

EXAMINATION: AUTHORISATION A

Paper I (Theory)

Time Allowed - 3Hrs

JULY 2016

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WRITE ALL YOUR WORK IN THE ANSWER BOOK PROVIDED. EVERY ANSWER SHOULD INCLUDE ALL WORKINGS, NECESSARY DIAGRAMS AND FORMULAE.

START EACH ANSWER ON A FRESH PAGE.

Choose any **FIVE** questions.

1. A moving-coil instrument gives full scale deflection with a current of 2.3 mA and its coil has a resistance of 44 ohms.
 - a. Draw a simple line diagram showing the moving-coil instrument when used as a voltmeter showing the meter's internal resistance and additional resistance required. (2 marks)
 - b. Draw a simple line diagram showing the moving-coil instrument when used as an ammeter showing the meter's internal resistance and shunt resistance required. (2 marks)
 - c. Determine the value of the multiplier required to produce a voltmeter reading up to 60 volts. (8 marks)
 - d. Determine the value of the shunt required to convert the instrument to an ammeter reading up to 15 amperes. (8 marks)
 2. Two resistors, A of 25 ohms and B of unknown value are connected in parallel. The group is then connected in series with a third resistor C of 5 ohms. If the voltage across C is 80 volts and the power dissipated in the whole circuit is 3.84 KW.
 - a. Draw a neat and well labelled circuit diagram. (5 marks)
 - b. Calculate the value of resistor B. (5 marks)
 - c. The current taken by each resistor. (5 marks)
 - d. Calculate the value of a resistor that must be connected in parallel with the whole combination so that the total circuit current will be increased by 100%. (5 marks)
 3. a. Find the rating in kW of an immersion heater element to raise 100 litres of water through 80°C in 4 hours. Assume an efficiency of 77.75%. (One litre of water has a mass of 1 kg and take the specific heat of water as 4200 J/Kg°C). (12 marks)
 - b. If the immersion heater is kept on for 3 hours daily, calculate the annual cost of electricity. Assume that one unit of electricity costs 3c. (8 marks)
4. A coil of resistance 10 Ω and inductance 175 mH, is connected in series with a 110 μF capacitor, across a 230 V, 50 Hz a.c. supply.
 - a. draw a circuit diagram (2 marks)
 - b. calculate the circuit current (4 marks)
 - c. calculate the circuit phase angle (3 marks)
 - d. calculate the p.d. across the coil (4 marks)
 - e. calculate the p.d. across the capacitor (4 marks)
 - f. calculate the power dissipated. (3 marks)

5. a. (i) Explain what is meant by the utilization factor (UF) and light loss factor (LLF) (4 marks)
- A discharge lamp is suspended from a ceiling 4 m above a bench. The luminance on the bench below the lamp was 375 lux. Find:

- (ii) The luminous intensity of the lamp (5 marks)
- (iii) The distance along the bench where the luminance falls to 161.5 lux. (5 marks)

- b. It is proposed to illuminate an electronic workshop of dimensions 10m x 8.5m x 4 m to a luminance of 620 lux at the bench level. The specification calls for luminaires having one 1500 mm 65 W natural tube with an initial output of 3700 lumens (refer to Table 1 below). Determine the number of luminaires required for this installation when the utilization factor (UF) and light loss factor (LLF) are 0.9 and 0.8 respectively. (6 marks)

Table 1: Characteristics of a Thorn Lighting 1500 mm 65 W bi-pin tube

Tube colour	Initial lamp lumens ¹	Lighting design lumens ²	Colour rendering quality	Colour appearance
Artificial daylight	2600	2100	Excellent	Cool
De Luxe Natural	2900	2500	Very Good	Intermediate
De Luxe Warm white	3500	3200	Good	Warm
Natural	3700	3400	Good	Intermediate
Daylight	4800	4450	Fair	Cool
Warm white	4950	4600	Fair	Warm
White	5100	4750	Fair	Warm
Red	250 ¹	250	Poor	Deep red

¹The initial lumens are the measured lumens after 100 hours of life.
²The lighting design lumens are the output lumens after 2000 hours.

Coloured tubes are intended for decorative purposes only.

6. a. Capacitors of 1 μF, 3 μF, 5 μF and 6 μF are connected in parallel to a direct voltage supply of 100V. Determine:
 - i. The equivalent circuit capacitance. (2 marks)
 - ii. The total charge taken. (2 marks)
 - iii. The charge on each capacitor. (6 marks)
- b. Capacitors of 3 μF, 6 μF and 12 μF are connected in series across a direct voltage supply of 350V. Calculate:
 - i. The equivalent circuit capacitance, (2 marks)
 - ii. The charge on each capacitor. (2 marks)
 - iii. The potential difference across each capacitor (6 marks)

END OF PAPER