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| SASTRA DEEMED TO BE UNIVERSITY (U/S 3 OF THE UGC ACT, 1956) THINK MERIT \| THINK TRANSPARENCY \| THINK SASTRA | **School of Electrical and Electronics Engineering**<br>**CIA I Examinations November 2022**<br>**Course Code:** EEE104<br>**Name:** Principles of Electrical Engineering<br>**Duration: 90 Min Max Marks: 50** | |

**Answer Key**

**PART A** **10 x 2 = 20 Marks**

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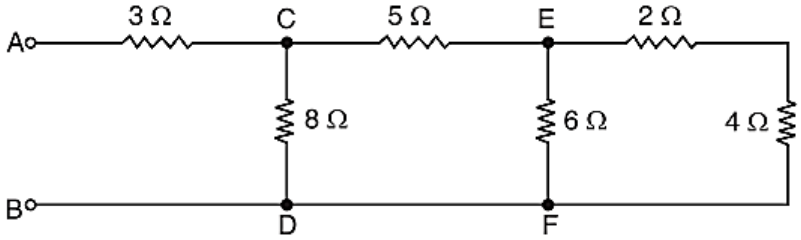
| **1.** | **A metal filament lamp whose resistance varies with temperature takes 0.3 A at 230 V. If the voltage is reduced to 115 V, will the current be halved? Explain your answer.** |
| | No. It is because Ohm's law is applicable only if the resistance of the circuit does not change. In the present case, when voltage is reduced from 230 V to 115 V, the temperature of the lamp will decrease too much, resulting in an enormous decrease of lamp resistance. Consequently, Ohm's law (I = V/R) cannot be applied. |
| **2.** | **The voltage at the terminals of a battery is 52V when no load is connected and 48.8V when a load taking 80A is connected. Find the internal resistance of the battery. What would be the terminal voltage when a load taking 20A is connected?** |
| | 0.04 ohm, 51.2V |
| **3.** | **State Coulomb's laws of electrostatics.** |
| | Law 1 & 2 – 1 marks each. |
| **4.** | **Find the equivalent resistance between terminals A & B.**<br>  |
| | 7 Ω |
| **5.** | **A cable consists of two conductors which, for the purposes of a test, are connected at one end of the cable. The combined loop resistance measured from the other end is found to be 100 Ω when the cable is 700 m long. Calculate the resistance of 8 km of similar cable.** |
| | $R \propto l$<br>$\frac{R_1}{R_2} = \frac{l_1}{l_2}$<br>$R_2 = \frac{R_1 l_2}{l_1} = \frac{100 \times 8000}{700} = 1143\ \Omega$ |
| **6.** | **A short circuit in an electric circuit is dangerous compared to an open circuit, why?** |
| | Fatal shock |
| **7.** | **A motor gives an output power of 20 kW and operates with an efficiency of 80 per cent. If the constant input voltage to the motor is 200 V, what is the constant supply current?** |

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| | $P_o = 20\,000\ \text{W}$<br>$P_{in} = \frac{P_o}{\eta} = \frac{20\,000}{0.8} = 25\,000\ \text{W} = VI$<br>$I = \frac{25\,000}{200} = 125\ \text{A}$ |
| **8.** | **A rechargeable flashlight battery is capable of delivering 90 mA for about 12 h. How much charge can it release at that rate? If its terminal voltage is 1.5 V, how much energy can the battery deliver?** |
| | Charge Q = I*t = 90m*12*60*60 = 3.8kC<br>Energy = 1.5*3.8k= 5.7 kJ |
| **9.** | **A 6.8 kΩ, 0.25 W resistor shows a potential difference of 40 V. Is the resistor safe?** |
| | P=V^2/R = 0.235W <0.25W. Safe |
| **10.** | **A $20Ah$ battery is discharged at '$10C$' rate. What is the discharge time?** |
| | 6 minutes |

**PART B** **3 x 10 = 30 Marks**

**11. A. Find the resistance of 1000 metres of a copper wire 25 sq.mm in cross-section. The resistance of copper is 1/58 ohm per metre length and 1 sq. mm cross-section. What will be the resistance of another wire of the same material, three times as long and one-half area of cross-section? (5 Marks)**

**Solution.** For the first case, $R_1 = ?\ ;\ a_1 = 25\ \text{mm}^2\ ;\ l_1 = 1000\ \text{m}$

For the second case, $R_2 = 1/58\ \Omega\ ;\ a_2 = 1\ \text{mm}^2\ ;\ l_2 = 1\ \text{m}$

$$R_1 = \rho\,(l_1/a_1)\ ;\quad R_2 = \rho\,(l_2/a_2)$$

$$\therefore \quad \frac{R_1}{R_2} = \frac{l_1}{l_2}\times\frac{a_2}{a_1} = \left(\frac{1000}{1}\right)\times\left(\frac{1}{25}\right) = 40$$

$$\text{or} \quad R_1 = 40\,R_2 = 40 \times \frac{1}{58} = \frac{\mathbf{20}}{\mathbf{29}}\,\Omega$$

For the third case, $R_3 = ?\ ;\ a_3 = a_1/2\ ;\ l_3 = 3l_1$

$$\therefore \quad \frac{R_3}{R_1} = \left(\frac{l_3}{l_1}\right)\times\left(\frac{a_1}{a_3}\right) = (3)\times(2) = 6$$

$$\text{or} \quad R_3 = 6R_1 = 6 \times \frac{20}{29} = \frac{\mathbf{120}}{\mathbf{29}}\,\Omega$$

**B. A battery is constructed from six cells (3.7 V, 3000 mAh) in the following way. First, two modules are constructed, where each module comprises three of these cells wired in series. Next, the two modules are wired in parallel to make the battery pack. Draw the circuit configuration and calculate the following :**

**i. nominal energy capacity of the battery (inWh)**
**ii. nominal capacity of the battery (in Ah)**
**iii. total discharge time if discharged at '$2C$' rate**
**iv. voltage rating of the battery pack** (5 Marks)

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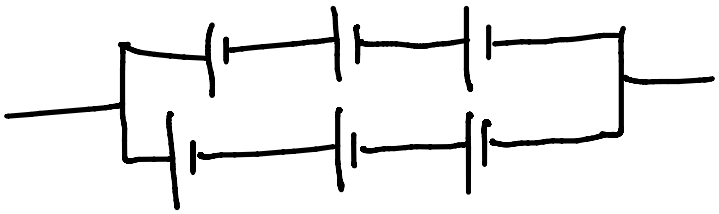
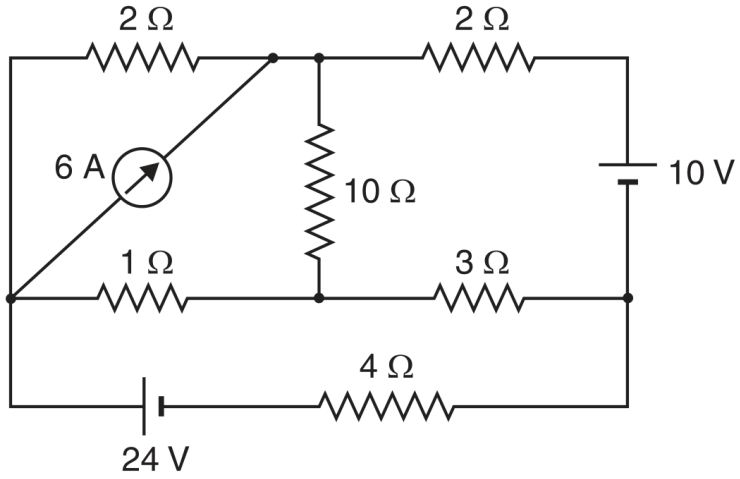
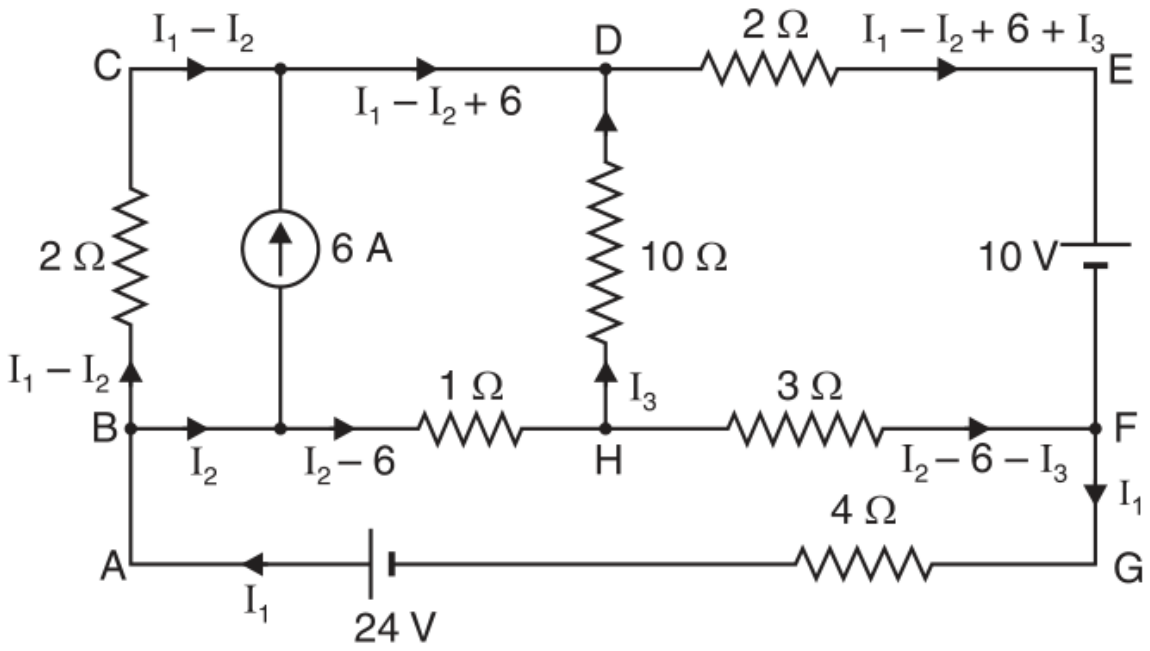
| |  <br>i. 11.1 V * 6000mAh = 66.6 Wh<br>ii. 3000 mAh * 2 = 6000 mAh<br>iii. 30 minutes<br>iv. 3.7 * 3 = 11.1 V |
| **12.** | **Write short notes on the following**<br>**i. Renewable and non-renewable energy sources (4 marks)**<br>**ii. Electric field intensity (3 marks)**<br>**iii. Energy stored in capacitors (3 marks)** |
| **13.** | **Determine the current in 4Ω resistance of the circuit, using Kirchhoff's laws.**<br>  <br> |
| |  <br> |

**Loop *BCDHB*.** Applying *KVL*, we have,

$$-2(I_1 - I_2) + 10I_3 + 1 \times (I_2 - 6) = 0$$

or $$2I_1 - 3I_2 - 10I_3 = -6$$

**Loop *DEFHD*.** Applying K*VL*, we have,

$$-2(I_1 - I_2 + 6 + I_3) - 10 + 3(I_2 - 6 - I_3) - 10I_3 = 0$$

or $$2I_1 - 5I_2 + 15I_3 = -40$$

**Loop *BHFGAB*.** Applying *KVL*, we have,

$$-1(I_2 - 6) - 3(I_2 - 6 - I_3) - 4I_1 + 24 = 0$$

or $$4I_1 + 4I_2 - 3I_3 = 48$$

Solving eqs. (*i*), (*ii*) and (*iii*), we get, $I_1 = 4.1$ A.

$\therefore$ Current in 4 Ω resistance $= I_1 =$ **4.1 A**