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Structural Equivalence between Electrical Circuits via Neutrosophic Nano Topology Induced by Digraphs

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Abstract: The purpose of the present work was to study the real life problems using neutrosophic nano topological graph theory. Most real-life situations need some sort of approximation to fit mathematical models. The beauty of using neutrosophic nano topology in approximation is achieved via approximation for qualitative sub graphs without coding or using assumption. By certain nano equivalence relation, we are formalizing the structural equivalence of basic circuit of the LED light from the graphs and their corresponding neutrosophic nano topologies generated by them.

Keywords: Neutrosophic nano topology; Neutrosophic nano neighborhood; Neutrosophic nano continuous; Neutrosophic nano homeomorphism; Neutrosophic nano isomorphism.

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1. Introduction

There are several reasons for the acceleration of interest in graph theory. It has become fashionable to mention that there are applications of graph theory in some areas of Physics, Chemistry, Communication Science and Computer Technology. The theory is also intimately related to many branches of Mathematics, including Group Theory, Matrix Theory, Numerical Analysis, Probability, Topology and Combinatorics.

A graph (resp., directed graph or digraph) [21], $G = (V(G), E(G))$ consists of a vertex set $V(G)$ and an edge set $E(G)$ of un-ordered (resp., ordered) pairs of elements of $V(G)$. To avoid ambiguities, we assume that the vertex and edge sets are disjoint. We say that two vertices v and w of a graph (resp., digraph) G are adjacent if there is an edge of the form $\overline{vw}$ (resp., $\overline{vw}$ or $\overline{wv}$) joining them, and the vertices v and $w$are then incident with such an edge. A sub graph of a graph G is a graph, each of whose vertices belong to $V(G)$ and each of whose edges belongs to $E(G)$. Many theories like, Theory of Fuzzy sets [22], Theory of Intuitionistic fuzzy sets [7], Theory of Neutrosophic sets [20] and The Theory of Interval Neutrosophic sets can be considered as tools for dealing with uncertainties. However, all of these theories have their own difficulties which are pointed out. In 1965, Zadeh [22] introduced fuzzy set theory as a mathematical tool for dealing with uncertainties where each element had a degree of membership. Later on fuzzy topology was introduced by Chang [10] in 1986. The Intuitionistic fuzzy set was introduced by Atanassov [7] in 1983 as a generalization of fuzzy set, where besides the degree of membership and the degree of non-membership of each element. After this intuitionistic fuzzy topology was introduced by Coker [11].

The neutrosophic set was introduced by Smarandache [20] as a generalization of intuitionistic fuzzy set. In 2012, Salama and Alblowi [18] introduced the concept of Neutrosophic topological spaces as a generalization of intuitionistic fuzzy topological space and a neutrosophic set besides the degree of membership, the degree of indeterminacy and the degree of non-membership of each element. In 2014 Salama, Smarandache and Valeri [19] introduced the concept of neutrosophic closed sets and neutrosophic continuous functions. Smarandache's neutrosophic concept have wide range of real time applications for the fields of [1-6] Information Systems, Computer Science, Artificial Intelligence, Applied Mathematics, decision making. Mechanics, Electrical & Electronic, Medicine and Management Science etc, Rough set theory is introduced by Pawlak [17] as a new mathematical tool for representing reasoning and decision-making dealing with vagueness and uncertainty.

This theory provides the approximation of sets by means of equivalence relations and is considered as one of the first non-statistical approaches in data analysis. A rough set can be described by a pair of definable sets called lower and upper approximations. The lower approximation is the greatest definable set contained in the given set of objects while the upper approximation is the smallest definable set that contains the given set. Rough set concept can be defined quite generally by means of topological operations, interior and closure, called approximations. In 2013, a new topology called Nano topology was introduced by Lellis Thivagar [13] which is an extension of rough set theory. He also introduced Nano topological spaces which were defined in terms of approximations and boundary region of a subset of a universe using an equivalence relation on it. The elements of a Nano topological space are called the Nano open sets and its complements are called the Nano closed sets. Nano means something very small. Nano topology thus literally means the study of very small surface. The fundamental ideas in Nano topology are those of approximations and indiscernibility relation.

Some properties of nano topology induced by graph were investigated by Arafa Nasef [8] et al. single valued neutrosophic graphs were introduced by Said Broumi [9] et al. in which they defined degree, order, size and neighborhood of single valued neutrosophic graph. The aim of this paper is to deal with some practical problems by utilizing neutrosophic nano topology. Nano homeomorphism [14] between two nano topological spaces are said to be topologically equivalent. Using this concept, we are formalizing the structural equivalence of basic circuit of the LED light from the graphs and their corresponding neutrosophic nano topologies generated by them.

2. Preliminaries

Definition 2.1. [13] Let $\mathcal{U}$ be a non-empty finite set of objects called the universe and $\mathcal{R}$ be an equivalence relation on $\mathcal{U}$ named as indiscernibility relation. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair $(\mathcal{U}, \mathcal{R})$ is said to be the approximation space. Let $\mathcal{X} \subseteq \mathcal{U}$.

(i) The lower approximation of $\mathcal{X}$ with respect to $\mathcal{R}$ is the set of all objects, which can be for certain classified as $\mathcal{X}$ with respect to $\mathcal{R}$ and is denoted by $\mathcal{L}_{\mathcal{R}}(\mathcal{X})$. That is, $\mathcal{L}_{\mathcal{R}}(\mathcal{X}) = \mathcal{U}_{x\in\mathcal{U}}\{\mathcal{R}(x) : \mathcal{R}(x) \subseteq \mathcal{X}\}$ where $\mathcal{R}(x)$ denotes the equivalence class determined by x.

(ii) The upper approximation of $\mathcal{X}$ with respect to $\mathcal{R}$ is the set of all objects, which can be possibly classified as $\mathcal{X}$ with respect to $\mathcal{R}$ and is denoted by $\mathcal{U}_{\mathcal{R}}(\mathcal{X})$. That is, $\mathcal{U}_{\mathcal{R}}(\mathcal{X}) = \mathcal{U}_{x\in\mathcal{U}}\{\mathcal{R}(x) : \mathcal{R}(x) \cap \mathcal{X} \neq \varphi\}$.

(iii) The boundary region of $\mathcal{X}$ with respect to $\mathcal{R}$ is the set of all objects which can be classified neither as $\mathcal{X}$ nor as not $\mathcal{X}$ with respect to $\mathcal{R}$ and it is denoted by $B_R(X)$. That is, $\mathcal{B}_{\mathcal{R}}(\mathcal{X}) = \mathcal{U}_{\mathcal{R}}(\mathcal{X}) - \mathcal{L}_{\mathcal{R}}(\mathcal{X})$.

Definition 2.2. [20] A neutrosophic set $\mathcal{S}$ is an object of the following form $\mathcal{A} = \{\langle s, \mathcal{P}_{\mathcal{A}}(s), \mathcal{Q}_{\mathcal{A}}(s), \mathcal{R}_{\mathcal{A}}(s) : s\epsilon\mathcal{S}\rangle\}$ where $\mathcal{P}_{\mathcal{A}}(s)$, $\mathcal{Q}_{\mathcal{A}}(s)$ and $\mathcal{R}_{\mathcal{A}}(s)$ denote the degree of membership, the degree of indeterminacy and the degree of non-membership for each element $s\epsilon\mathcal{S}$ to the set $\mathcal{A}$, respectively.

Definition 2.3. [18] A neutrosophic topology in a nonempty set $\mathcal{X}$ is a family $\mathfrak{I}$ of neutrosophic sets in $\mathcal{X}$ satisfying the following axioms:

(i) $0_N, 1_N \in \mathfrak{I}$;

(ii) $\mathcal{A} \cap \mathcal{B} \in \mathfrak{I}$ for any $\mathcal{A}, \mathcal{B} \in \mathfrak{I}$;

(iii) $\cup (\mathcal{A})_i$ for any arbitrary family $(\mathcal{A})_i : i \in J \subseteq \mathfrak{I}$.

Definition 2.4. [15] Let $\mathcal{U}$ be a universe and $\mathcal{R}$ be an equivalence relation on $\mathcal{U}$ and Let $\mathcal{S}$ be a neutrosophic subset of $\mathcal{U}$. Then the neutrosophic nano topology is defined by $\tau_{\mathcal{N}}(\mathcal{S}) = \{0_{\mathcal{N}}, 1_{\mathcal{N}}, \overline{\mathcal{N}}(\mathcal{S}), \underline{\mathcal{N}}(\mathcal{S}), \mathcal{B}_{\mathcal{N}}(\mathcal{S})\}$, where

(i). $\underline{\mathcal{N}}(\mathcal{S}) = \{\langle y, \mathcal{M}_{\underline{\mathcal{R}}(y)}, \mathcal{I}_{\underline{\mathcal{R}}(y)}, \mathcal{N}_{\underline{\mathcal{R}}(y)}\rangle / z\epsilon[y]\mathcal{R}, y\epsilon\mathcal{U}\}$.

(ii) $\overline{\mathcal{N}}(\mathcal{S}) = \{\langle y, \mathcal{M}_{\overline{\mathcal{R}}(y)}, \mathcal{I}_{\overline{\mathcal{R}}(y)}, \mathcal{N}_{\overline{\mathcal{R}}(y)}\rangle / z\epsilon[y]\mathcal{R}, y\epsilon\mathcal{U}\}$.

(iii) $\mathcal{B}_{\mathcal{N}}(\mathcal{S}) = \underline{\mathcal{N}}(\mathcal{S}) - \overline{\mathcal{N}}(\mathcal{S})$, where $\mathcal{M}_{\underline{\mathcal{R}}(y)} = \wedge_{z\epsilon[y]\mathcal{R}} \mathcal{M}_{\mathcal{S}}(z)$, $\mathcal{I}_{\underline{\mathcal{R}}(y)} = \wedge_{z\epsilon[y]\mathcal{R}} \mathcal{I}_{\mathcal{S}}(z)$, $\mathcal{N}_{\underline{\mathcal{R}}(y)} = \vee_{z\epsilon[y]\mathcal{R}} \mathcal{N}_{\mathcal{S}}(z)$, $\mathcal{M}_{\overline{\mathcal{R}}(y)} = \vee_{z\epsilon[y]\mathcal{R}} \mathcal{M}_{\mathcal{S}}(z)$, $\mathcal{I}_{\overline{\mathcal{R}}(y)} = \vee_{z\epsilon[y]\mathcal{R}} \mathcal{I}_{\mathcal{S}}(z)$, $\mathcal{N}_{\overline{\mathcal{R}}(y)} = \wedge_{z\epsilon[y]\mathcal{R}} \mathcal{N}_{\mathcal{S}}(z)$.

Definition 2.5. [8] Let $(\mathcal{U}, \tau_{\mathcal{R}}(\mathcal{X}))$ and $(\mathcal{U}, \tau_{\mathcal{R}'}(y))$ be a neutrosophic nano topological spaces, then the mapping $g: (\mathcal{U}, \tau_{\mathcal{R}}(\mathcal{X})) \rightarrow (\mathcal{U}, \tau_{\mathcal{R}'}(y))$ is said to be a neutrosophic nano continuous if the inverse image of every neutrosophic nano closed set in $\mathcal{V}$ is neutrosophic nano closed in $\mathcal{U}$.

Definition 2.6. [14] Let $(\mathcal{U}, \tau_{\mathcal{R}}(\mathcal{X}))$ and $(\mathcal{U}, \tau_{\mathcal{R}'}(y))$ be a neutrosophic nano topological spaces, then the mapping $g: (\mathcal{U}, \tau_{\mathcal{R}}(\mathcal{X})) \rightarrow (\mathcal{U}, \tau_{\mathcal{R}'}(y))$ is said to be a neutrosophic nano homeomorphism if

(i) g is one to one and onto.

(ii) g is neutrosophic nano continuous.

(iii) g is neutrosophic nano open.

Definition 2.7. [14] Let $\mathcal{G}$ and $\mathcal{G}'$ be any two graphs. They are isomorphic if there exist a neutrosophic nano homeomorphism $\varphi: [\mathcal{V}(\mathcal{G}), \tau(\mathcal{V}(\mathcal{H}))] \rightarrow [\mathcal{V}(\mathcal{G}), \tau(f(\mathcal{V}(\mathcal{H})))]$ for every sub graph $\mathcal{H}$ of $\mathcal{G}$.

Definition 2.8. [14] $\mathcal{N}[v]$ is said to be neutrosophic nano neighborhood of v if it is defined by $\mathcal{N}[v] = \{w \in \mathcal{V} :$ w is a neutrosophic nano neighborhood of v$\} \cup \{v\}$.

Definition 2.9. [14] Let $\mathcal{G}$ be a neutrosophic nano graph, $\mathcal{N}(v)$ a neutrosophic nano neighborhood of v in $\mathcal{V}$ and $\mathcal{H}$ a neutrosophic nano sub graph of $\mathcal{G}$, then $\tau(\mathcal{V}(\mathcal{H}))$ is a neutrosophic nano topology induced by graph $[\mathcal{V}(\mathcal{G}), \tau(\mathcal{V}(\mathcal{H}))]$. It is denoted by $\tau(\mathcal{V}(\mathcal{H})) = \{\varphi, \mathcal{V}(\mathcal{G}), \overline{\mathcal{N}}[\mathcal{V}(\mathcal{G})], \underline{\mathcal{N}}[\mathcal{V}(\mathcal{G})], \mathcal{B}_{\mathcal{N}}[\mathcal{V}(\mathcal{G})]\}$

Definition 2.10. [9] A single valued neutrosophic digraph $\mathcal{B}$is of the form $\mathcal{D} = (\mathcal{V}_{\mathcal{D}}, \mathcal{A}_{\mathcal{D}})$ where, $\mathcal{V}_{\mathcal{D}} = \{v_1, v_2, \ldots, v_n\}$ and the functions $t_{\mathcal{V}_{\mathcal{D}}} : \mathcal{V}_{\mathcal{D}} \rightarrow [0,1]$, $i_{\mathcal{V}_{\mathcal{D}}} : \mathcal{V}_{\mathcal{D}} \rightarrow [0,1]$, $f_{\mathcal{V}_{\mathcal{D}}} : \mathcal{V}_{\mathcal{D}} \rightarrow [0,1]$ denote the truth-membership function, a indeterminacy-membership function and falsity-membership function of the element $v_i \in \mathcal{V}_{\mathcal{D}}$, respectively and $0 \leq t_{\mathcal{V}_{\mathcal{D}}}(v_i) + i_{\mathcal{V}_{\mathcal{D}}}(v_i) + f_{\mathcal{V}_{\mathcal{D}}}(v_i) \leq 3$, $\forall v_i \in \mathcal{V}_{\mathcal{D}}$, $i = 1,2,\ldots,n$.

$\mathcal{A}_{\mathcal{D}} = \{(v_i,v_j):(v_i,v_j) \in \mathcal{V}_{\mathcal{D}} \times \mathcal{V}_{\mathcal{D}}\}$ provided that $0 < \mathcal{E}(v_i)\mathcal{E}(v_j) \leq 0.5$ and the functions $t_{\mathcal{A}_{\mathcal{D}}}: \mathcal{A}_{\mathcal{D}} \to [0,1]$, $i_{\mathcal{A}_{\mathcal{D}}}: \mathcal{A}_{\mathcal{D}} \to [0,1]$, $f_{\mathcal{A}_{\mathcal{D}}}: \mathcal{A}_{\mathcal{D}} \to [0,1]$ are defined by

$t_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) \leq \min [t_{\mathcal{V}_{\mathcal{D}}}(v_i), t_{\mathcal{V}_{\mathcal{D}}}(v_j)]$

$i_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) \geq \max [i_{\mathcal{V}_{\mathcal{D}}}(v_i), i_{\mathcal{V}_{\mathcal{D}}}(v_j)]$

$f_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) \geq \max [f_{\mathcal{V}_{\mathcal{D}}}(v_i), f_{\mathcal{V}_{\mathcal{D}}}(v_j)]$

Where $t_{\mathcal{A}_{\mathcal{D}}}, i_{\mathcal{A}_{\mathcal{D}}}, f_{\mathcal{A}_{\mathcal{D}}}$ denote the truth-membership function, a indeterminacy membership function and falsity-membership function of the $\mathrm{arc}(v_i,v_j) \in \mathcal{A}_{\mathcal{D}}$ respectively, where $0 \leq t_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) + i_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) + f_{\mathcal{A}_{\mathcal{D}}}(v_i,v_j) \leq 3, \forall (v_i,v_j) \in \mathcal{A}_{\mathcal{D}},\ i,j \in \{1,2,\ldots n\}$.

Definition 2.11. [14] If $\mathcal{G}$ is a directed graph and $u, v \in \mathcal{V}$, then: u is in-vertex of v if $\overline{uv} \in \mathcal{E}(\mathcal{G})$. u is out-vertex of v if $\overline{vu} \in \mathcal{E}(\mathcal{G})$. The in-degree of a vertex v is the number of vertices u such that $\overline{uv} \in \mathcal{E}(\mathcal{G})$. The out-degree of a vertex v is the number of vertices u such that $\overline{vu} \in \mathcal{E}(\mathcal{G})$. Throughout this paper the word graph means directed simple graph.

3. Identifying Structural equivalence between LED light via neutrosophic nano topology

Definition 3.1. Let $\mathcal{G}$ be a neutrosophic nano graph, $v \in \mathcal{V}(\mathcal{G})$. Then we define the neutrosophic nano neighborhood of v as follows $\mathcal{N}[v] = \{u \in \mathcal{V}(\mathcal{G}) : \overline{vu} \in \mathcal{E}(\mathcal{G})\} \cup \{v\}$

Definition 3.2. Let $\mathcal{G}$ be a neutrosophic nano graph, $\mathcal{H}$ a neutrosophic nano sub graph of $\mathcal{G}$ and $\mathcal{N}(v)$ a neutrosophic nano neighborhood of v in $\mathcal{V}$. Then we define,

The lower approximation operation as follows: $\mathcal{L}: \mathcal{P}[\mathcal{V}(\mathcal{G})] \to \mathcal{P}[\mathcal{V}(\mathcal{G})]$ such that $\mathcal{N}_{\mathcal{L}}[\mathcal{V}(\mathcal{H})] = \cup_{v \in \mathcal{V}(\mathcal{G})} \{v: \mathcal{N}(v) \subseteq \mathcal{V}(\mathcal{H})\}$.

The upper approximation operation as follows: $\mathcal{U}: \mathcal{P}[\mathcal{V}(\mathcal{G})] \to \mathcal{P}[\mathcal{V}(\mathcal{G})]$ such that $\mathcal{N}_{\mathcal{U}}[\mathcal{V}(\mathcal{H})] = \cup_{v \in \mathcal{V}(\mathcal{G})} \{\mathcal{N}(v): v \in \mathcal{V}(\mathcal{H})\}$.

(iii) The boundary region is defined as $\mathcal{N}_{\mathcal{B}}[\mathcal{V}(\mathcal{H})] = \mathcal{N}_{\mathcal{L}}[\mathcal{V}(\mathcal{H})] - \mathcal{N}_{\mathcal{U}}[\mathcal{V}(\mathcal{H})]$

Algorithm

Step:1 Taken two different electrical circuits of LED light denoted as $\mathcal{E}1$ and $\mathcal{E}2$.

Step:2 Convert the electrical circuits $\mathcal{E}1$ and $\mathcal{E}2$ to $\mathcal{N}_{\mathcal{G}1}$ and $\mathcal{N}_{\mathcal{G}2}$.

Step:3 Check whether $\mathcal{N}_{\mathcal{G}1}$ and $\mathcal{N}_{\mathcal{G}2}$ are homeomorphism corresponding neutrosophic nano topologies induced from their vertices.

Step:4 Check whether $\mathcal{N}_{\mathcal{G}1}$ is isomorphic to $\mathcal{N}_{\mathcal{G}2}$ and $[\mathcal{N}_{\mathcal{V}(\mathcal{G}1)}, \tau(\mathcal{N}_{\mathcal{V}(\mathcal{H}1)})]$ is isomorphic to $[\mathcal{N}_{\mathcal{V}(\mathcal{G}2)}, \tau(\mathcal{N}_{\mathcal{V}(\mathcal{H}2)})]$ then both graphs are isomorphic.

Step:5 Otherwise, we conclude that both the electrical circuits are entirely different.

Remark 3.3. Using the above algorithm to check that two electrical circuits are structurally equivalent.

Step:1 Consider the following basic circuit of the LED light. Using the above algorithm, we can prove whether these two circuits have functional similarities via neutrosophic nano topology induced by the vertices of its neutrosophic nano sub graphs (Figure 1).

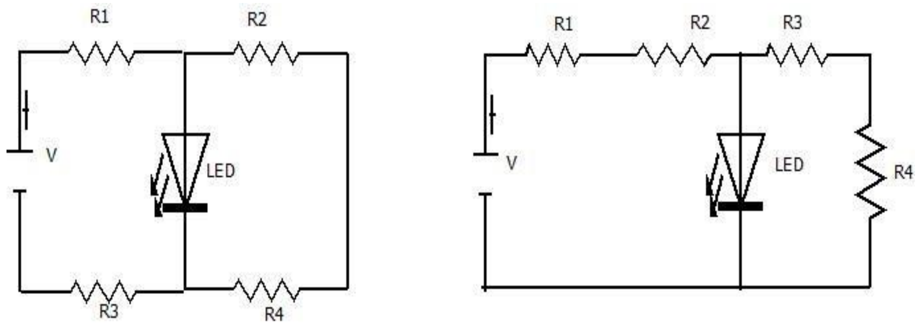
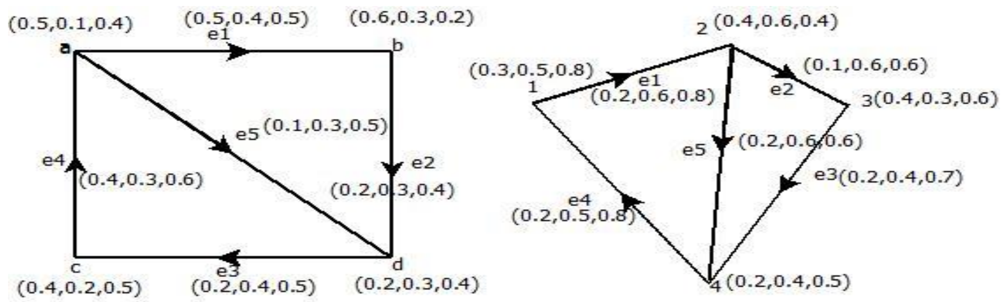


Figure 1

E1 E2

Step:2 Convert the basic circuit $\mathcal{E}1$ and $\mathcal{E}2$ into neutrosophic nano graphs $\mathcal{N}_{\mathcal{G}1}$ and $\mathcal{N}_{\mathcal{G}2}$ respectively. (Figure 2).



NG1 Figure 2 NG2

Step:3 Let $\mathcal{N}_{\mathcal{G}1}$ and $\mathcal{N}_{\mathcal{G}2}$ be two neutrosophic nano graphs.

Then $\mathcal{N}_{\mathcal{V}(\mathcal{G}1)} = \{a, b, c, d\}$ and $\mathcal{N}_{\mathcal{V}(\mathcal{G}2)} = \{1,2,3,4\}$, then the neighborhood of both graphs are $\mathcal{N}_n[d] = \{c, d\}$, $\mathcal{N}_n[c] = \{a, c\}$, $\mathcal{N}_n[b] = \{b, d\}$, $\mathcal{N}_n[a] = \{a, b, d\}$, and , $\mathcal{N}_n[1] = \{1,2\}$ Then the one to one mapping is defined as follows: .$\mathcal{N}_n[4] = \{1,4\}$, $\mathcal{N}_n[3] = \{3,4\}$, $\mathcal{N}_n[2] = \{2,3,4\}$

$f(a) = 2, f(b) = 3, f(c) = 1, f(d) = 4.$

Here f is a bijection between every pair of vertices $\mathcal{N}_{\mathcal{G}1}$ and $\mathcal{N}_{\mathcal{G}2}$, the path between every pair of vertices are equal.

Now, we prove that f is open map. Let us consider the two vertices, $\mathcal{V}(\mathcal{H}) = \{a, c\}$ and $\mathcal{V}(f(\mathcal{H})) = \{1,2\}$, then the neutrosophic nano topology of these two vertices are $\tau_{\mathcal{N}}\big(\mathcal{V}(\mathcal{H})\big) = \{\mathcal{V}(\mathcal{G}1), \varphi, \{a, c\}, \{b, d\}\}$and $\tau_{\mathcal{N}}\big(\mathcal{V}(\mathcal{H})\big) = \{\mathcal{V}(\mathcal{G}2), \varphi, \{1,2\}, \{3,4\}\}$. Hence the function are homeomorphism. Then the function f

$\varphi: [\mathcal{V}(\mathcal{G}1), \tau_{\mathcal{N}}(\mathcal{V}(\mathcal{H}))] \rightarrow [\mathcal{V}(\mathcal{G}2), \tau_{\mathcal{N}}(\mathcal{V}(\mathcal{H}))]$ is a neutrosophic nano homeomorphism. This holds for every sub graph $\mathcal{H}$ of $\mathcal{G}$.

Step:4 From the above given neutrosophic nano topology, it is concluded that all the sub graphs are neutrosophic nano homeomorphism. Hence the two different graphs are isomorphic, that is structural equivalence from the table 3.

Step:5 **Observation:** If all the sub graphs are neutrosophic nano homeomorphism then the two graphs are called neutrosophic nano isomorphism, which are structural equivalence. Using the above structural equivalence technique, we can check whether two circuits are equivalent and we can also extend our theory to many industrial products.

Table:1 Possible sub graph of $\mathcal{N}_{G1}$

$\mathcal{V}(\mathcal{H}1)$	$\mathcal{N}_L[\mathcal{V}(\mathcal{H}1)]$	$\mathcal{N}_U[\mathcal{V}(\mathcal{H}1)]$	$\mathcal{N}_B[\mathcal{V}(\mathcal{H}1)]$	$\tau_{\mathcal{N}}[\mathcal{V}(\mathcal{H}1)]$
$\{a\}$	φ	$\{a,b,d\}$	$\{a,b,d\}$	$\{V(G1),\ \varphi,\ \{a,b,d\}\}$
$\{b\}$	φ	$\{b,d\}$	$\{b,d\}$	$\{V(G1),\ \varphi,\ \{b,d\}\}$
$\{c\}$	φ	$\{a,c\}$	$\{a,c\}$	$\{V(G1),\ \varphi,\ \{a,c\}\}$
$\{d\}$	φ	$\{c,d\}$	$\{c,d\}$	$\{V(G1),\ \varphi,\ \{c,d\}\}$
$\{a,b\}$	φ	$\{a,b,d\}$	$\{a,b,d\}$	$\{V(G1),\ \varphi,\ \{a,b,d\}\}$
$\{b,c\}$	φ	$V(G1)$	$V(G1)$	$\{V(G1),\ \varphi\}$
$\{c,d\}$	$\{c,d\}$	$\{a,c,d\}$	$\{a\}$	$\{V(G1),\ \varphi,\ \{a\},\ \{c,d\},\{a,c,d\}\}$
$\{a,d\}$	φ	$V(G1)$	$V(G1)$	$\{V(G1),\ \varphi\}$
$\{a,c\}$	$\{a,c\}$	$V(G1)$	$\{b,d\}$	$\{V(G1),\ \varphi,\ \{a,c\},\ \{b,d\}\}$
$\{b,d\}$	$\{b,d\}$	$\{b,c,d\}$	$\{c\}$	$\{V(G1),\ \varphi,\{c\},\ \{b,d\},\ \{b,c,d\}\}$
$\{a,b,c\}$	$\{a,c\}$	$V(G1)$	$\{b,d\}$	$\{V(G1),\ \varphi,\ \{a,c\},\ \{b,d\}\}$
$\{a,b,d\}$	$\{a,b,d\}$	$V(G1)$	$\{c\}$	$\{V(G1),\ \varphi,\ \{c\},\ \{a,b,d\}\}$
$\{b,c,d\}$	$\{b,c,d\}$	$V(G1)$	$\{a\}$	$\{V(G1),\ \varphi,\ \{a\},\ \{b,c,d\}\}$
$\{a,c,d\}$	$\{a,c,d\}$	$V(G1)$	$\{b\}$	$\{V(G1),\ \varphi,\ \{b\},\ \{a,c,d\}\}$
$V(G1)$	$V(G1)$	$V(G1)$	φ	$\{V(G1),\ \varphi\}$
φ	φ	φ	φ	$\{V(G1),\ \varphi\}$

Table:2 Possible sub graph of $\mathcal{N}_{G2}$

$\mathcal{V}(\mathcal{H}2)$	$\mathcal{N}_L[\mathcal{V}(\mathcal{H}2)]$	$\mathcal{N}_U[\mathcal{V}(\mathcal{H}2)]$	$\mathcal{N}_B[\mathcal{V}(\mathcal{H}2)]$	$\tau_{\mathcal{N}}[\mathcal{V}(\mathcal{H}2)]$
$\{1\}$	φ	$\{1,2\}$	$\{1,2\}$	$\{V(G2),\ \varphi,\ \{1,2\}\}$
$\{2\}$	φ	$\{2,3,4\}$	$\{2,3,4\}$	$\{V(G2),\ \varphi,\ \{2,3,4\}\}$
$\{3\}$	φ	$\{3,4\}$	$\{3,4\}$	$\{V(G2),\ \varphi,\ \{3,4\}\}$
$\{4\}$	φ	$\{1,4\}$	$\{1,4\}$	$\{V(G2),\ \varphi,\ \{1,4\}\}$
$\{1,2\}$	$\{1,2\}$	$V(G2)$	$\{3,4\}$	$\{V(G2),\ \varphi,\ \{1,2\},\ \{3,4\}\}$
$\{2,3\}$	φ	$\{2,3,4\}$	$\{2,3,4\}$	$\{V(G2),\ \varphi,\ \{2,3,4\}\}$
$\{3,4\}$	$\{3,4\}$	$\{1,3,4\}$	$\{1\}$	$\{V(G2),\ \varphi,\ \{1\},\ \{3,4\},\{1,3,4\}\}$
$\{1,4\}$	$\{1,4\}$	$\{1,2,4\}$	$\{2\}$	$\{V(G2),\ \varphi,\{2\},\ \{1,4\},\ \{1,2,4\}\}$
$\{1,3\}$	φ	$V(G2)$	$V(G2)$	$\{V(G2),\ \varphi\}$
$\{2,4\}$	φ	$\{2,3,4\}$	$\{2,3,4\}$	$\{V(G2),\ \varphi,\ \{2,3,4\}\}$
$\{1,2,3\}$	$\{1,2\}$	$V(G2)$	$\{3,4\}$	$\{V(G2),\ \varphi,\ \{1,2\},\ \{3,4\}\}$
$\{1,2,4\}$	$\{1,2,4\}$	$V(G2)$	$\{3\}$	$\{V(G2),\ \varphi,\ \{3\},\ \{1,2,4\}\}$
$\{2,3,4\}$	$\{2,3,4\}$	$V(G2)$	$\{1\}$	$\{V(G2),\ \varphi,\ \{1\},\ \{2,3,4\}\}$
$\{1,3,4\}$	$\{1,3,4\}$	$V(G2)$	$\{2\}$	$\{V(G2),\ \varphi,\ \{2\},\ \{1,3,4\}\}$
$V(G2)$	$V(G2)$	$V(G2)$	φ	$\{V(G2),\ \varphi\}$
φ	φ	φ	φ	$\{V(G2),\ \varphi\}$

Table:3 Neutrosophic Nano Isomorphic Table

$\mathcal{V}(\mathcal{H})$	$\tau_{\mathcal{N}}[\mathcal{V}(\mathcal{H})]$	$\mathcal{V}[f(\mathcal{H})]$	$\tau_{\mathcal{N}}[\mathcal{V}[f(\mathcal{H})]]$
$\{a\}$	$\{V(G1),\ \varphi,\ \{a,b,d\}\}$	$\{2\}$	$\{V(G2),\ \varphi,\ \{2,3,4\}\}$
$\{b\}$	$\{V(G1),\ \varphi,\ \{b,d\}\}$	$\{3\}$	$\{V(G2),\ \varphi,\ \{3,4\}\}$
$\{c\}$	$\{V(G1),\ \varphi,\ \{a,c\}\}$	$\{1\}$	$\{V(G2),\ \varphi,\ \{1,2\}\}$
$\{d\}$	$\{V(G1),\ \varphi,\ \{c,d\}\}$	$\{4\}$	$\{V(G2),\ \varphi,\ \{1,4\}\}$
$\{a,b\}$	$\{V(G1),\ \varphi,\ \{a,b,d\}\}$	$\{2,3\}$	$\{V(G2),\ \varphi,\ \{2,3,4\}\}$
$\{b\ ,c\}$	$\{V(G1),\ \varphi\}$	$\{1,3\}$	$\{V(G2),\ \varphi\}$
$\{c,d\}$	$\{V(G1),\ \varphi,\ \{a\},\ \{c,d\},\{a,c,d\}\}$	$\{1,4\}$	$\{V(G2),\ \varphi,\ \{2\},\ \{1,4\},\ \{1,2,4\}\}$
$\{a,d\}$	$\{V(G1),\ \varphi\}$	$\{2,4\}$	$\{V(G2),\ \varphi\}$
$\{a,c\}$	$\{V(G1),\ \varphi,\ \{a,c\},\ \{b,d\}\}$	$\{1,2\}$	$\{V(G2),\ \varphi,\ \{1,2\},\ \{3,4\}\}$
$\{b,d\}$	$\{V(G1),\ \varphi,\{c\},\ \{b,d\},\ \{b,c,d\}\}$	$\{3,4\}$	$\{V(G2),\ \varphi,\ \{1\},\ \{3,4\},\{1,3,4\}\}$
$\{a,b,c\}$	$\{V(G1),\ \varphi,\ \{a,c\},\ \{b,d\}\}$	$\{1,2,3\}$	$\{V(G2),\ \varphi,\ \{1,2\},\ \{3,4\}\}$
$\{a,b,d\}$	$\{V(G1),\ \varphi,\ \{c\},\ \{a,b,d\}\}$	$\{2,3,4\}$	$\{V(G2),\ \varphi,\ \{1\},\ \{2,3,4\}\}$
$\{b,c,d\}$	$\{V(G1),\ \varphi,\ \{a\},\ \{b,c,d\}\}$	$\{1,3,4\}$	$\{V(G2),\ \varphi,\ \{2\},\ \{1,3,4\}\}$
$\{a,c,d\}$	$\{V(G1),\ \varphi,\ \{b\},\ \{a,c,d\}\}$	$\{1,2,4\}$	$\{V(G2),\ \varphi,\ \{3\},\ \{1,2,4\}\}$
$V(G1)$	$\{V(G1),\ \varphi\}$	$V(G2)$	$\{V(G2),\ \varphi\}$
φ	$\{V(G1),\ \varphi\}$	φ	$\{V(G2),\ \varphi\}$

Conclusion:

The purpose of the present work was to make headway for the application of neutrosophic nano topology via graph theory. We believe that neutrosophic nano topological graph structure will be an important base for modification of knowledge extraction and processing.

The aim of this paper was to generate neutrosophic nano topological structure on the power set of vertices of simple neutrosophic digraphs, by using new definition neutrosophic neighbourhood. Based on the neutrosophic neighborhood, we define the approximations of the subgraphs of a graph. A new neutrosophic nano topological graph have been used to analyze the symbolic circuit in this paper. By means of structural equivalence on neutrosophic nano topology induced by graph we have framed an algorithm for detecting patent infringement suit.

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