Physics 112

Preliminary Laboratory Questions Experiment 3

Solution of Networks

Kirchoff’s rules and Superposition Principle

1. Comment on the statement “ Kirchoff’s rules are direct consequences of elementary conservation laws”.

This is because the tow theorems of kiechof's low are a results of tow conservation laws . In fact , Loop theorem is just the principle of conversation of energy as applied to electric circuits . And Junction theorem is just the principle of conversation of charge applied to electric circuits .

1. Suppose that in Fig. 1 in the manual;

Ε1=8 V , Ε2=10 V, R1=2 KΩ, R2= 3 KΩ and R3=6 KΩ;

Find using Kirchoff’s rules the current flowing on each resistance.

$$ε\_{1}= I\_{3}R\_{3}+ I\_{1}R\_{1} \left( I\_{3}=I\_{1}-I\_{2}\right)$$

$$ε\_{1}=\left(I\_{1}-I\_{2}\right)R\_{3}+ I\_{1}R\_{1}$$

$$8=\left(\left(I\_{1}-I\_{2}\right)×6×10^{3}\right)+ \left(I\_{1}×2×10^{3}\right)………………..\left(1\right)$$

$$ε\_{2}= I\_{3}R\_{3}- I\_{2}R\_{2} \left( I\_{3}=I\_{1}-I\_{2}\right)$$

$$ε\_{2}=\left(I\_{1}-I\_{2}\right)R\_{3}+ I\_{2}R\_{2}$$

$$10=\left(\left(I\_{1}- I\_{2}\right)×6×10^{3}\right)- \left(I\_{2}×3×10^{3} \right)…………………\left(2\right)$$

Solving these tow equations we get :

$I\_{2}= \frac{-8}{9} mA , I\_{1}=\frac{1}{3} mA , I\_{3}= \frac{11}{9} mA $

 3- As in question 2, but by using the superposition Principle.

1. To find $I\_{3}$ :

$$I\_{31}= \frac{ε\_{1}R\_{2} }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{8×3×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=\frac{2}{3} mA$$

$$I\_{31}= \frac{ε\_{2}R\_{1} }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{10×2×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=\frac{5}{9}mA$$

$$I\_{3}= I\_{31}+I\_{32}=\frac{2}{3}+\frac{5}{9}=\frac{11}{9}mA$$

1. To find $I\_{2}$ :

$$I\_{21}= \frac{ε\_{1}R\_{3} }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{8×6×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=\frac{4}{3}mA$$

$$I\_{22}= \frac{ε\_{2}(R\_{1}+R\_{3}) }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{10×(2+6)×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=\frac{20}{9}mA$$

$$I\_{2}=I\_{21}-I\_{22}=\frac{4}{3}-\frac{20}{9}=\frac{-8}{9}mA$$

1. To find $I\_{1}$ :

$$I\_{11}= \frac{ε\_{1}(R\_{2}+R\_{3}) }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{8×(3+6)×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=2 mA$$

$$I\_{12}= \frac{ε\_{2}R\_{3} }{R\_{1}R\_{2}+R\_{2}R\_{3}+R\_{1}R\_{3} }= \frac{10×6×10^{3}}{\left(2×10^{3}×3×10^{3}\right)+\left(2×10^{3}×6×10^{3}\right)+\left(3×10^{3}×6×10^{3}\right)}=\frac{5}{3}mA$$

$$I\_{1}=I\_{11}-I\_{12}=2-\frac{5}{3}=\frac{1}{3}mA$$