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, 12 DECEMBER 2013

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 supplied by each battery; (12)

   (b) the load current; (2)

   (c) the p.d. across the load. (2)

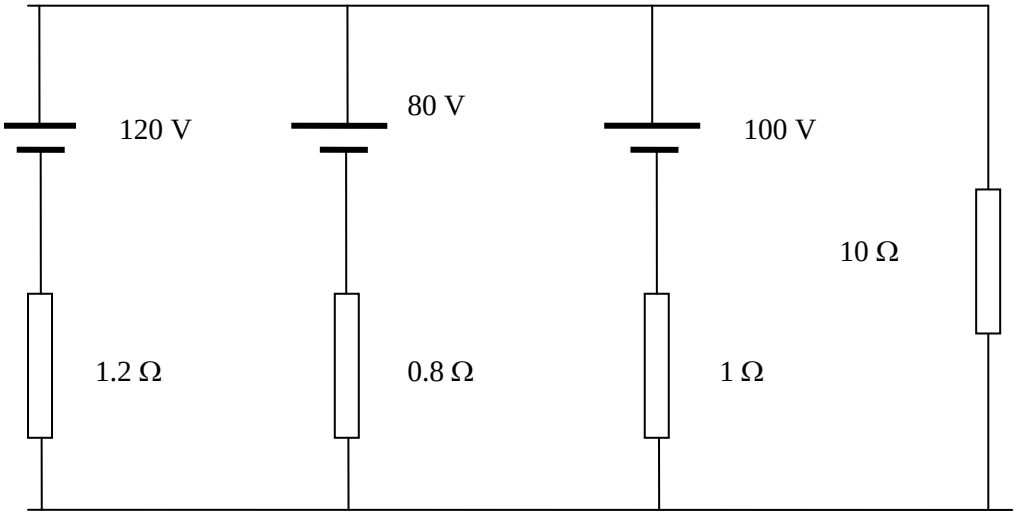

Fig Q1

2. A non-linear resistor whose characteristic is given by $I = kV^{1/2}$ is connected in series with a variable resistance across a 120 V d.c. supply. When the variable resistance is set to 56 Ω the current in the circuit is 1A.

   Calculate EACH of the following:

   (a) the value of the constant k; (6)

   (b) the value to which the variable resistance must be set to make the current 0.75 A; (6)

   (c) the power dissipated in the non-linear resistor when the current is 0.75 A. (4)

3. A simple voltage stabilizer circuit consists of a 1 Watt Zener diode and a series resistance R. The Zener diode has a breakdown voltage of 12 V and a slope resistance of 2 Ω. It requires a minimum current of 2 mA for successful stabilization. The unregulated d.c. input voltage can vary between 18 V and 24 V.

Calculate EACH of the following:

(a) the minimum value of the resistor R if the output current is zero and the input voltage is a maximum of 24 V; (7)

(b) the maximum output current which can be drawn when the input voltage is 18 V if satisfactory stabilization is to be maintained; (6)

(c) the power dissipated in the Zener diode in Q3(b). (3)

4. A single phase a.c. circuit comprises a coil of inductance 0.5 H and resistance 100 Ω in series with a capacitor 'C'. It is connected to 120 V 50 Hz and draws a current at a leading power factor. The volt drop across the coil is 150 V.

Determine EACH of the following:

(a) the current in the circuit; (4)

(b) the value of the capacitor; (6)

(c) the power factor of the circuit; (4)

(d) the power dissipated in the coil. (2)

5. A balanced star connected three phase load has a coil of inductance 0.2 H and resistance 50 Ω in each phase. It is supplied at 415 V, 50 Hz.

Calculate EACH of the following:

(a) the line current; (4)

(b) the power factor; (3)

(c) the value of each of three identical delta connected capacitors to be connected across the same supply to raise the power factor to 0.9 lag; (6)

(d) the new value of the line current. (3)

6. Two three phase 415 V alternators supply a ship's load comprising:

- lighting totalling 800 kW at unity power factor; and
- motors totalling 1700 kW at power factor 0.7 lag.

One alternator supplies 1400 kVA at power factor 0.75 lag.

(a) Calculate EACH of the following for the other alternator:

(i) the kVA output; (6)

(ii) the power factor; (2)

(iii) the line output current. (2)

(b) An overexcited synchronous motor is now added to the system to raise the overall power factor of the system to 0.9 lag.

Calculate the power factor at which it must operate, if the motor takes 300 kW. (6)

7. (a) Sketch the circuit diagram for a three-phase full wave rectifier indicating on your sketch the current directions for both half cycles of one phase. (8)

(b) Sketch the output waveform for the three-phase rectifier described in Q7(a). (3)

(c) Explain why, if a smoothing capacitor is included in Q7(a) rectifier circuit, less capacitance is required for a three phase set compared to a single phase circuit for the same acceptable level of 'ripple' on the output voltage. (5)

8. With reference to an a.c. generator used in marine practice:

(a) derive an expression for the frequency of the generated emf in terms of speed and number of poles; (3)

(b) explain the difference between the generated emf "E" and the terminal voltage "V" if the resistance of the stator output windings is low enough to be neglected; (5)

(c) state an expression for the regulation of the generator in terms of E and V; (3)

(d) explain the effect on the terminal voltage of increasing the load power factor if the excitation and load ouput power are fixed. (5)

9. (a) Explain how torque is produced in a 3 phase squirrel cage induction motor. (5)

(b) State why the starting current is several times higher than the full load current. (3)

(c) State why the power factor is very low on starting. (3)

(d) Describe ONE method of construction by means of which the starting power factor may be raised, the starting current lowered and the starting torque improved. (5)