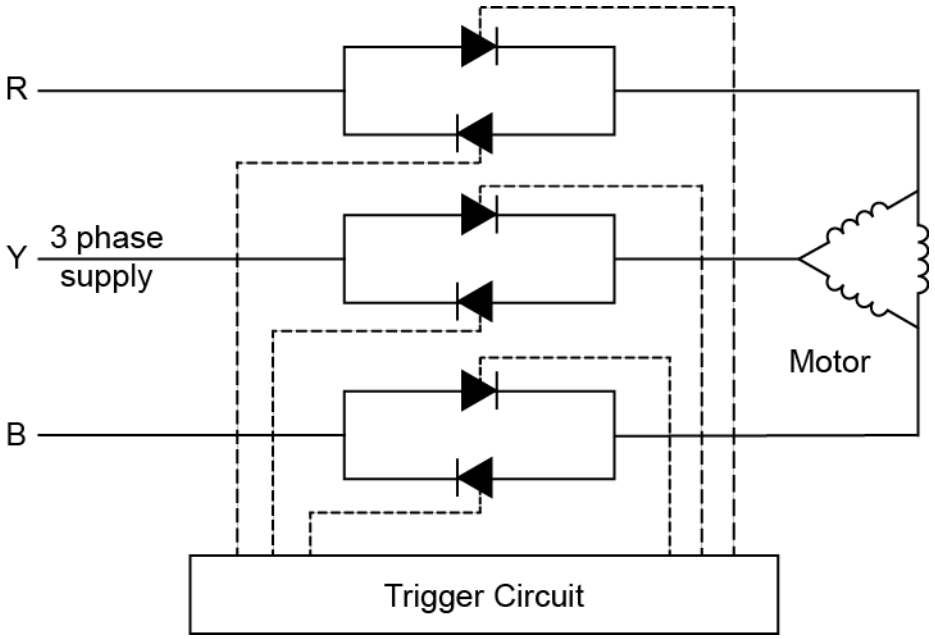

Fig Q7

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)