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EXAMINATION FOR THE ISSUE OF A LICENCE TO ACT AS WIREMAN - LIC 'A'

Paper I (Theory)   Time Allowed - 3Hrs

February 2015

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. (i) Write down the symbols and units of resistance, reactance, impedance, capacitance, inductance and admittance. **(6 marks)**

   (ii) Write down the following in index notation: $1\mu A$, 10mA, 2kV, 4MHz **(4 marks)**

   b. (i) Determine the resistance between terminals A and B of the circuit shown in Fig. 1. ($R1 = 10\Omega$; $R2 = 20\Omega$; $R3 = 5\Omega$; $R4 = 10\Omega$) **(4 marks)**

   (ii) If 5A is flowing between terminals A and B, what is the voltage measured across resistance R4? **(4 marks)**

   (iii) What is the power dissipated in **(2 marks)**
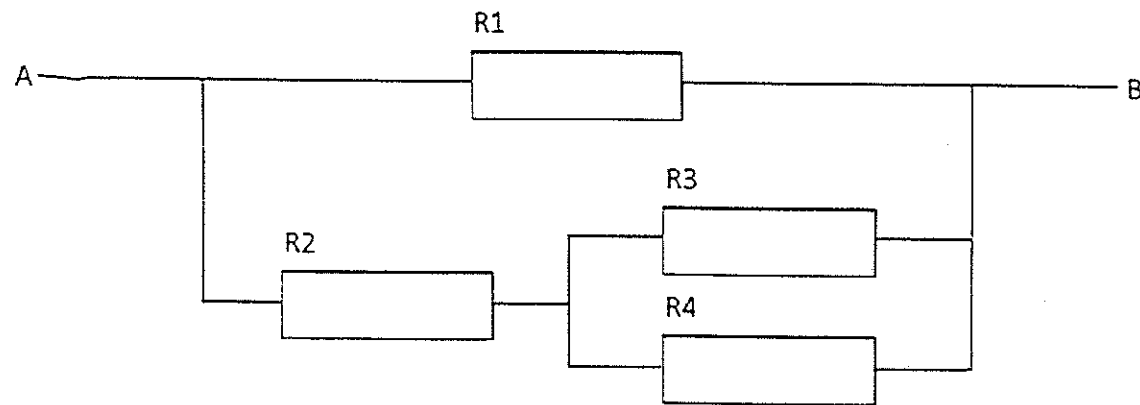   - all the circuit, and
   - in resistance R4?

Fig. 1

2. An electric water heater has a capacity of 120 litres and an electric heating element rated 3kW, 230V, 50Hz. Using the temperature indicator, the water heater takes 95 minutes to heat the water from 18°C to 85°C. Take the specific heat capacity of water as 4187J/kg°C and the mass of water as 1kg per litre.
Calculate:

   (i) The heat energy required. **(6 marks)**

   (ii) The resistance of the heating element. **(4 marks)**

   (iii) The annual cost of energy if the water heater is operated three times a day, 95 minutes each all year round. The tariff cost is 16 €uro cent per unit. **(6 marks)**

   (iv) Assuming that 20% of the energy is wasted, determine the actual time that the heating operation will take for the conditions given above. **(4 marks)**

3. a. Name two methods for charging secondary batteries and for each method briefly explain how the batteries are charged. **(8 marks)**

   b. Nine cells each of emf 2.2V and internal resistance of 0.15Ω are arranged in three parallel rows. The whole cells arrangement forms a battery which is supplying a load of resistance 7Ω. Calculate,

   (i) The load current, **(4 marks)**
   (ii) The battery terminal voltage **(4 marks)**
   (iii) The Load Power supplied by the battery. **(4 marks)**

4. a. Give a typical range for the Utilization Factor (UF) and explain why the Maintenance Factor (MF) needs to be taken into consideration for any luminaires in use. **(5 marks)**

   b. An electronic workshop of dimensions 13.5m x 10m x 3m has to be illuminated to a luminance of 650 lux at the bench level. The specifications call for luminaires having one 1500mm 65W natural tube with an initial output of 3700 lumens. Determine the number of luminaires required for this installation when UF and MF are 0.91 and 0.85 respectively. **(6 marks)**

   c. Two incandescent lamps of luminous intensity 300 candelas and 150 candelas respectively in all directions are fixed to the ends of a photometer bench. A double-sided matt white screen is placed directly between the two lamps with the opposite faces normal to the rays of the lamps. Calculate the distance of each lamp from the screen when the illumination on the screen is the same on both sides. **(9 marks)**

5. a. (i) Calculate the peak value of a sine-wave voltage with an rms value of 230V. **(2 marks)**
   (ii) Determine the period of a sine wave with a 50Hz frequency. **(2 marks)**

   b. (i) State the formula for the reactance of a capacitor and inductor. **(4 marks)**
   (ii) State how the reactance of an inductor and capacitor vary when the frequency is increased. **(4 marks)**
   (iii) Derive the formula to determine the reactance of a number of capacitors in parallel. **(4 marks)**
   (iv) Derive the formula to determine the impedance of a capacitor and inductor in series. **(4 marks)**

6. a. With the aid of well labelled diagrams explain briefly the construction of a single phase
   - Double wound transformer, **(3 marks)**
   - Auto transformer. **(3 marks)**

   b. Explain the principle of operation of a single phase double wound transformer. **(4 marks)**

   c. What safety precaution need to be considered when using an Auto transformer. **(4 marks)**

   d. A double wound single phase transformer has its primary winding connected to a supply of 230V and its secondary winding is supplying a load at 60V. If the primary winding has 1200 turns, find

   (i) The number of secondary turns, **(3 marks)**
   (ii) The secondary current when the current taken from the supply is 3A. **(3 marks)**

END OF PAPER