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Pairwise Neutrosophic *b*-Continuous Function in Neutrosophic Bitopological Spaces

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Abstract: The main focus of this article is to procurethe notions of pairwise neutrosophic continuous and pairwise neutrosophic *b*-continuous mappings in neutrosophic bitopological spaces. Then, we formulate some results on them via neutrosophic bitopological spaces.

Keywords: Neutrosophic Topology; Neutrosophic Bitopology; Pairwise Neutrosophic*b*-Interior; Pairwise Neutrosophic *b*-Closure; Pairwise Neutrosophic Continuous.

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1. Introduction

Zadeh [31] presented the notions of fuzzy set (in short FS) in the year 1965. Afterwards, Chang [4] applied the idea of topology on fuzzy sets and introduced the fuzzy topological space. In the year 2017, Dutta and Tripathy [15] studied on fuzzy *b*-θ open sets via fuzzy topological space. Later on, Smarandache [23] grounded the idea of neutrosophic set (in short N-set) in the year 1998, as anextension of the concept of intuitionistic fuzzy set (in short IF-set) [3], where every element has threeindependent memberships values namely truth, indeterminacy, and false membership values respectively. Afterwards, Salama and Alblowi [21] applied the notions of topology on N-sets and introduced neutrosophic topological space (in short NT-space) by extending the notions of fuzzy topological spaces. Salama and Alblowi [22] also defined generalized N-set and introduced the concept of generalized NT-space. Later on, Arokiarani et al. [2] introduced the ideas of neutrosophic point and studied some functions in neutrosophic topological spaces. The notions of neutrosophic pre-open (in short NP-O) and neutrosophic pre-closed (in short NP-C) sets via NT-spaces are studied by Rao and Srinivasa [20]. The idea of *b*-open sets via topological spaces was established by Andrijevic [1]. Afterwards, Ebenanjar et al. [16] presents the concept of neutrosophic *b*-open set (in short N-*b*-O-set) via NT-spaces. In the year 2020, Das and Pramanik [8] presents the generalized neutrosophic *b*-open sets in NT-spaces. The notions of neutrosophic Φ-open set and neutrosophic Φ-continuous functions via NT-spaces was also presented by Das and Pramanik [9]. The concept of neutrosophic simply soft open set in neutrosophic soft topological space was studied by Das and Pramanik [10]. In the year 2021, Das and Tripathy [14] presented the notions of neutrosophic simply *b*-open set via NT-spaces. In the year 2020, Das and Tripathy [12] grounded the notions of neutrosophic multiset and applied topology on it. In the year 2021, Das et al. [5] studied the concept of quadripartitioned neutrosophic topological spaces. The notion of bitopological space was introduced by Kelly [17] in the year 1963. In the year 2011, Tripathy and Sarma [26] studied on *b*-locally open sets via bitopological spaces. The idea of pairwise *b*-locally open and b-locally closed functions in bitopological spaces was studied by Tripathy and Sarma [27]. Tripathy and Sarma [28] also studied on weakly b-continuous mapping via bitopological spaces in the year 2013. Later on, the concept of generalized b-closed sets in ideal bitopological spaces was studied by Tripathy and Sarma [29]. Afterwards, Tripathy and Debnath [25] presented the notions of fuzzy b-locally open sets in fuzzy bitopological space. Thereafter, Ozturk and Ozkan [19] introduced the idea of neutrosophic bitopological space (in short NBi-T-space) in the year 2019. Recently, Das and Tripathy [13] presented the idea of pairwise N-b-O-sets and studied their different properties.

The main focus of this article is to procure the notions of pairwise τ_{ij}-neutrosophic-b-interior (in short P-τ_{ij}-$N_{b\text{-}int}$), pairwise τ_{ij}-neutrosophic-b-closure (in short P-τ_{ij}-$N_{b\text{-}cl}$), pairwise neutrosophic continuous mapping (in short P-N-C-mapping), pairwise neutrosophic b-continuous mapping (in short pairwise N-bC-mapping) via NBi-T-spaces.

2. Preliminaries and Definitions:

The notion of N-set is defined as follows:

Let X be a fixed set. Then, an N-set [23] L over X is denoted as follows:
$L=\{(t,T_L(t),I_L(t),F_L(t)):t\in X\}$, where T_L, I_L, F_L $:X\rightarrow[0,1]$ are called the truth-membership, indeterminacy-membership and false-membership functions and $0 \leq T_L(t) + I_L(t) + F_L(t)\leq 3$, for all $t\in X$.

The neutrosophic null set (0_N) and neutrosophic whole set (1_N) over a fixed set X are definedas follows:

(i) $0_N=\{(t,0,0,1): t\in X\}$;

(ii) $1_N=\{(t,1,0,0): t\in X\}$.

The N-sets 0_N and 1_N also has three other representations. They are given below:

$$0_N=\{(t,0,0,0): t\in X\} \ \& \ 1_N=\{(t,1,1,1): t\in X\};$$
$$0_N =\{(t,0,1,0): t\in X\} \ \& \ 1_N=\{(t,1,0,1): t\in X\};$$
$$0_N =\{(t,0,1,1): t\in X\} \ \& \ 1_N=\{(t,1,1,0): t\in X\}.$$

Let p, q, $r\in[0,1]$. An neutrosophic point (in short N-point) [2] $x_{p.q.r}$ is an N-set over X given by

$$x_{p.q.r}(y)=\begin{cases}(p,q,r), if\ x = y,\\ (0,0,1), if\ x \neq y,\end{cases}$$

where p, q, r denotes the truth, indeterminacy and false membership value of $x_{p.q.r}$.

The notion of NT-space is defined as follows:

A family τ of N-sets over X is called an [21] neutrosophic topology (in short N-topology) on X if the following axioms hold:

(i) 0_N, $1_N\in\tau$;

(ii) L_1, $L_2\in\tau\Rightarrow L_1\cap L_2\in\tau$;

(iii) $\cup L_i\in\tau$, for every $\{L_i: i\in\Delta\} \subseteq\tau$, where Δ is the support set.

Then, (X,τ) is called an NT-space. Each element of τ is an neutrosophic open set (in short NO-set). If L is an NO-set in (X, τ), then L^c is called an neutrosophic closed set (in short NC-set).

The notion of NBi-T-space is defined as follows:

Let τ_1 and τ_2 be two different N-topologies on X. Then, (X,τ_1,τ_2) is [19] called an NBi-T-space. An N-set L is called a pairwise NO-set in (X,τ_1,τ_2), if there exist an NO-set L_1 in τ_1 and an NO-set L_2 in τ_2 such that $L=L_1\cup L_2$. The complement of L i.e., L^c is called a pairwise neutrosophic closed set (in short pairwise NC-set) in (X,τ_1,τ_2).

Remark 2.1.[13] In an NBi-T-space(X,τ_1,τ_2), every τ_i-NO-set is a pairwise τ_{ij}-NO-set.

Remark 2.2. Let G be an N-set over X and (X,τ_1,τ_2) be an NBi-T-space. Then, we shall use the following notations throughout the article:

(*i*) $N_{cl}^{i}(G)$= Neutrosophic closure of G in (X,τ_i) (i=1, 2);

(*ii*) $N_{int}^{i}(G)$= Neutrosophic interior of G in (X,τ_i)(i=1, 2).

Definition 2.1.[13] Let (X,τ_1,τ_2) be an NBi-T-space. Then, P is called a

(*i*) τ_i-neutrosophic semi-open set (in short τ_i-NSO-set) if and only if $P\subseteq N_{cl}^{i}N_{int}^{i}(P)$;

(*ii*) τ_i-neutrosophic pre-open set (in short τ_i-NPO-set) if and only if $P\subseteq N_{int}^{i}N_{cl}^{i}(P)$;

(*iii*) τ_i-neutrosophic *b*-open set (in short τ_i-N-*b*O-set) if and only if $P\subseteq N_{cl}^{i}N_{int}^{i}(P)\cup N_{int}^{i}N_{cl}^{i}(P)$.

Remark 2.3.[13] Let (X,τ_1,τ_2) be an NBi-T-space. Then, an N-set P over X is called a τ_i-neutrosophic *b*-closed set (in short τ_i-N-*b*C-set) if and only if P^c is a τ_i-N-*b*O-set.

Proposition 2.1.[13] In an NBi-T-space (X,τ_1,τ_2), if P is τ_i-NSO-set (τ_i-NPO-set), then P is a τ_i-N-*b*O-set.

Proposition 2.2.[13] Let (X,τ_1,τ_2) be an NBi-T-space. Then, the union of any two τ_i-N-*b*O-sets is a τ_i-N-*b*O-set.

Definition 2.2.[13] Let (X,τ_1,τ_2) be an NBi-T-space. Then, P is called a

(*i*) τ_{ij}-neutrosophic semi-open set (in short τ_{ij}-NSO-set) if and only if $P\subseteq N_{cl}^{i}N_{int}^{j}(P)$;

(*ii*) τ_{ij}-neutrosophic pre-open set (in short τ_{ij}-NPO-set) if and only if $P\subseteq N_{int}^{j}N_{cl}^{i}(P)$;

(*iii*) τ_{ij}-neutrosophic *b*-open set (in short τ_{ij}-N-*b*-O-set) if and only if $P\subseteq N_{cl}^{i}N_{int}^{j}(P)\cup N_{int}^{j}N_{cl}^{i}(P)$.

Remark 2.4.[13] An N-set L over X is called a τ_{ij}-neutrosophic *b*-closed set (in short τ_{ij}-N-*b*C-set) if and only if L^c is a τ_{ij}-N-*b*O-set in (X,τ_1,τ_2).

Theorem 2.1.[13] Let (X,τ_1,τ_2) be an NBi-T-space. Then, every τ_{ij}-NSO-set (τ_{ij}-NPO-set) is a τ_{ij}-N-*b*O-set.

Definition 2.3.[13] An N-set L is called a pairwise τ_{ij}-NPO-set (pairwise τ_{ij}-NSO-set) in an NBi-T-space(X,τ_1,τ_2) if $L=K\cup M$, where K is a τ_{ij}-NPO-set (τ_{ij}-NSO-set) and M is a τ_{ji}-NPO-set (τ_{ji}-NSO-set) in (X,τ_1,τ_2).

Definition 2.4.[13] An N-set L is called a pairwise τ_{ij}-N-*b*O-set in a NBi-T-space(X,τ_1,τ_2) if $L=K\cup M$, where K is a τ_{ij}-N-*b*O-set and M is a τ_{ji}-N-*b*O-set in (X,τ_1,τ_2). If L is a pairwise τ_{ij}-N-*b*O-set in (X,τ_1,τ_2), then L^c is called a pairwise τ_{ij}-neutrosophic-*b*-closed set (in short pairwise τ_{ij}-N-*b*C-set) in (X,τ_1,τ_2).

Lemma 2.1.[13] In an NBi-T-space(X,τ_1,τ_2), every pairwise τ_{ij}-NPO-set (pairwise τ_{ij}-NSO-set) is a pairwise τ_{ij}-N-*b*O-set.

Proposition 2.3.[13] Let(X,τ_1,τ_2) be an NBi-T-space. Then, the union of two pairwise τ_{ij}-N-*b*O-set in (X,τ_1,τ_2) is also a pairwise τ_{ij}-N-*b*O-set.

Theorem 2.2. Let (X,τ_1,τ_2) be an NBi-T-space. Then, the union of two pairwise τ_{ij}-NSO-set in (X,τ_1,τ_2) is also a pairwise τ_{ij}-NSO-set.

Proof. Let L and M be two pairwise τ_{ij}-NSO-sets in an NBi-T-space(X,τ_1,τ_2). So, one can write $L=L_1\cup L_2$ and $M=M_1\cup M_2$, where L_1, M_1 are τ_{ij}-NSO-sets and L_2, M_2 are τ_{ji}-NSO-sets in (X,τ_1,τ_2). Since, L_1 and M_1 are τ_{ij}-NSO-sets, so $L_1\subseteq N_{cl}^{i}N_{int}^{j}(L_1)$ and $M_1\subseteq N_{cl}^{i}N_{int}^{j}(M_1)$. Further, Since L_2 and M_2 are τ_{ji}-NSO-sets, so $L_2\subseteq N_{cl}^{j}N_{int}^{i}(L_2)$, $M_2\subseteq N_{cl}^{j}N_{int}^{i}(M_2)$.

Now, $L\cup M=(L_1\cup L_2)\cup(M_1\cup M_2)=(L_1\cup M_1)\cup(L_2\cup M_2)$.

Therefore, $L_1\cup M_1 \subseteq N_{cl}^{i}N_{int}^{j}(L_1)\cup N_{cl}^{i}N_{int}^{j}(M_1)$

$=N_{cl}^{i}(N_{int}^{j}(L_1)\cup N_{int}^{j}(M_1))$

$\subseteq N_{cl}^{i}N_{int}^{j}(L_1\cup M_1)$.

This implies, $L_1\cup M_1$ is a τ_{ij}-NSO-set in (X,τ_1,τ_2).

Similarly, it can be established that $L_2\cup M_2$ is a τ_{ji}-NSO-set in (X,τ_1,τ_2). Therefore, $L\cup M$ is a pairwise τ_{ij}-NSO-set in (X,τ_1,τ_2). Hence, the union of two pairwise τ_{ij}-NSO-set in (X,τ_1,τ_2) is again a pairwise τ_{ij}-NSO-set in (X,τ_1,τ_2).

Theorem 2.4. Let (X,τ_1,τ_2) be an NBi-T-space. Then, the union of two pairwise τ_{ij}-NPO-set in (X,τ_1,τ_2) is a pairwise τ_{ij}-NPO-set.

Proof. Let L and M be two pairwise τ_{ij}-NPO-sets in an NBi-T-space(X,τ_1,τ_2). So, one can write $L=L_1\cup L_2$ and $M=M_1\cup M_2$, where L_1, M_1 are τ_{ij}-NPO-sets and L_2, M_2 are τ_{ji}-NPO-sets in (X,τ_1,τ_2). Since, L_1 and M_1 are τ_{ij}-NPO-sets, so $L_1\subseteq N_{int}^{j}N_{cl}^{i}(L_1)$ and $M_1\subseteq N_{int}^{j}N_{cl}^{i}(M_1)$. Further, since L_2 and M_2 are τ_{ji}-NPO-sets, so $L_2\subseteq N_{int}^{i}N_{cl}^{j}(L_2)$ and $M_2\subseteq N_{int}^{i}N_{cl}^{j}(M_2)$.

Now, $L\cup M=(L_1\cup L_2)\cup(M_1\cup M_2)=(L_1\cup M_1)\cup(L_2\cup M_2)$.

Therefore, $L_1\cup M_1 \subseteq N_{int}^{j}N_{cl}^{i}(L_1)\cup N_{int}^{j}N_{cl}^{i}(M_1)$

$=N_{int}^{j}(N_{cl}^{i}(L_1)\cup N_{cl}^{i}(M_1))$

$\subseteq N_{int}^{j}N_{cl}^{i}(L_1\cup M_1)$.

This implies, $L_1\cup M_1$ is a τ_{ij}-NPO-set in (X,τ_1,τ_2). Similarly, it can be established that $L_2\cup M_2$ is a τ_{ji}-NPO-set in (X,τ_1,τ_2). Therefore, $L\cup M$ is a pairwise τ_{ij}-NPO-set in (X,τ_1,τ_2). Hence, the union of two pairwise τ_{ij}-NPO-sets in (X,τ_1,τ_2) is again a pairwise τ_{ij}-NPO-set.

3. Pairwise *b*-Continuous Function:

In this section, we procure the notions of pairwise *b*-continuous functions via neutrosophic bitopological space and formulate some results on it.

Definition 3.1. Let (X,τ_1,τ_2) be an NBi-T-space. Then, the pairwise τ_{ij}-neutrosophic-*b*-interior (in short P-τ_{ij}-$N_{b\text{-}int}$) of an N-set L is the union of all pairwise τ_{ij}-N-*b*O-sets contained in L, i.e. P-τ_{ij}-$N_{b\text{-}int}(L)=\cup\{K:K$ is a pairwise τ_{ij}-N-*b*O-set in X and $K\subseteq L\}$.

Clearly, P-τ_{ij}-$N_{b\text{-}int}(L)$ is the largest pairwise τ_{ij}-N-*b*O-set which contained in L.

Definition 3.2. Let (X,τ_1,τ_2) be an NBi-T-space. Then, the pairwise τ_{ij}-neutrosophic-*b*-closure (in short P-τ_{ij}-$N_{b\text{-}cl}$) of an N-set L is the intersection of all pairwise τ_{ij}-N-*b*C-sets containing L, i.e. P-τ_{ij}-$N_{b\text{-}cl}(L)=\cap\{K:K$ is a pairwise τ_{ij}-N-*b*C-set in X and $L\subseteq K\}$.

Clearly, P-τ_{ij}-$N_{b\text{-}cl}(L)$ is the smallest pairwise τ_{ij}-N-*b*C-set which containing L.

Theorem 3.1. Let L and K be two neutrosophic subsets of an NBi-T-space (X,τ_1,τ_2). Then,

(*i*) P-τ_{ij}-$N_{b\text{-}int}(0_N)=0_N$, P-$\tau_{ij}$-$N_{b\text{-}int}(1_N)=1_N$;

(*ii*) P-τ_{ij}-$N_{b\text{-}int}(L)\subseteq L$;

(*iii*) $L\subseteq M\Rightarrow$ P-τ_{ij}-$N_{b\text{-}int}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}int}(M)$;

(iv) P-τ_{ij}-$N_{b\text{-}int}(L)=L$ if L is a pairwise τ_{ij}-N-bO-set.

Proof. (i) Straight forward.

(ii) By Definition 3.1, we have P-τ_{ij}-$N_{b\text{-}int}(L)=\cup\{K:K$ is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}$. Since, each $K\subseteq L$, so $\cup\{K:K$ is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}\subseteq L$, i.e. P-$\tau_{ij}$-$N_{b\text{-}int}(L)\subseteq L$. Therefore, P-$\tau_{ij}$-$N_{b\text{-}int}(L)\subseteq L$.

(iii) Let L and M be two neutrosophic subset of an NBi-T-space (X,τ_1,τ_2) such that $L\subseteq M$.

Now, P-τ_{ij}-$N_{b\text{-}int}(L)=\cup\{K:K$ is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}$

$\subseteq\cup\{K:K$ is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq M\}$ [since $L\subseteq M$]

=P-τ_{ij}-$N_{b\text{-}int}(M)$

$\Rightarrow$ P-τ_{ij}-$N_{b\text{-}int}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}int}(M)$.

Therefore, $L\subseteq M\Rightarrow$P-τ_{ij}-$N_{b\text{-}int}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}int}(M)$.

(iv) Let L be a pairwise τ_{ij}-N-bO-set in an NBi-T-space (X,τ_1,τ_2).

Now, P-τ_{ij}-$N_{b\text{-}int}(L)=\cup\{K$: K is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}$. Since, L is a pairwise τ_{ij}-N-bO-set in (X,τ_1,τ_2), so L is the largest pairwise τ_{ij}-N-bO-set in (X,τ_1,τ_2), which is contained in L. Therefore, $\cup\{K:K$ is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}=L$. This implies, P-τ_{ij}-$N_{b\text{-}int}(L)=L$.

Theorem 3.2. Let L and K be two neutrosophic subsets of an NBi-T-space (X,τ_1,τ_2). Then,

(i) P-τ_{ij}-$N_{b\text{-}cl}(0_N)=0_N$ & P-τ_{ij}-$N_{b\text{-}cl}(1_N)=1_N$;

(ii) $L\subseteq$P-τ_{ij}-$N_{b\text{-}cl}(L)$;

(iii) $L\subseteq M\Rightarrow$ P-τ_{ij}-$N_{b\text{-}cl}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}cl}(M)$;

(iv) P-τ_{ij}-$N_{b\text{-}cl}(L)=L$ if L is a pairwise τ_{ij}-N-bC-set.

Proof. (i) Straightforward.

(ii) It is clear that P-τ_{ij}-$N_{b\text{-}cl}(L)=\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}$.

Since, each $L\subseteq K$, so $L\subseteq\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}$, i.e. $L\subseteq$P-τ_{ij}-$N_{b\text{-}cl}(L)$.

(iii) Let L and M be two neutrosophic subset of an NBi-T-space (X,τ_1,τ_2) such that $L\subseteq M$.

Now, P-τ_{ij}-$N_{b\text{-}cl}(L)=\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}$.

$\subseteq\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $M\subseteq K\}$ [since $L\subseteq M$]

=P-τ_{ij}-$N_{b\text{-}cl}(M)$

$\Rightarrow$ P-τ_{ij}-$N_{b\text{-}cl}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}cl}(M)$.

Therefore, $L\subseteq M\Rightarrow$P-τ_{ij}-$N_{b\text{-}cl}(L)\subseteq$P-$\tau_{ij}$-$N_{b\text{-}cl}(M)$.

(iv) Let L be a pairwise τ_{ij}-N-bC-set in an NBi-T-space (X,τ_1,τ_2). Now, P-τ_{ij}-$N_{b\text{-}cl}(L)=\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}$. Since, L is a pairwise τ_{ij}-N-bC-set in a (X,τ_1,τ_2), so L is the smallest pairwise τ_{ij}-N-bC-set, which contains L. This implies, $\cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}=L$. Therefore, P-τ_{ij}-$N_{b\text{-}cl}(L)=L$.

Proposition 3.3. Let L be a neutrosophic subset of an NBi-T-space (X,τ_1,τ_2). Then,

(i) [P-τ_{ij}-$N_{b\text{-}int}(L)]^c$ =P-τ_{ij}-$N_{b\text{-}cl}(L^c)$;

(ii) [P-τ_{ij}-$N_{b\text{-}cl}(L)]^c$ =P-τ_{ij}-$N_{b\text{-}int}(L^c)$.

Proof. (i) Let (X,τ_1,τ_2) be an NBi-T-space. Let $L=\{(w, T_L(w), I_L(w), F_L(w)): w\in X\}$ be an neutrosophic subset of (X,τ_1,τ_2).

Now, P-τ_{ij}-$N_{b\text{-}int}(L)$ =$\cup\{K$: K is a pairwise τ_{ij}-N-bO-set in X and $K\subseteq L\}$

$=\{(w,\vee T_{L_p}(w),\wedge I_{L_p}(w),\wedge F_{L_p}(w)):w\in X\}$,

where L_p is a pairwise τ_{ij}-N-bO-set in X such that $L_p\subseteq L$, for each $p\in\Delta$.

This implies, $[P\text{-}\tau_{ij}\text{-}N_{b\text{-}int}(L)]^c=\{(w,\wedge T_{L_p}(w),\vee I_{L_p}(w),\vee F_{L_p}(w)):w\in X\}$.

Here $\wedge T_{L_p}(w)\leq T_L(w), I_{L_p}(w)\geq I_L(w), F_{L_p}(w)\geq F_L(w)$, for each $w\in X$.

Therefore, $P\text{-}\tau_{ij}\text{-}N_{b\text{-}int}(L^c)=\{(w, \wedge T_{L_p}(w), \vee I_{L_p}(w),\vee F_{L_p}(w)): w\in X\}$

$=\cap\{L_p: p\in\Delta$ and L_p is a pairwise τ_{ij}-N-bC-set in X such that $L^c\subseteq L_p\}$

Hence, $[P\text{-}\tau_{ij}\text{-}N_{b\text{-}int}(L)]^c = P\text{-}\tau_{ij}\text{-}N_{b\text{-}cl}(L^c)$.

(*ii*) Let (X,τ_1,τ_2) be an NBi-T-space and $L=\{(w, T_L(w), I_L(w), F_L(w)): w\in X\}$ be a N-set over X. Then,

$P\text{-}\tau_{ij}\text{-}N_{b\text{-}cl}(L) = \cap\{K:K$ is a pairwise τ_{ij}-N-bC-set in X and $L\subseteq K\}$

$=\{(w,\wedge T_{L_p}(w),\vee I_{L_p}(w),\vee F_{L_p}(w)):w\in X\}$,

where L_p is a pairwise τ_{ij}-N-bC-set in X such that $L\subseteq L_p$, for each $p\in\Delta$.

This implies, $[P\text{-}\tau_{ij}\text{-}N_{b\text{-}cl}(L)]^c = \{(w,\vee T_{L_p}(w),\wedge I_{L_p}(w),\wedge F_{L_p}(w)):w\in X\}$.

Here, $\vee T_{L_p}(w)\geq T_L(w),\wedge I_{L_p}(w)\leq I_L(w),\wedge F_{L_p}(w)\leq F_L(w)$, for each $w\in X$.

Therefore, $P\text{-}\tau_{ij}\text{-}N_{b\text{-}int}(L^c)=\{(w,\vee T_{L_p}(w),\wedge I_{L_p}(w),\wedge F_{L_p}(w)):w\in X\}$

$=\cup\{L_p: p\in\Delta$ and L_p is a pairwise τ_{ij}-N-bO-set in X such that $L_p\subseteq L^c\}$.

Hence, $[P\text{-}\tau_{ij}\text{-}N_{b\text{-}cl}(L)]^c= P\text{-}\tau_{ij}\text{-}N_{b\text{-}int}(L^c)$.

Theorem 3.1. Let (X,τ_1,τ_2) be an NBi-T-space. Then, the neutrosophic null set (0_N) and the neutrosophic whole set (1_N) are both τ_{ij}-N-bO-set and τ_{ji}-N-bO-set.

Proof. Let (X,τ_1,τ_2) be an NBi-T-space. Now, $N_{cl}^iN_{int}^j(0_N)\cup N_{int}^jN_{cl}^i(0_N)=N_{cl}^i(0_N)\cup N_{int}^j(0_N)= 0_N\cup 0_N=0_N$. Therefore, $0_N\subseteq 0_N=N_{cl}^iN_{int}^j(0_N)\cup N_{int}^jN_{cl}^i(0_N)$. Hence, the neutrosophic null set (0_N) is a τ_{ij}-N-bO-set.

Similarly, it can be established that the neutrosophic null set (0_N) is a τ_{ji}-N-bO-set.

Further, one can show that the neutrosophic whole set (1_N) are both τ_{ij}-N-bO-set and τ_{ji}-N-bO-set.

Theorem 3.2. In an NBi-T-space(X,τ_1,τ_2), every τ_i-NO-set is a τ_{ji}-N-bO-set.

Proof. Let L be a τ_i-NO-set in an NBi-T-space(X,τ_1,τ_2). Therefore, $N_{int}^i(L)=L$. Now,$L\subseteq N_{cl}^j(L)= N_{cl}^jN_{int}^i(L)$. This implies, $L\subseteq N_{cl}^jN_{int}^i(L)\cup N_{int}^iN_{cl}^j(L)$. Hence, L is a τ_{ji}-N-bO-set in (X,τ_1,τ_2).

Theorem 3.3. In an NBi-T-space (X,τ_1,τ_2),

(*i*) every τ_{ij}-N-bO-set is a pairwise τ_{ij}-N-bO-set;

(*ii*) every τ_{ji}-N-bO-set is a pairwise τ_{ji}-N-bO-set;

(*iii*) every τ_{ij}-N-bC-set is a pairwise τ_{ij}-N-bC-set;

(*iv*) every τ_{ji}-N-bC-set is a pairwise τ_{ji}-N-bC-set.

Proof. (*i*) Let L be a τ_{ij}-N-bO-set in an NBi-T-space (X,τ_1,τ_2). Then, L can be expressed as $L=L\cup 0_N$, where L is a τ_{ij}-N-bO-set and 0_N is a τ_{ji}-N-bO-set in (X,τ_1,τ_2). This implies, L is a pairwise τ_{ij}-N-bO-set in (X,τ_1,τ_2).

(*ii*) Straightforward.

(*iii*) Let L be a τ_{ij}-NC-set in an NBi-T-space (X,τ_1,τ_2). Then, L can be expressed as $L=L\cap 1_N$, where L is a τ_{ij}-NC-set and 1_N is a τ_{ji}-NC-set in (X,τ_1,τ_2). This implies, L is a pairwise τ_{ij}-N-bC-set in (X,τ_1,τ_2).

(*iv*) Straightforward.

Theorem 3.4. In an NBi-T-Space (X,τ_1,τ_2), every τ_i-NO-set is a pairwise τ_{ij}-N-bO-set.

Proof. Let L be a τ_i-NO-set in an NBi-T-space(X,τ_1,τ_2). By Theorem 3.2., it is clear that L is a τ_{ji}-N-bO-set. Further, by Theorem 3.3., it is clear that L is a pairwise τ_{ij}-N-bO-set.

Theorem 3.5. Let (X,τ_1,τ_2) be an NBi-T-space. Then, 0_N and 1_N are both pairwise τ_{ij}-N-bO-set and pairwise τ_{ji}-N-bO-set.

Proof. Let (X,τ_1,τ_2) be an NBi-T-space. One can write $0_N=A\cup B$, where $A=0_N$ is a τ_{ij}-N-*b*O-set and $B=0_N$ is a τ_{ji}-N-*b*O-set in (X,τ_1,τ_2). This implies, 0_N is a pairwise τ_{ij}-N-*b*O-set in (X,τ_1,τ_2).

Similarly, it can be established that 0_N is a pairwise τ_{ji}-N-*b*O-set in (X,τ_1,τ_2).

Again, one can write $1_N=L\cup M$, where $L=1_N$ is a τ_{ij}-N-*b*O-set and $M=1_N$ is a τ_{ji}-N-*b*O-set in (X,τ_1,τ_2). This implies, 1_N is a pairwise τ_{ij}-N-*b*O-set in (X,τ_1,τ_2).

Similarly, it can be also established that 1_N is a pairwise τ_{ji}-N-*b*O-set in (X,τ_1,τ_2).

Theorem 3.6. Let (X,τ_1,τ_2) be an NBi-T-space. Then, both 0_N and 1_N are pairwise τ_{ij}-N-*b*C-set and pairwise τ_{ji}-N-*b*C-set.

Proof. By Theorem 3.5, it is clear that 0_N is both pairwise τ_{ij}-N-*b*O-set and pairwise τ_{ji}-N-*b*O-set. Hence, its complement 1_N is both pairwise τ_{ij}-N-*b*C-set and pairwise τ_{ji}-N-*b*C-set.

Similarly, from Theorem 3.5, it is clear that 1_N is both pairwise τ_{ij}-N-*b*O-set and pairwise τ_{ji}-N-*b*O-set. Hence, its complement 0_N is both pairwise τ_{ij}-N-*b*C-set and pairwise τ_{ji}-N-*b*C-set.

Remark 3.1. Throughout the article, we denote τ_{ij}^b as a collection of all pairwise τ_{ij}-N-*b*O-sets and τ_{ij}^C as a collection of all pairwise τ_{ij}-N-*b*C-sets in (X,τ_1,τ_2). The collection τ_{ij}^b forms an neutrosophic supra topology on X.

Definition 3.3. Let (X,τ_1,τ_2) and (Y,δ_1,δ_2) be two NBi-T-spaces. Then, an one to one and onto mapping $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is called a

(*i*) pairwise neutrosophic semi continuous mapping (in short P-NS-C-mapping) if and only if $\xi^{-1}(L)$ is a τ_i-NSO-set in X, whenever L is a pairwise δ_{ij}-NO-set in Y.

(*ii*) pairwise neutrosophic pre continuous mapping (in short P-NP-C-mapping) if and only if $\xi^{-1}(L)$ is a τ_i-NPO-set in X, whenever L is a pairwise δ_{ij}-NO-set in Y.

(*iii*) pairwise neutrosophic continuous mapping (in short P-N-C-mapping) if and only if $\xi^{-1}(L)$ is a τ_i-NO-set in X, whenever L is a pairwise δ_{ij}-NO-set in Y.

(*iv*) pairwise neutrosophic *b*-continuous mapping (in short P-N-*b*-C-mapping) if and only if $\xi^{-1}(L)$ is a τ_i-N-*b*O-set in X, whenever L is a pairwise δ_{ij}-NO-set in Y.

Theorem 3.7. Let (X,τ_1,τ_2) and (Y,δ_1,δ_2) be two NBi-T-spaces. Then, every P-N-C-mapping from (X,τ_1,τ_2) to (Y,δ_1,δ_2) is a P-NP-C-mapping (P-NS-C-mapping).

Proof. Let L be a pairwise δ_{ij}-NO-set in (Y,δ_1,δ_2). Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-C-mapping from (X,τ_1,τ_2) to (Y,δ_1,δ_2), so $\xi^{-1}(L)$ is a τ_i-NO-set in (X,τ_1,τ_2). It is known that every τ_i-NO-set is a τ_i-NPO-set (τ_i-NSO-set). Therefore, $\xi^{-1}(L)$ is a τ_i-NPO-set (τ_i-NSO-set) in (X,τ_1,τ_2). Hence, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-NP-C-mapping (P-NS-C-mapping).

Theorem 3.8. Let (X,τ_1,τ_2) and (Y,δ_1,δ_2) be two NBi-T-spaces. Then, every P-NS-C-mapping (P-NP-C-mapping) from (X,τ_1,τ_2) to (Y,δ_1,δ_2) is a P-N-*b*-C-mapping.

Proof. Let L be a pairwise δ_{ij}-NO-set in (Y,δ_1,δ_2). Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-NS-C-mapping (P-NP-C-mapping) from (X,τ_1,τ_2) to (Y,δ_1,δ_2), so $\xi^{-1}(L)$ is a τ_i-NSO-set (τ_i-NPO-set) in (X,τ_1,τ_2). It is known that, every τ_i-NSO-set (τ_i-NPO-set) is a τ_i-N-*b*O-set. Therefore, $\xi^{-1}(L)$ is a τ_i-N-*b*O-set in (X,τ_1,τ_2). Hence, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-*b*-C-mapping.

Theorem 3.9. Let (X,τ_1,τ_2) and (Y,δ_1,δ_2) be two NBi-T-spaces. Then, every P-N-C-mapping from (X,τ_1,τ_2) to (Y,δ_1,δ_2) is a P-N-*b*-C-mapping.

Proof. Let L be a pairwise δ_{ij}-NO-set in (Y,δ_1,δ_2). Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-C-mapping from (X,τ_1,τ_2) to (Y,δ_1,δ_2), so $\xi^{-1}(L)$ is a τ_i-NO-set in (X,τ_1,τ_2). It is known that, every τ_i-NO-set is a

τ_i-N-b-O-set. Therefore, $\xi^{-1}(L)$ is a τ_i-N-b-O-set in (X,τ_1,τ_2). Hence, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a p-N-b-C-mapping.

Theorem 3.10. If $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ and $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ be two P-N-C-mapping, then the composition mapping $\chi°\xi:(X,\tau_1,\tau_2)\rightarrow(Z,\theta_1,\theta_2)$ is also a P-N-C-mapping.

Proof. Let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ and $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ be two P-N-C-mappings. Let L be a pairwise θ_{ij}-NO-set in (Z,θ_1,θ_2). Since, $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ is a P-N-C-mapping, so $\chi^{-1}(L)$ is a δ_i-NO-set in Y. Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-C-mapping, so $\xi^{-1}(\chi^{-1}(L))= (\chi°\xi)^{-1}(L)$ is a τ_i-NO-set in X.

Theorem 3.11. If $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be an one to one and onto mapping between two NBi-T-spaces, then the following two are equivalent:

(*i*) ξ is a P-N-b-C-mapping.

(*ii*) $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A)) \subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$, for every neutrosophic subset A of Y.

Proof. (*i*)$\Rightarrow$(*ii*)

Let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a P-N-b-C-mapping. Let A be an neutrosophic subset of Y. Here, $\text{P-}\delta_{ij}\text{-}N_{int}(A)$ is a pairwise δ_{ij}-NO-set in Y and $\text{P-}\delta_{ij}\text{-}N_{int}(A)\subseteq A$. This implies, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))\subseteq\xi^{-1}(A)$. By the hypothesis, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))$ is a τ_i-N-b-O-set in X. Therefore, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))$ is a τ_i-N-b-O-set in X such that $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))\subseteq\xi^{-1}(A)$. It is known that $\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$ is the largest τ_i-N-b-O-set in X, which is contained in $\xi^{-1}(A)$. Hence, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$.

(*ii*)$\Rightarrow$(*i*)

Let A be a pairwise δ_{ij}-NO-set in (Y,δ_1,δ_2). Therefore, $\text{P-}\delta_{ij}\text{-}N_{int}(A)=A$. By hypothesis, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A))\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$. This implies, $\xi^{-1}(A)\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$. It is known that $\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))\subseteq\xi^{-1}(A)$. Therefore, $\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))=\xi^{-1}(A)$. Hence,$\xi^{-1}(A)$ is a τ_i-N-b-O-set in (X,τ_1,τ_2). Therefore, ξ is a P-N-b-C-mapping from an NBi-T-space (X,τ_1,τ_2) to another NBi-T-space (Y,δ_1,δ_2).

Theorem 3.12. An one to one and onto mapping $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping if and only if $\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A))\subseteq\xi(\tau_i\text{-}N_{b\text{-}int}(A))$, for every N-set A over X and i, j= 1,2, and $i\neq j$.

Proof. Let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a P-N-b-C-mapping. Let A be an N-set over X. Then, $\xi(A)$ is also an N-set over Y. By Theorem 3.11, we have $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A)))\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(\xi(A)))$. This implies, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A)))\subseteq\tau_i\text{-}N_{b\text{-}int}(A)$. Hence, $\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A))\subseteq\xi(\tau_i\text{-}N_{b\text{-}int}(A))$. Therefore, $\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A))\subseteq \xi(\tau_i\text{-}N_{b\text{-}int}(A))$, for every N-set A over X and i, j= 1,2; and $i\neq j$.

Conversely, let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a mapping between two NBi-T-spaces such that

$$\text{P-}\delta_{ij}\text{-}N_{int}(\xi(A))\subseteq\xi(\tau_i\text{-}N_{b\text{-}int}(A)) \quad (1)$$

for every N-set A overX and i, j = 1,2; and $i\neq j$.

Let A be an N-set over Y. Then, $\xi^{-1}(A)$ is an N-set over X. By putting $A=\xi^{-1}(A)$ in eq. (1), we have,

$\text{P-}\delta_{ij}\text{-}N_{int}(\xi(\xi^{-1}(A))) \subseteq\xi(\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A)))$

$\Rightarrow\text{P-}\delta_{ij}\text{-}N_{int}(A)\subseteq\xi(\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A)))$

$\Rightarrow\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A)\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$.

Therefore, $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(A)\subseteq\tau_i\text{-}N_{b\text{-}int}(\xi^{-1}(A))$, for every N-set A of Y. Hence, by Theorem 3.11., the mapping $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping.

Corollary 3.1. If $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is an one to one and onto mapping from an NBi-T-space (X,τ_1,τ_2) to another NBi-T-space (Y,δ_1,δ_2), then the following two are equivalent:

(*i*) ξ is a P-N-C-mapping.

(*ii*) $\xi^{-1}(\text{P-}\delta_{ij}\text{-}N_{int}(Q)) \subseteq\tau_i\text{-}N_{int}(\xi^{-1}(Q))$, for every N-set Q over$Y$.

Definition 3.4. Let (X,τ_1,τ_2) be an NBi-T-space. Let $x_{a,b,c}$ be an N-point in X. Then, an N-set Q over X is called a pairwise τ_{ij}-neutrosophic b-neighbourhood (in short P-τ_{ij}-N-b-nbd) of $x_{a,b,c}$, if there exist a pairwise τ_{ij}-N-bO-set U such that $x_{a,b,c}\in U\subseteq Q$.

Theorem 3.13. Let (X,τ_1,τ_2) be an NBi-T-space. An N-set Q over X is a pairwise τ_{ij}-N-bO-set if and only if Q is a P-τ_{ij}-N-b-nbd of all of its N-points.

Proof. Let Q be a pairwise τ_{ij}-N-bO-set in an NBi-T-space (X,τ_1,τ_2). Let $x_{a,b,c}$ be an N-point in X such that $x_{a,b,c}\in Q$. Therefore, $x_{a,b,c}\in Q\subseteq Q$. This implies, Q is a P-τ_{ij}-N-b-nbd of $x_{a,b,c}$. Hence, Q is the P-τ_{ij}-N-b-nbd of all of its N-points.

Conversely, let Q be a P-τ_{ij}-N-b-nbd of all of its N-points. Assume that $x_{a,b,c}$ be an N-point in X, such that $x_{a,b,c}\in Q$. Therefore, there exist a pairwise τ_{ij}-N-bO-set G such that $x_{a,b,c}\in G\subseteq Q$.
Now, $Q=\cup_{x_{a,b,c}\in Q} x_{a,b,c}\subseteq\cup_{x_{a,b,c}\in Q} G\subseteq\cup_{x_{a,b,c}\in Q} Q=Q$. This implies, $Q=\cup_{x_{a,b,c}\in Q} G$, which is a pairwise τ_{ij}-N-bO-set. Therefore, Q is a pairwise τ_{ij}-N-bO-set in (X,τ_1,τ_2).

Theorem 3.14. An one to one and onto mapping $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping if and only if for every N-point $x_{a,b,c}\in Y$ and for any P-δ_{ij}-N-b-nbd V of $x_{a,b,c}$ in Y, there exist a τ_i-neutrosophic-b-neighbourhood (in short τ_i-N-b-nbd) U of $\xi^{-1}(x_{a,b,c})$ in X such that $U\subseteq\xi^{-1}(V)$.

Proof. Let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a P-N-b-C-mapping. Let $x_{a,b,c}$ be an N-point in Y and V be a P-δ_{ij}-N-b-nbd of $x_{a,b,c}$. Then, there exist a pairwise δ_{ij}-NO-set G in Y such that $x_{a,b,c}\in G\subseteq V$. This implies, $\xi^{-1}(x_{a,b,c})\in\xi^{-1}(G)\subseteq\xi^{-1}(V)$. Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping, so $\xi^{-1}(G)$ is a τ_i-N-bO-set in X. By taking $U=\xi^{-1}(G)$, we see that U is a τ_i-N-bO-set in X such that $\xi^{-1}(x_{a,b,c})\in U\subseteq\xi^{-1}(V)$. Hence, $U=\xi^{-1}(G)$ is a τ_i-N-b-nbd of $\xi^{-1}(x_{a,b,c})$ and $U\subseteq\xi^{-1}(V)$.

Conversely, let for every N-point $x_{a,b,c}\in Y$ and for any P-δ_{ij}-N-nbd V of $x_{a,b,c}$ in Y, there exist a τ_i-N-b-nbd U of $\xi^{-1}(x_{a,b,c})$ in X such that $U\subseteq\xi^{-1}(V)$. Let G be a pairwise δ_{ij}-NO-set in Y and $x_{a,b,c}\in G$. By Theorem 3.13., G is a P-δ_{ij}-N-nbd of $x_{a,b,c}$. By hypothesis, there exists a τ_i-N-b-nbd H of $\xi^{-1}(x_{a,b,c})\in X$ such that $\xi^{-1}(x_{a,b,c})\in H\subseteq\xi^{-1}(G)$. This implies, $\xi^{-1}(G)$ is the τ_i-N-b-nbd of each of its N-points. Therefore, $\xi^{-1}(G)$ is a τ_i-N-bO-set in X. Hence, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping.

Theorem 3.15. If $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a P-N-b-C-mapping and $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ be a P-N-C-mapping, then the composition mapping $\chi\circ\xi:(X,\tau_1,\tau_2)\rightarrow(Z,\theta_1,\theta_2)$ is a P-N-b-C-mapping.

Proof. Let $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ be a P-N-b-C-mapping and $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ be a P-N-C-mapping. Let L be a pairwise θ_{ij}-NO-set in (Z,θ_1,θ_2). Since, $\chi:(Y,\delta_1,\delta_2)\rightarrow(Z,\theta_1,\theta_2)$ is a P-N-C-mapping, so $\chi^{-1}(L)$ is a δ_i-NO-set in Y. Now, by Lemma 2.1., it is clear that $\chi^{-1}(L)$ is a pairwise δ_{ij}-NO-set in (Y,δ_1,δ_2). Since, $\xi:(X,\tau_1,\tau_2)\rightarrow(Y,\delta_1,\delta_2)$ is a P-N-b-C-mapping, so $\xi^{-1}(\chi^{-1}(L))=(\chi\circ\xi)^{-1}(L)$ is a τ_i-NO-set in X. Since, every τ_i-NO-set is a τ_i-N-bO-set, so $(\chi\circ\xi)^{-1}(L)$ is a τ_i-N-bO-set in X. Hence, $\chi\circ\xi:(X,\tau_1,\tau_2)\rightarrow(Z,\theta_1,\theta_2)$ is a P-N-b-C-mapping.

4. Conclusion

In this article, we introduce the notion of pairwise neutrosophic-b-interior, pairwise neutrosophic-b-closure, pairw neutrosophic b-continuous mapping, we prove some propositions and theorems on NBi-T-spaces. In the future, we hope that based on these notions in NBi-T-spaces, many new investigations can be carried out.

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References:

[1]. Andrijevic, D. (1996). On *b*-open sets. *MatematickiVesnik*, 48, 59-64.

[2]. Arokiarani, I., Dhavaseelan, R., Jafari, S., & Parimala, M. (2017). On some new notations and functions in neutrosophic topological spaces. *Neutrosophic Sets and Systems*, 16, 16-19.

[3]. Atanassov, K. (1986). Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 20, 87-96.

[4]. Chang, C.L. (1968). Fuzzy Topological Spaces. *Journal of Mathematical Analysis and Applications*, 24, 182-190.

[5]. Das, S., Das, R., & Granados, C. (2021). Topology on Quadripartitioned Neutrosophic Sets. *Neutrosophic Sets and Systems*. (In Press).

[6]. Das, S., Das, R., Granados, C., & Mukherjee, A. (2021). Pentapartitioned Neutrosophic *Q*-Ideals of *Q*-Algebra. *Neutrosophic Sets and Systems*, 41, 52-63.

[7]. Das, S., Das, R., &Tripathy, B.C. (2020). Multi-criteria group decision making model using single-valued neutrosophic set. *LogForum*, 16 (3), 421-429.

[8]. Das, S., & Pramanik, S. (2020). Generalized neutrosophic *b*-open sets in neutrosophic topological space, *Neutrosophic Sets and Systems*, 35, 522-530.

[9]. Das, S., & Pramanik, S. (2020). Neutrosophic Φ-open sets and neutrosophic Φ-continuous functions.*Neutrosophic Sets and Systems*, 38, 355-367.

[10]. Das, S., & Pramanik, S. (2020). Neutrosophic simply soft open set in neutrosophic soft topological space. *Neutrosophic Sets and Systems*, 38, 235-243.

[11]. Das, R., Smarandache, F., &Tripathy, B.C. (2020). Neutrosophic fuzzy matrices and some algebraic operation. *Neutrosophic Sets and Systems*, 32, 401-409.

[12]. Das, R., & Tripathy B.C. (2020). Neutrosophic multiset topological space. *Neutrosophic Sets and Systems*, 35, 142-152.

[13]. Das, S., & Tripathy, B.C. (2020). Pairwise neutrosophic-*b*-open set in neutrosophic bitopological spaces. *Neutrosophic Sets and Systems*, 38, 135-144.

[14]. Das, S., & Tripathy, B.C. (2021). Neutrosophic simply *b*-open set in neutrosophic topological spaces. *Iraqi Journal of Science*, In Press.

[15]. Dutta, A., & Tripathy, B.C. (2017). On fuzzy *b*-θ open sets in fuzzy topological space. *Journal of Intelligent and Fuzzy Systems*, 32 (1), 137-139.

[16]. Ebenanjar, E., Immaculate, J., & Wilfred, C.B. (2018). On neutrosophic *b*-open sets in neutrosophic topological space. *Journal of Physics Conference Series*, 1139 (1), 012062.

[17]. Kelly, J.C. (1963). Bitopological Spaces. *Proceedings of the London Mathematical Society*, 3 (1), 71-89.

[18]. Mukherjee, A., & Das, R. (2020). Neutrosophic Bipolar Vague Soft Set and Its Application to Decision Making Problems. *Neutrosophic Sets and Systems*, 32, 410-424.

[19]. Ozturk, T.Y., & Ozkan, A. (2019). Neutrosophic Bitopological Spaces. *Neutrosophic Sets and Systems*, 30, 88-97.

[20]. Rao, V.V., & Srinivasa, R. (2017). Neutrosophic pre-open sets and pre-closed sets in Neutrosophic topology. *International Journal of Chemical Technology Research*, 10 (10), 449-458.

[21]. Salama, A.A., & Alblowi, S.A. (2012a). Neutrosophic set and neutrosophic topological space. *ISOR Journal of Mathematics*, 3 (4), 31-35.

[22]. Salama, A.A., & Alblowi, S.A. (2012b). Generalized Neutrosophic Set and Generalized Neutrosophic Topological Space. *Computer Science and Engineering*, 2, 129-132.

[23]. Smarandache, F. (1998). A unifying field in logics, neutrosophy: neutrosophic probability, set and logic. *Rehoboth: American Research Press*.

[24]. Smarandache, F. (2005). Neutrosophic set: a generalization of the intuitionistic fuzzy sets. *International Journal of Pure and Applied Mathematics*, 24, 287-297.

[25]. Tripathy, B.C., & Debnath, S. (2015). On fuzzy *b*-locally open sets in bitopological spaces. *Songklanakarin Journal of Science and Technology*, 37 (1), 93-96.

[26]. Tripathy, B.C., & Sarma, D.J. (2011). On *b*-Locally Open Sets in Bitopological Spaces. *Kyungpook Mathematical Journal*, 51, 429-433.

[27]. Tripathy, B.C., & Sarma, D.J. (2012). On pairwise *b*-locally open and pairwise *b*-locally closed functions in bitopological spaces. *Tamkang Journal of Mathematics*, 43 (4), 533-539.

[28]. Tripathy, B.C., & Sarma, D.J. (2013). On weakly *b*-continuous functions in bitopological spaces. *ActaScientiarum Technology*, 35 (3), 521-525.

[29]. Tripathy, B.C., & Sarma, D.J. (2014). Generalized *b*-closed sets in Ideal bitopological spaces. *Proyecciones Journal of Mathematics*, 33 (3), 315-324.

[30]. Tripathy, B.C., & Sarma, D.J. (2017). Pairwise generalized b-R_0 spaces in bitopological spaces. *Proyecciones Journal of Mathematics*, 36 (4), 589-600.

[31]. Zadeh, L.A. (1965). Fuzzy sets. *Information and Control*, 8, 338-353.

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