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Execution of System of Linear Equations in Electrical Networks

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Abstract: ***We can apply the methods for solving linear systems to solve problems involving electrical circuits. In a given circuit if enough values of currents, resistance and potential difference is known, we should be able to find the other unknown values of these quantities. We mainly use the OHM's law, Kirchhoff's voltage law and Kirchhoff's current law.***
Keywords: ***Augmented matrices, ohm's law, Kirchhoff's voltage law, Kirchhoff's current law***

I. INTRODUCTION

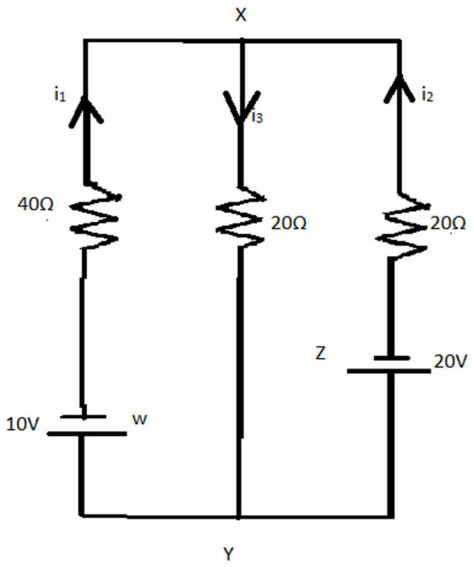
For circuits with series and parallel section ,break the circuit up into portions of series and parallel , then calculate values for these portions and use these values to calculate the resistance of the entire circuit that is , first , for each individual series path , calculate the total resistance for that path .Second , using these values , by assuming that each path as a single resistor , calculate the total resistance of the circuit.

II. PRELIMINARIES

1) *Definition 2.1.1:* Ohm's law is a law that states that the voltage across a resistor is directly proportional to the current flowing through the resistance. ... Ohm's law is a law that states that the voltage across a resistor is directly proportional to the current flowing through the resistance.
2) *Definition 2.1.2 :* (KVL) The algebraic sum of potential rises and potential drops in a closed loop is called Kirchoff's Voltage law
3) *Definition 2.1.3:* (KCL) The algebraic sum of currents (incoming or outgoing) meeting at a junction is equal to zero is called Kirchoff's second law.
4) *Definition 2.1.4:* A matrix whose elements are the coefficients of a set of simultaneous linear equations with the constant terms of the equations entered in an added column.

A. Main Result

Determine the currents e_1, e_2, e_3 for the following electrical network:



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Let's assign currents to each part of the circuit between the node points which will give us three different currents.

Let's assume that currents are clockwise direction so the current on the segment XYWX is e_1 on the segment XY is e_2 on the segment XZYX is e_3.

Applying kirchhoff's voltage law to either of the nodes X or Y we find $e_3=e_1+e_2$ .in other words

$$e_1+e_2-e_3=0$$

Applying kirchhoff's current law to the loops XZYX and XYWX we obtain the equations

$$40e_1+20e_3=10 \quad => \quad 4e_1+2e_3=1$$
$$20e_3+20e_2= -10 \quad => \quad 2e_3+2e_2= -1$$

This gives a linear system of three equations

$$e_1+e_2-e_3=0 \qquad \rightarrow (1)$$
$$4e_1+2e_3=1 \qquad \rightarrow (2)$$
$$2e_3+2e_2= -1 \qquad \rightarrow (3)$$

The augmented matrix of the above system is

$$[A\ x] = \begin{bmatrix} 1 & 1 & -1 & 0 \\ 4 & 0 & 2 & 1 \\ 0 & 2 & 2 & -1 \end{bmatrix}$$

$R_2:R_2-4R_1$

$$= \begin{bmatrix} 1 & 1 & -1 & 0 \\ 0 & -4 & 6 & 1 \\ 0 & 2 & 2 & -1 \end{bmatrix}$$

$R_1:4R_1+R_2;$
$R_3:2R_3+R_2$

$$= \begin{bmatrix} 4 & 0 & 2 & 1 \\ 0 & -4 & 6 & 1 \\ 0 & 0 & 10 & -1 \end{bmatrix}$$

$R_1:5R_1-R_3;$
$R_2:10R_2-6R_3$

$$= \begin{bmatrix} 20 & 0 & 0 & 6 \\ 0 & -40 & 0 & 16 \\ 0 & 0 & 10 & -1 \end{bmatrix}$$

$R_1/20;$
$R_2/-40;$
$R_3/10;$

$$= \begin{bmatrix} 1 & 0 & 0 & 3/10 \\ 0 & 1 & 0 & -4/10 \\ 0 & 0 & 1 & -1/10 \end{bmatrix}$$

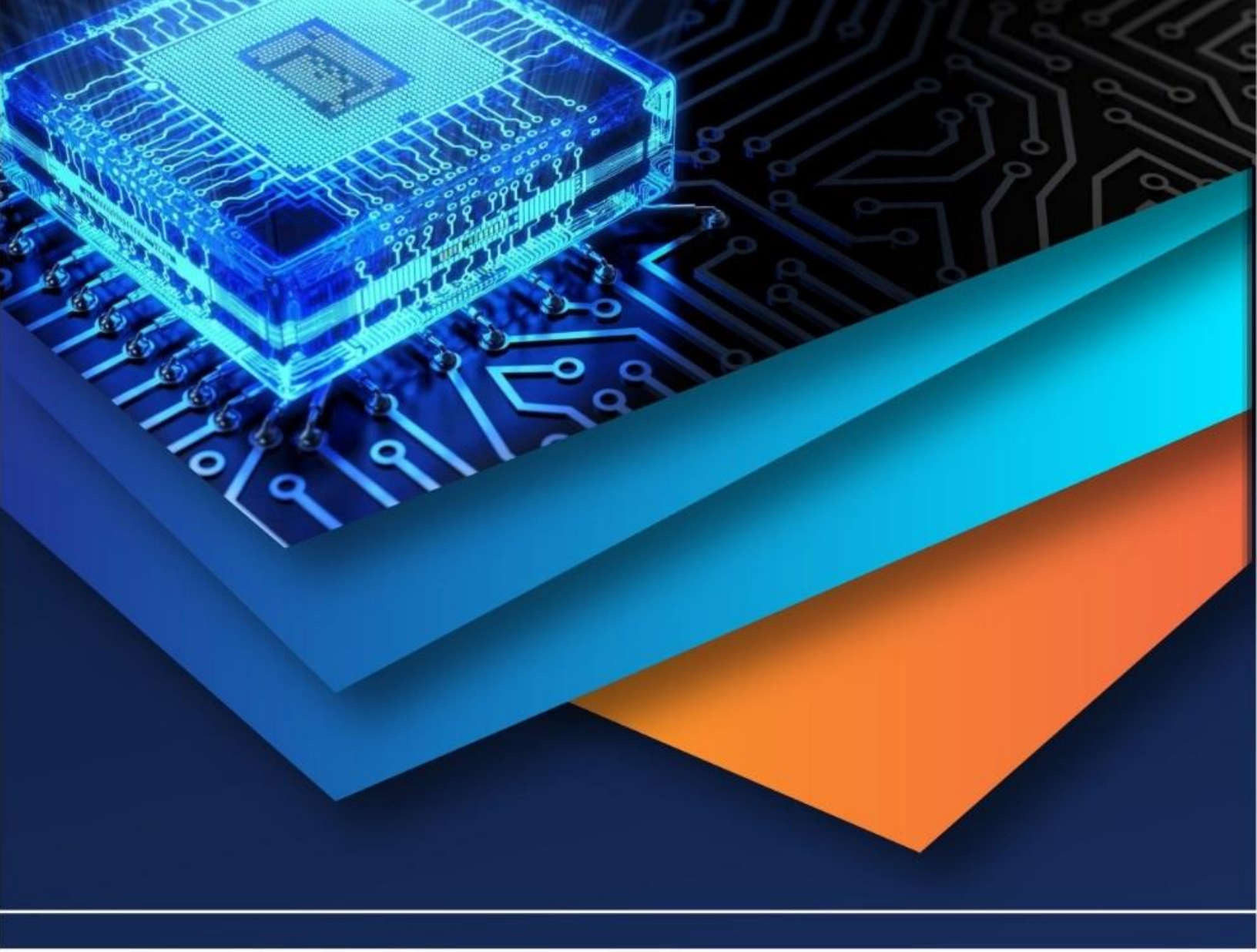
III. CONCLUSION

Since e_2 is negative, the current flow is from Y to X rather than X to Y, as this linear system can be solved by methods of linear algebra. Algebra is more useful when the network is very complicated and the number of the unknown is large.

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