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, 19 JULY 2012

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. (a) For the measuring network shown in Fig Q1 calculate the resistance (R_M) of the moving coil instrument if it is to read 10 mA. (8)

   (b) Calculate the reading on the instrument if the 100 Ω and the 80 Ω resistors are interchanged. (8)

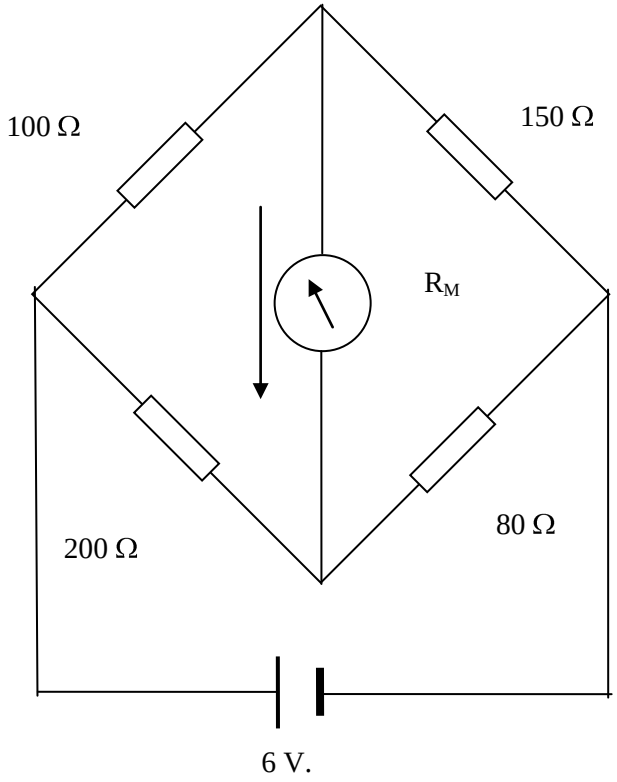

Fig Q1

Fig Q1

2. A non-linear element is connected in series with a variable resistor across a 240 V d.c. supply. The non-linear element has a characteristic given by $I = kV^2$. When the variable resistor is set to 10 Ω the supply current is 12 A.

Determine EACH of the following:

(a) the value to which the variable resistor must be set to reduce the current to 6 A; (6)

(b) the power dissipated in the non-linear element when the current is 6 A; (2)

(c) the current if the supply voltage is reduced to 150 V and the series resistor is set to 10 Ω. (8)

3. A simple voltage stabiliser consists of a 1 W Zener diode and a series resistor 'R' as shown in Fig Q3. 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 stabilisation. The unregulated input voltage can vary between 18 V and 24 V.

Calculate EACH of the following:

(a) the minimum value of R if the input voltage is 24 V and the output current is zero; (6)

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

(c) the power dissipated by the Zener diode in Q3(b). (4)

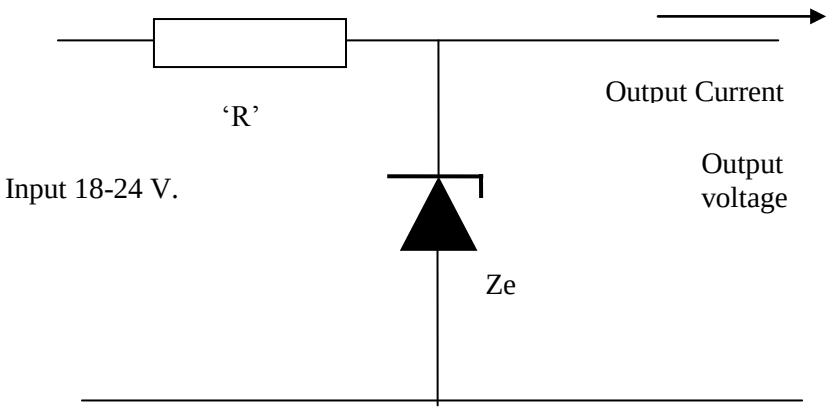

Fig Q3

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.

Calculate 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 circuit. (2)

5. A three phase four wire unbalanced system has a current in the red phase of 10 A at unity power factor and the current in the yellow phase is 8 A lagging by 30°. If the current in the neutral is 3.07 A in phase with the red phase 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; (4)

(c) the total power dissipated in the three phase loads if the value of the phase voltage is 240 V. (6)

6. A 6 pole, three phase squirrel cage induction motor runs on a 415 V, 60 Hz supply. It draws a line current of 85 A at a power factor of 0.75 lag. The shaft speed is 19 revs/sec. If the iron losses are 2 KW, the stator copper loss is 1 KW and the rotational losses (windage and friction) are 1.5 KW, calculate EACH of the following:

(a) the slip as a per unit value; (3)

(b) the rotor copper loss; (5)

(c) the shaft output power; (5)

(d) the efficiency. (3)

7. (a) Sketch a basic circuit showing a d.c. winch motor driven by a Ward Leonard circuit powered by a single speed squirrel cage motor. (8)

(b) Explain how reversal of the winch motor is achieved using the Ward Leonard system. (4)

(c) State ONE advantage and ONE disadvantage of the Ward Leonard drive system. (4)

8. With reference to the squirrel cage induction motor:

(a) state TWO reasons why the starting current is much higher (typically 3-6 times) than the full load running current; (4)

(b) explain why the rotor power factor is very low on starting (typically 0.2); (3)

(c) explain why almost all the iron loss occurs in the stator, with only a very small iron loss in the rotor; (3)

(d) describe, with the aid of a sketch, one form of rotor construction which provides improved starting torque with reduced starting current. (6)

9. (a) Sketch the circuit diagram for an uncontrolled, 3-phase, bridge rectifier, indicating on the sketch the direction of current flow for both halves of one phase. (8)

(b) Sketch the output waveform for the circuit sketched in Q9(a). (3)

(c) If a smoothing capacitor was added to the rectifier circuit sketched in Q9(a), explain why less capacitance is needed for the three phase rectifier set than a single phase rectifier for the same acceptable level of *ripple* voltage at the output. (5)