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RESEARCH ARTICLE

To Analyse Energy of the Electric Circuit by Using Neutrosophic Labelling

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Abstract

Objectives: Neutrosophic labeling was used in electric circuits for evaluating energy. **Methods:** Defuzzification method, $\overline{A} = \frac{a+4b+c}{6}$ was applied to the neutrosophic labeling circuit graph which produces crisp values. **Findings:** The energy of the electric circuit is equal to the energy of the neutrosophic applied electric circuit. **Novelty :** Neutrosophic Fuzzy Labeling values are converted into crisp values using Defuzzification Graded Mean Integration Method.

Keywords: Labeling; Neutrosophic Labeling; Electric circuit; Kirchhoff law; Energy

1 Introduction

Energy is a concept that is connected to a graph's spectrum. Gutman provided a mathematical definition of energy for all graphs in 1978. A graph can have several matrices connected to it, including the adjacency matrix.

Labeling is one of the branches of graph theory. Labeling is used in various fields like wireless communication, networks, etc. A new concept of labeling in Pythagorean neutrosophic fuzzy graphs is studied[(1)]. To analyse energy and spectrum analysis of interval valued neutrosophic graph using MATLAB[(2)]. The Score, Accuracy, and Certainty Functions of Neutrosophic Triplets (T, I, F) and Total Order of the Set are discussed[(3)] Take a survey of graph labeling with a dynamic approach[(4)]. Graceful labeling is applied to the step grid graph and investigated about the step grid graph cycle, path, etc.[(5)]. Electric circuits are converting into graph and circuit matrix is studied[(6)]. Novel concept of labeling odd some prime labeling, which is applied some graphs[(7)] Then the next level of fuzzy labeling goes to intuitionistic fuzzy labeling graphs are introduced[(8)]. Neutrosophic fuzzy labeling on vague graphs is studied and this work is applied to real-time applications like social network models and operation research[(9)]. Deneutrosophication was possible to use[(3)]. But in this Research paper, we have chosen Graded Mean Integration method.

In this work, we present some innovative concepts that are applied in electric circuits and results of the energy of the circuit with application of physics (Kirchhoff circuit law). Many researchers have focused more than their application research work. In this paper, two types of electric circuits are studied: DC circuits and AC circuits. Both circuits are first converted into a graph (directed graph), then the adjacency matrix and energy of the graph are determined. At the same time, the energy of the graph equals the energy of the electric circuit using Kirchhoff circuit law, specifically Kirchhoff voltage law. Research is also done on the energy of all types of graphs, including regular graphs, irregular graphs, and circular and random graphs.

2 Methodology

Our assumption was first electric circuits are converted into directed graph. Then applied neutrosophic labeling to the electric circuit graph.

2.1. Intuitionistic Fuzzy labeling

Intuitionistic fuzzy labeling graph $\mathrm{H} = (\mathrm{V}, \tau, \rho)$ is called an intuitionistic fuzzy labeling sub graph of $\mathrm{G} = (\mathrm{V}, \sigma, \mu)$ if

(i) $\tau_1(u) \leq \sigma_1(u),\ \tau_2(u) \geq \sigma_2(u)\ \ for\ all\ u\ \in V\ and$

(ii) $\rho_1(u,v) \leq \mu_1(u,v),\ \rho_2(u,v) \geq \mu_2(u,v)\ \ for\ all\ edges\ (u,\ v).$

2.2. Neutrosophic Labeling

A neutrosophic graph $\mathrm{G}* = (\mathrm{V}, \sigma, \mu)$ is said to be an neutrosophic labeling graph if $\mathrm{T}_1 : \mathrm{V} \rightarrow [0, 1]$, $\mathrm{I}_1 : \mathrm{V} \rightarrow [0, 1]$ $\mathrm{F}_1 : \mathrm{V} \rightarrow [0, 1]$ and $\mathrm{T}_2 : \mathrm{V} \times \mathrm{V} \rightarrow [0, 1]$, $\mathrm{I}_2 : \mathrm{V} \times \mathrm{V} \rightarrow [0, 1]$, $\mathrm{F}_2 : \mathrm{V} \times \mathrm{V} \rightarrow [0, 1]$ is bijective such that truth-membership function, indeterminacy-membership function and falsity membership of the vertices and edges are distinct and for every edges (vi, vj),

(i) $T_2(v_i, v_j) \leq min\{T_1(v_i),\ T_1(v_j)\},$

(ii) $I_2(v_i, v_j) \leq min\{I_1(v_i),\ I_1(v_j)\}$

(iii) $F_2(v_i, v_j) \leq max\{F_1(v_i),\ F_1(v_j)\}$, and $0 \leq T_2(v_i, v_j) + I_2(v_i, v_j) + F_2(v_i, v_j) \leq 3$

2.3. Kirchhoff's Voltage Law

The voltage around a loop equals the sum of every voltage drop in the same loop for any closed network and equals zero. Put differently, the algebraic sum of every voltage in the loop has to be equal to zero and this property of Kirchhoff's law is called conservation of energy.

2.4. Kirchhoff's Current Law

The total current entering a junction or a node is equal to the charge leaving the node as no charge is lost. Put differently, the algebraic sum of every current entering and leaving the node has to be null.

2.5. Direct Circuit

A Direct Current circuit is a circuit that Electric Current flows through in one direction. DC is commonly found in many low-voltage applications, especially where these are powered by Battery. Most electronic circuits require a DC power supply.

3 Result and Discussion

From [Figure 1]

ABEFA ——– (1) loop

BCDEB ——– (2) loop

$I_1 + I_2 = I_3$

The Electric flow equations

$$20 - 1.1I_1 - I_2 = 0 \tag{1}$$

$$25 - I_1 - 1.2I_2 = 0 \tag{2}$$

After simplifying these two equations we get,

$I_1 = -3.125\ A$

$I_2 = 23.475\ A$

$I_1 + I_2 = I_3$

$-3.125+23.475=20.3125$
$I_3=20.3125$
By using Kirchhoff voltage law $\Sigma V=0$
Voltage V_1,V_2,V_3
$V_1=I_1\times R_1$
$=-3.125\times 0.1=-0.3125\ V$
$V_2=I_2\times R_2$
$=23.475\times 0.2=4.6875\ V$
$V_3=I_3\times R_3$
$=20.3125\times 1=20.3125\ V$
1^{st} Loop $\Sigma V=0$
$20-V_1-V_3=0$
$20-(-0.3125)-20.3125=0$
2^{nd} Loop $\Sigma V=0$
$25-V_2-V_3=0$
$25-(-0.3125)-20.3125=0$
By the above calculation using Kirchhoff voltage law, Energy of the Electric circuit is 0.
After converting electric circuit as a directed graph is an easiest way to find the energy of the Electric Circuit.

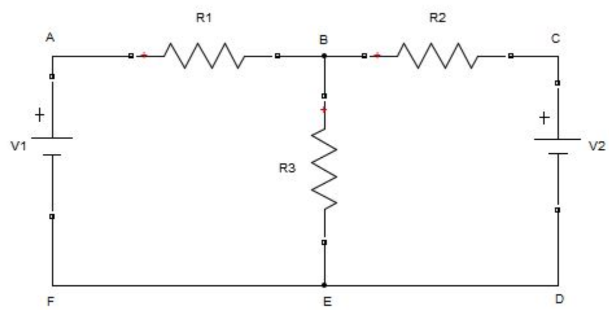

Fig 1. DC Circuit with 2 Loops

Defuzzition Method for Neutrosophic Labeling Circuit Graph

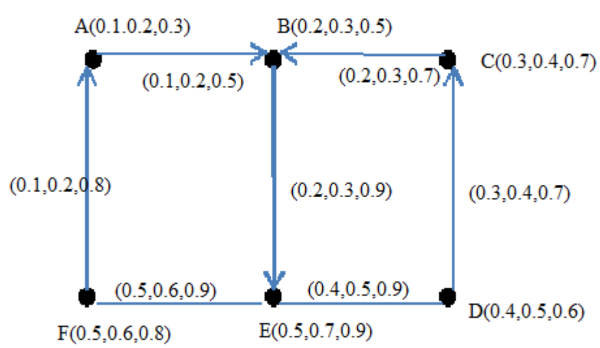

Fig 2. Neutrosophic labeling circuit graph with Neutrosophic Numbers

Let us take Neutrosophic Labeling Numbers of the circuit graph to convert crisp values using Graded Mean Integration Representation Method formula.

$\bar{A} = \frac{a+4b+c}{6}$

$= \frac{0.1+4(02)+0.3}{6} = 0.95.$

Similarly by proceeding with the formula for Graded Mean Integration Representation Method, we can find the crisp values given in the [Table 1] below.

Table 1. Neutrosophic labeling numbers to crisp values for 2 loops graph

Vertices / Edges	Neutrosophic Labeling Numbers	Crisp Values
A	(0.1,0.2,0.3)	0.95
B	(0.2,0.3,0.5)	0.31
C	(0.3,0.4,0.7)	0.43
D	(0.4,0.5,0.6)	0.5
E	(0.5,0.7,0.9)	0.7
F	(0.5,0.6,0.8)	0.616
AF	(0.1,0.2,0.8)	0.28
CD	(0.3,0.4,0.7)	0.43
BC	(0.2,0.3,0.7)	0.35
AB	(0.1,0.2,0.5)	0.23
BE	(0.2,0.3,0.9)	0.38
DE	(0.4,0.5,0.9)	0.55
EF	(0.5,0.6,0.9)	0.63

Then we have to find the Energy of a Neutrosophic Fuzzy Circuit Graph.

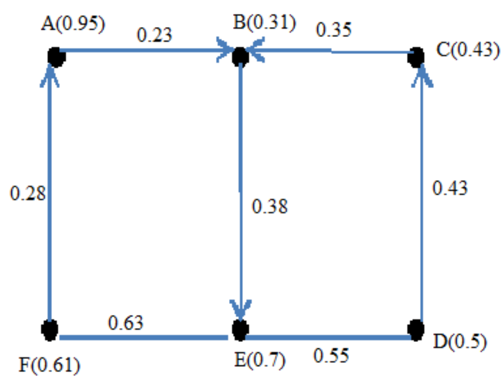

Fig 3. Neutrosophic Labeling circuit Graph with crisp values

To find the Eigan values

$$A(N_l(G)) = \begin{bmatrix} 0 & 0.23 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.38 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.43 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$det\ (A(N_l(G)) - \lambda I) = 0$$

$$det\ (A-\lambda I)=\begin{bmatrix}-\lambda & 0.23 & 0 & 0 & 0 & 0\\ 0 & -\lambda & 0 & 0 & 0.38 & 0\\ 0 & 0 & -\lambda & 0 & 0 & 0\\ 0 & 0 & 0.43 & -\lambda & 0 & 0\\ 0 & 0 & 0 & 0 & -\lambda & 0\\ 0 & 0 & 0 & 0 & 0 & -\lambda\end{bmatrix}$$

Eigen Values

$\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$.

Spectrum of $(N_l\,(G)) = (0,0,0,0,0,0)$

Energy of a Neutrosophic Labeling circuit graph E (N_l (G)) = 0 < 1.

DC Circuit with 4 Loop

From [Figure 4] $R_1 = 1\Omega$, $R_2 = 2\Omega$, $R_3 = 3\Omega$, $R_4 = 4\Omega$, $R_5 = 5\Omega$, $R_6 = 6\Omega$

Voltage = 10 v, Battery = 5v.

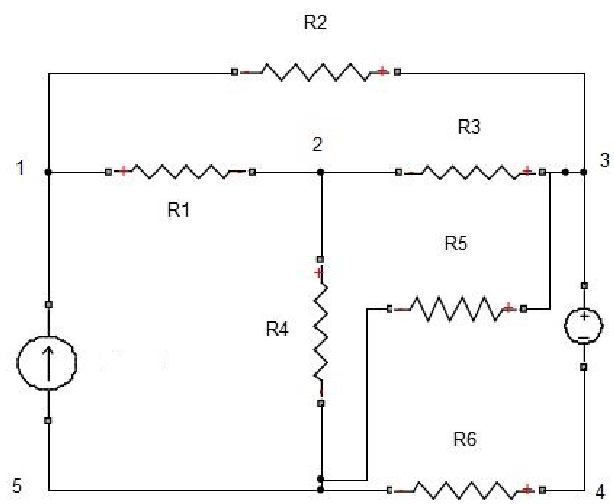

Fig 4. Electric circuit with 4 loops

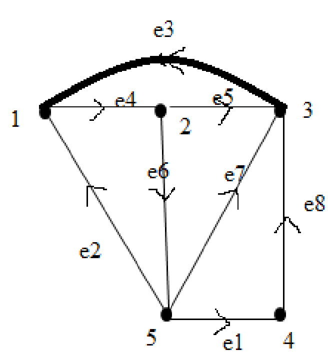

Fig 5. Neutrosophic Labeling Electric circuit graph

To find the current and Voltage for this circuit using mesh analysis method

Let us take Neutrosophic Labeling Numbers (4 Loop circuit) of the circuit graph to convert crisp values using Graded Mean Integration Representation Method formula.

A $= \frac{a+4b+c}{6}$

$= \frac{0.2+4(0.3)+0.5}{6} = 0.31$

Similarly by proceeding with the formula for Graded Mean Integration Representation Method, we can find the crisp values given in the [Table 2] below.

Table 2. Neutrosophic labeling numbers to crisp values for 4 loop graph

Vertices / Edges	Neutrosophic Labeling Numbers	Crisp Values
A	(0.2,0.3,0.5)	0.31
B	(0.3,0.4,0.6)	0.41
C	(0.3,0.5,0.7)	0.5
D	(0.4,0.6,0.8)	0.6
E	(0.4,0.5,0.7)	0.5
DE	(0.3,0.5,0.8)	0.5
AE	(0.2,0.3,0.7)	0.35
AC	(0.2,0.3,0.7)	0.35
AB	(0.1,0.2,0.6)	0.25
BC	(0.1,0.3,0.6)	0.31
BE	(0.2,0.3,0.7)	0.35
CE	(0.1,0.4,0.7)	0.4
CD	(0.2,0.4,0.8)	0.43

Then we have to find the Energy of a Neutrosophic Fuzzy Circuit Graph

To find the Eigan values

$$A(N_l(G)) = \begin{bmatrix} 0 & 0.25 & 0.35 & 0 & 0.35 \\ 0.25 & 0 & 0.31 & 0 & 0.35 \\ 0.35 & 0.31 & 0 & 0.43 & 0.4 \\ 0 & 0 & 0.4 & 0 & 0.5 \\ 0.35 & 0.35 & 0.4 & 0.5 & 0 \end{bmatrix}$$

$$det\ (A(N_l(G)) - \lambda I) = \begin{bmatrix} -\lambda & 0.25 & 0.35 & 0 & 0.35 \\ 0.25 & -\lambda & 0.31 & 0 & 0.35 \\ 0.35 & 0.31 & -\lambda & 0.43 & 0.4 \\ 0 & 0 & 0.4 & -\lambda & 0.5 \\ 0.35 & 0.35 & 0.4 & 0.5 & -\lambda \end{bmatrix}$$

Eigen Values, λ_1 = -2.857, λ_2 = 0.063 λ_3 = 3.577, λ_4 = -0.391, λ_5= -0.391

Spectrum of $(N_l$ (G)) = (-2.857, 0.063, 3.577, -0.391, -0.391)

Energy of a Neutrosophic Labeling circuit graph E $(N_l$(G)) = 0.001 < 1.

AC circuit with 2 loops

From the above AC Circuit with 2 Loops [Figure 6]

sR_1=10Ω, R_2= 8Ω, L= j6Ω, C= -j5Ω.

To using mesh analysis method for find the current and voltage,

$$\begin{bmatrix} 10-j5 & -(-j5) \\ -(-j5) & 8-j5+j6 \end{bmatrix} \begin{bmatrix} I1 \\ I2 \end{bmatrix} = \begin{bmatrix} 100\angle 0^\circ \\ 0 \end{bmatrix}$$

$$I_1 = \frac{\begin{bmatrix} 100\angle 0^\circ & j5 \\ 0 & 8+j \end{bmatrix}}{\begin{bmatrix} 10-j5 & j5 \\ j5 & 8+j \end{bmatrix}}$$

I_1 = 7.07∠ 22.38.

$$I_2 = \frac{\begin{bmatrix} 10-j5 & 100\angle 0^{\circ} \\ j5 & 0 \end{bmatrix}}{\begin{bmatrix} 10-j5 & j5 \\ j5 & 8+j \end{bmatrix}}$$

I_2 = 4.39 $\angle$ -74.74.

$Source\ Power = VI\ Cos\phi = 653.75\ W.$

P_{10}= $I_1^2 \times 10$ = 499.85 W

P_8= $I_2^2 \times 8$ = 154 W.

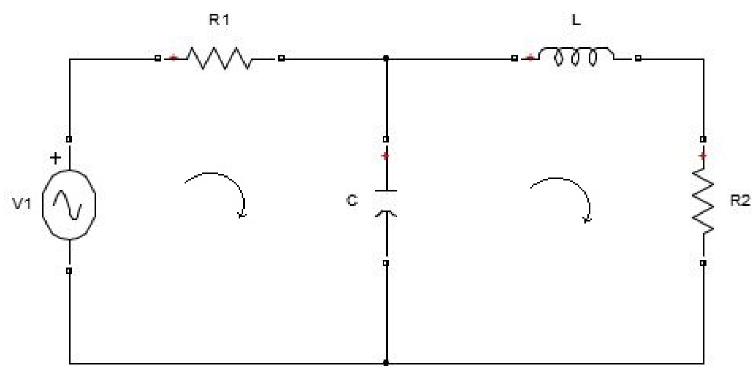

Fig 6. AC circuit with 2 Loops

AC Circuit with Neutrosophic Labeling

$$A\left(N_l\left(G\right)\right) = \begin{bmatrix} 0 & 0.025 & 0 & 0 \\ 0 & 0 & 0 & 0.036 \\ 0 & 0.035 & 0 & 0 \\ 0.026 & 0 & 0.051 & 0 \end{bmatrix}$$

$$det\ \left(A-\lambda I\right) = \begin{bmatrix} -\lambda & 0.025 & 0 & 0 \\ 0 & -\lambda & 0 & 0.036 \\ 0 & 0.035 & -\lambda & 0 \\ 0.026 & 0 & 0.051 & -\lambda \end{bmatrix}$$

Eigen Values

λ_1 = 0, λ_2 = 0.04 λ_3 = -0.02, λ_4 = -0.02

Spectrum of (N_l (G)) = ()

Energy of a Neutrosophic Labeling AC circuit graph E (N_l (G)) = 0 < 1.

Similarly, defuzzified AC circuit neutrosophic labeling graph, then find the energy of the AC Circuit.

The two types of Circuits (AC & DC) with multiloops energy is zero. Because how much voltage and Current give to the Circuits. Circuits are share voltage and current equally. (By KVL and KCL).First takes an electric circuit (DC) and it is converted into a neutrosophic labeling electric circuit graph, then the defuzzification method was applied to neutrosophic fuzzy values and it was converted into crisp values. This process was similar to an AC circuit. Then find the adjacency matrix for neutrosophic labeling electric circuit and energy of the graph. This process was similar to an AC circuit. Finally, from this work, we concluded the energy of the electric circuit is equal to the energy of the neutrosophic labeling electric circuit graph using Kirchhoff law.

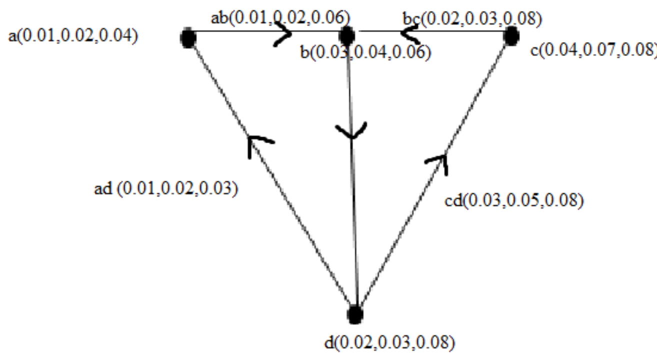

Fig 7. AC Circuit with Neutrosophic Labeling graph

4 Conclusion

This study concludes the simplest way for calculating the energy of an electric circuit, which is the neighboring matrix method using Neutrosophic labeling. Electric circuits shared voltage and current equally. So the energy of the electric circuit was equal to the energy of the neutrosophic labeling electric circuit graph. With the help of the defuzzification method, neutrosophic labeling numbers are converted into crisp values, making it very useful to find the energy of the electric circuit. Finally, analysing the energy of the electric circuit is equal to the energy of the neutrosophic labeling electric circuit graph only DC circuits. The strength of this study it was only applicable for DC circuits and weakness of this AC circuits are not applicable. Because it has a LCR series.

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