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, PAPER 65

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

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. Fig Q1 shows a measuring circuit in the form of a bridge network. The meter, of resistance 200 Ω, reads 10 mA in the direction shown.

   (a) Calculate the value of the resistance R_X. (8)

   (b) The range of the instrument is increased by connecting a resistor of 200 Ω in parallel with the meter.

   Calculate the new reading on the meter. (8)

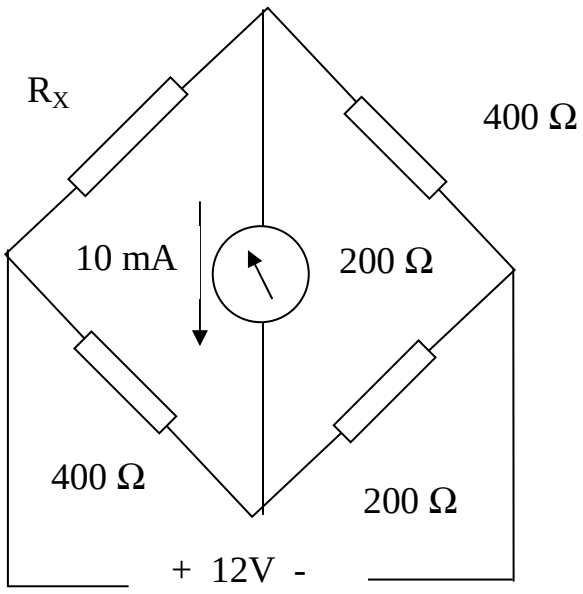

Fig Q1

2. A capacitor of 100 μF is charged for 5 secs from a 100 volt d.c. supply via a resistor of 100 kΩ.

(a) Calculate EACH of the following:

(i) the voltage across the capacitor at the end of this period; (4)

(ii) the energy stored in the capacitor at the end of this period. (4)

(b) At the end of this period the capacitor is disconnected and a second capacitor of 100 μF already charged to 70 volts is connected in parallel with it.

Calculate EACH of the following:

(i) the final steady state voltage across the pair; (4)

(ii) the energy stored by the pair of capacitors. (4)

3. Fig Q3 shows a basic voltage stabilising circuit using a Zener diode and a series resistor. The Zener diode has a breakdown voltage of 12 V and is rated at 2 W maximum dissipation. The diode requires a minimum reverse current of 2 mA for satisfactory stabilisation and its slope resistance is negligible

Calculate EACH of the following:

(a) the maximum safe input voltage when the output current is zero; (8)

(b) the maximum output current for satisfactory stabilisation when the input voltage is 18 volts. (8)

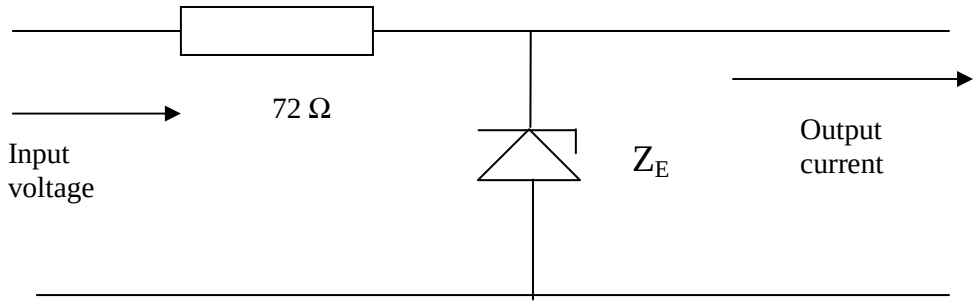

Fig Q3

4. A single phase circuit consists of a capacitor of 50 μF in parallel with a coil of unknown resistance and unknown inductance. When connected to 240 V 50 Hz the circuit draws 7 A at power factor 0.8 lag.

(a) Calculate EACH of the following:

(i) the resistance of the coil; (5)

(ii) the inductance of the coil; (5)

(iii) the power factor of the coil. (2)

(b) Calculate the current drawn if the coil and capacitor are now connected in series to the same supply. (4)

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

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

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

(ii) its angular relationship to the blue line voltage. (6)

(b) Calculate the total power drawn by this unbalanced circuit, if the value of the phase voltage is 240 V. (4)

6. A four pole three phase induction motor runs off 440 Volt 50 Hz supply. It delivers a shaft output power of 50 kW. The rotational losses (windage and friction) amount to 4 kW and the speed is 24 rev/sec. If the input current is 120 A at a lagging power factor of 0.7 and the stator copper loss is 3 kW, calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the stator iron loss; (6)

(c) the efficiency. (4)

7. (a) Sketch a circuit diagram showing the essential features of a brushless alternator suitable for marine use. (8)

(b) Explain the function of EACH of the main features sketched in Q7(a). (8)

8. (a) Sketch a circuit diagram showing how a thyristor (silicon controlled rectifier) may be used to vary the d.c. voltage supplied to a load from a single phase a.c. supply. (6)

(b) Explain the operation of the circuit sketched in Q8(a). (6)

(c) Sketch the load voltage waveform for EACH of the following delay angles:

(i) 60°; (2)

(ii) 120°. (2)

9. (a) Explain why it is the usual practice to use instrument transformers in a marine distribution system. (4)

(b) Explain why it may be dangerous to open circuit the secondary winding of a CT (current transformer) whilst operating on load. (4)

(c) Draw a circuit diagram showing a voltmeter, an ammeter and a wattmeter connected to a single phase power circuit from the same pair of instrument transformers. (5)

(d) A voltmeter, ammeter and wattmeter connected to a single phase system read 240 V, 70 A and 12.6 kW respectively.

Determine the load power factor. (3)