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Bipolar Pentapartitioned Neutrosophic set and it's Generalized Semi-closed Sets

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A B S T R A C T

In this paper, we introduce the concept of Bipolar Pentapartitioned Neutrosophic [BPN]sets and its properties are investigated. Also we studied several properties of Preopen sets in bipolar Pentapartitioned Neutrosophic topological space [BPNTS].The concept of Bipolar Pentapartitioned Neutrosophic generalized semi-closed set is introduced and several properties are discussed .

Keywords: Pentapartitioned Neutrosophic set, Bipolar Pentapartitioned Neutrosophic set, bipolar pentapartitioned Neutrosophic topological space.

1. Introduction

To cope with uncertainty primarily based real and scientific issues, Prof. Zadeh [20] introduced the fuzzy set as a constructive tool. Later on Prof. Atanassov [1] extended the idea of fuzzy set theory to the intuitionistic fuzzy set(IFS), during which every element has both a membership degree and a non-membership degree. It's quite clear that IFS are more useful than fuzzy set theory to deal the varied sorts s of uncertainty model. In 2005, Smarandache [19]introduced the thought of a neutrosophic set (NS) as a further generalization of IFS from philosophical purpose of read. Gradually neutrosophic sets become more powerful technique to represent incomplete, inconsistent and indeterminate data that exists in our real universe. In neutrosophic set, truth membership functions (TA), indeterminacy membership functions (IA), and falsity membership functions (FA) are represented independently. However just in case of NS, all components lie in]0−, 1+[.Thus it is terribly powerful to use NS sets in real world issues. To resolve this problem Wang et al. [7] introduced single valued NS sets in 2010. Recently bipolar fuzzy set and set theoretical operations supported on fuzzy bipolar sets are introduced by Deli et al. in their paper [5]. They have shown that a bipolar fuzzy set consists two independent components, positive membership degree $T+ \rightarrow [0, 1]$ and a negative membership degree $T - \rightarrow [-1, 0]$. In a while, many researchers have studied bipolar fuzzy sets and applied it to completely different socio-economic model .

Asa continuation of neutrosophic set, Deli et al. [6] introduced the thought of bipolar neutrosophic sets, where each element has both + ve and − ve neutrosophic degrees. Here, the positive membership degree T_A^+, I_A^+, F_A^+ denotes the truth membership, indeterminate membership and false membership of an element x ∈X corresponding to a bipolar neutrosophic set A and the negative membership degree T_A^-, I_A^-, F_A^- denotes the truth membership, indeterminate membership and false membership of a component x ∈X to some anti-property similar to a bipolar neutrosophic set A.. Rama Malik and Surpati Pranamik[18] has developed Pentapartitioned neutrosophic set and its properties. It is five valued logic set consisting truth membership, a contradiction membership , an ignorance-membership, an unknown membership and a falsity membership for each x ∈X. Now pentapartitioned single valued neutrosophic set becomes an important tool in solving various types of decision making problems, medical diagnosis problems, clustering issues

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etc. The concept of Bipolar Quadripartitioned single valued neutrosophic sets was developed by Kalyan Sinha.et.al[8]. In this paper, we develop Bipolar pentapartitioned neutrosophic set and studied some of its properties.

2. Preliminaries

2.1 Definition

Let X be a universe. A Neutrosophic set A on X can be defined as follows:

$$A = \{< x, T_A(x), I_A(x), F_A(x) >: x \in X\}$$

Where $T_A\ , I_A, F_A: U \rightarrow [0,1]\ and 0 \leq T_A(x) + I_A(x) + F_A\ (x) \leq 3$

Here,$T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of inderminancy and $F_A(x)$ is the degree of non-membership.

Here, $T_A(x)$ and $F_A(x)$are dependent neutrosophic components and $I_A(x)$ is an independent component.

2.2Definition

Let P be a non-empty set. A Pentapartitioned neutrosophic set A over P characterizes each element p in P a truth -membership function T_A , a contradiction membership function C_A, an ignorance membership function G_A, unknown membership function U_A and a false membership function F_A , such that for each p in P

$$T_A + C_A + G_A + U_A + F_A \leq 5$$

2.3 Definition

The complement of a pentapartitioned neutrosophic set A on R Denoted by A^C or A^* and is defined as

$A^C = \{< x, F_A(x), U_A(x), 1 - G_A(x), C_A(x), T_A(x) > : x \in X\}$

2.4 Definition

Let A = $< x, T_A(x), C_A(x), G_A(x), U_A(x), F_A(x) >$ and B = $< x, T_B(x), C_B(x), G_B(x), U_B(x), F_B(x) >$ are pentapartitioned neutrosophic sets. Then

A ∪ B = $<x, max(T_A(x), T_B(x)), max(C_A(x), C_B(x)), \min(G_A(x), G_B(x)), \min(U_A(x), U_B(x)),$

$\min(F_A(x), F_B(x)), >$

A ∩ B = $< x, min(T_A(x), T_B(x)), min(C_A(x), C_B(x)), \max(G_A(x), G_B(x))$

$, max(U_A(x), U_B(x)), max(F_A(x), F_B(x)) >$

2.5 Definition

A PN topology on a nonempty set R is a family of a PN sets in R satisfying the following axioms

1) 0,1∈ τ
2) $R_1 \cap R_2 \in \tau$ for any $R_1, R_2 \in \tau$
3) $\cup R_i \in \tau$ for any $R_i : i \in I \subseteq \tau$

The complement R^* of PN open set (PNOS, in short) in PN topological space [PNTS] (R,$\boldsymbol{\tau}$), is called a PN closed set [PNCS].

2.6 Definition

Let (R,τ) be a PNTS and L be a PNTS in R. Then the PN interior and PN Closure of R denoted by

PNCl(L) = $\cap\{K$: K is a PNCS in R and L⊆ K}.

PNInt(L) = ∪{G: G is a PNOS in R and G⊆ L}.

3. Bipolar Pentapartitioned Neutrosophic Set

3.1 Definition

Suppose X be a non-empty set. A bipolar pentapartitioned neutrosophic set (BPNS) A, over X characterizes each element x in X by a positive truth-membership function T_A^+, a positive contradiction membership function C_A^+, a positive ignorance-membership function U_A^+, a positive falsity membership function F_A^+, a positive unknown membership G_A^+, a negative truth membership function T_A^-, a negative contradiction membership function C_A^-, a negative ignorance-membership function U_A^-, a negative falsity membership function F_A^-, a negative unknown membership function G_A^-such that for each $x \in X$, $T_A^+, C_A^+, G_A^+, U_A^+, F_A^+ \in [0,1], T_A^-, C_A^-, G_A^-, U_A^-, F_A^- \in [0,1]$,

and $T_A^+ + C_A^+ + G_A^+ + U_A^+ + F_A^+ \leq 5, -5 \leq T_A^- + C_A^- + G_A^- + U_A^- + F_A^- \leq 0$

When X is discrete, A is represented as

A = $\sum_{i=1}^{n} < T_A^+, C_A^+, G_A^+,, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^- >/$ x_i , $x_i \in X$

3.2 Example

Consider the case where five different persons x_1,x_2,x_3,x_4,x_5were asked to give their opinion on the statement "is there any climate change in India" in the year 2020. Each of the five persons will give their opinion in terms of degree of agreement, agreement or disagreement both, neither agreement nor disagreement, disagreement in terms of degree of positive and negative arguments and unknown agreement respectively. The aggregate of their opinion is very well expressed by a BPNS *A* as follows:

A = < 0.8, 0.7,0.6,0.4,0.2,-0.5,-0.8,-0.7,-0.3,-0.1>/x_1 +

< 0.5,0.7,0.9,0.2,0.7,-0.2,-0.5.-0.6,-0.7,-0.3>/x_2 +

< 0.7, 0.7,0.4,0.5,0.2,-0.5,-0.8,-0.5,-0.2,-0.4>/x_3 +

< 0.9,0.3,0.6,0.2,0.7,-0.2,-0.5.-0.6,-0.7,-0.3>/x_4 +

< 0.2, 0.6,0.6,0.4,0.7,-0.5,-0.4,-0.7,-0.9,-0.1>/x_5 +

Here according to x_1, the degree of agreement with the statement is 0.8 and the degree of negative agreement with the statement is 0.5, the degree of both agreement and disagreement is 0.7 and the degree of negative argument of "both agreement and disagreement" is 0.8. The degree of neither agreement nor disagreement is 0.4, while the degree of negative argument of it is 0.3. Similarly the degree of disagreement with the statement is 0.2 and degree of negative disagreement is 0.1 and the degree of unknown agreement is 0.6 and the degree of negative unknown agreement is 0.7. This is how BPNS set has been made.

3.3 Definition .

A BPNS *B* over *X* is said to be an absolute BPNS, denoted by 1_X, if and only if its membership values are respectively defined as $T_A^+(x) = 1, C_A^+(x) = 1, G_A^+(x) = 0, U_A^+(x) = 0, F_A^+(x) = 0, T_A^-(x) = 0, C_A^-(x) = 0, G_A^-(x) = -1, U_A^-(x) = -1,$

$F_A^-(x) = -1$, for all x ∈ [0,1].

3.4 Definition

A BPNS *B* over *X* is said to be an empty BPNS, denoted by 0_X, if and only if its membership values are respectively defined as $T_A^+(x) = 0, C_A^+(x) = 0, G_A^+(x) = 1, U_A^+(x) = 1, F_A^+(x) = 1, T_A^-(x) = -1, C_A^-(x) = -1, G_A^-(x) = 0, U_A^-(x) = 0, F_A^-(x) = 0$, for all x ∈ [0,1].

Remark

A BPNS is a generalization of a bipolar neutrosophic set. If we take average the components C^+, U^+, G^+ and C^-, U^-, G^-together respectively, we can easily get a bipolar SVN set.

3.5 Definition

A BPN set A = $\{T_A^+, C_A^+, G_A^+, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^-\}$ is contained in a BPN set B = $\{T_B^+, C_B^+, G_B^+, U_B^+, F_B^+, T_B^-, C_B^-, G_B^-, U_B^-, F_B^-\}$ if and only if $T_A^+(x) \le T_B^+(x), C_A^+(x) \le C_B^+(x), U_A^+(x) \ge U_B^+(x), G_A^+(x) \ge G_B^+(x), F_A^+(x) \ge F_B^+(x),$

$T_A^-(x) \ge T_B^-(x), C_A^-(x) \ge C_B^-(x), G_A^-(x) \le G_B^-(x), U_A^-(x) \le U_B^-(x)$ and $F_A^-(x) \le F_B^-(x)$.

3.6 Definition

The complement of BPNS A = $\{T_A^+, C_A^+, G_A^+, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^-\}$is denoted by A^C and is defined as

$A^C = \{F_A^+, U_A^+, (1 - G_A^+), C_A^+, T_A^+, F_A^-, U_A^-, (-1 - G_A^-), C_A^-, T_A^-\}$

3.7 Example

Let X ={a,b}. Then the BPNS R of X is given by

$$R = \begin{cases} < a, (0.5,0.7,0.6,0.2,0.4, -0.1, -0.8, -0.5, -0.7, -0.7) > \\ < b, (0.4,0.6,0.7,0.8,0.3, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

$$R^C = \begin{cases} < a, (0.4,0.2,0.4,0.7,0.5, -0.7, -0.7, -0.5, -0.8, -0.1) > \\ < b, (0.3,0.8,0.3,0.6,0.4, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

3.8 Definition

The union of any two BPNS A = $\{T_A^+, C_A^+, G_A^+, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^-\}$ and

B = $\{T_B^+, C_B^+, G_B^+, U_B^+, F_B^+, T_B^-, C_B^-, G_B^-, U_B^-, F_B^-\}$ is denoted by A∪B and is defined as follows

A∪B = {max $\{T_A^+, T_B^+\}$, max $\{C_A^+, C_B^+\}$, min $\{G_A^+, G_B^+\}$, min $\{U_A^+, U_B^+\}$, min $\{F_A^+, F_B^+\}$,

min $(T_A^-, T_B^-\}$, min $(C_A^-, C_B^-\}$, max $(G_A^-, G_B^-\}$, max $(U_A^-, U_B^-\}$, max $(F_A^-, F_B^-\}$}

3.9 Example

Let X = {p, q}. Then the bipolar pentapartitioned neutrosophic subsets A and B of X can be given as follows.

$$A = \begin{cases} < p, (0.5, 0.7, 0.6, 0.2, 0.4, -0.1, -0.8, -0.5, -0.7, -0.7) > \\ < q, (0.4, 0.6, 0.7, 0.8, 0.3, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

$$B = \begin{cases} < p, (0.9, 0.2, 0.4, 0.7, 0.5, -0.7, -0.7, -0.5, -0.8, -0.1) > \\ < q, (0.5, 0.8, 0.3, 0.6, 0.4, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

Then the union of two BPNS A and B is

$$A \cup B = \begin{cases} < p, (0.9, 0.7, 0.4, 0.2, 0.4, -0.7, -0.8, -0.5, -0.7, -0.1) > \\ < q, (0.5, 0.8, 0.3, 0.6, 0.3, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

3.10 Definition

The intersection of any two BPNS A = $\{T_A^+, C_A^+, G_A^+, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^-\}$ and

B = $\{T_B^+, C_B^+, G_B^+, U_B^+, F_B^+, T_B^-, C_B^-, G_B^-, U_B^-, F_B^-\}$ is denoted by A∩B and is defined as follows

A∩B = {min $\{T_A^+, T_B^+\}$, min $\{C_A^+, C_B^+\}$, max $\{G_A^+, G_B^+\}$, max $\{U_A^+, U_B^+\}$, max $\{F_A^+, F_B^+\}$,

max $\{T_A^-, T_B^-\}$, max $(\{, C_B^-\}$, min $\{G_A^-, G_B^-\}$, min $\{U_A^-, U_B^-\}$, min $\{F_A^-, F_B^-\}$}

3.11 Example:

Let X = {p, q}. Then the bipolar pentapartitioned neutrosophic subsets A and B of X can be given as follows.

$$A = \begin{cases} < p, (0.5, 0.7, 0.6, 0.2, 0.4, -0.1, -0.8, -0.5, -0.7, -0.7) > \\ < q, (0.4, 0.6, 0.7, 0.8, 0.3, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

$$B = \begin{cases} < p, (0.9, 0.2, 0.4, 0.7, 0.5, -0.7, -0.7, -0.5, -0.8, -0.1) > \\ < q, (0.5, 0.8, 0.3, 0.6, 0.4, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

Then the intersection of two BPNS A and B is

$$A \cap B = \begin{cases} < p, (0.5, 0.2, 0.6, 0.7, 0.5, -0.1, -0.7, -0.5, -0.8, -0.7) > \\ < q, (0.4, 0.6, 0.7, 0.8, 0.4, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

3.12 Proposition

The set-theoretic axioms are satisfied by any BPNS as it can be easily verified. Consider BPNS sets *A*, *B*, *C* over the same universe *X*. Then the following properties holds all for BPNS over *X*.

(i) $A \cup B = B \cup A$
(ii) $A \cap B = B \cap A$.
(iii) $A \cup (B \cup C) = (A \cup B) \cup C$
(iv) $A \cap (B \cap C) = (A \cap B) \cap C$
(v) $A \cap (A \cup B) = A$
(vi) $A \cup (A \cap B) = A$.
(vii) $(A^c)^c = A$.
(viii) $(A \cup B)^c = A^c \cap B^c$
(ix) $(A \cap B)^c = A^c \cup B^c$
(x) $A \cup A = A \cup A$;
(xi) $A \cap A = A \cap A$.
(xii) $A \cup \emptyset = A$;
(xiii) $A \cap \emptyset = \emptyset$.
(xiv) $A \cup \emptyset = A$
(xv) $A \cap \emptyset = \emptyset$.

3.13 Definition

A bipolar pentapartitioned neutrosophic topology (BPNT) on a non empty X is a of BPN sets satisfying the following axioms.

[1] $0_x, 1_x \in \tau$

[2] $A \cap B \in \tau$ for any a,b$\in \tau$

[3] $\cup A_i \in \tau$ for any arbitrary family$\{ A_i \in J\} \in \tau$

The pair (X, τ) is called Bipolar Pentapartitioned neutrosophic topological spaces (BPNTS).

Any BPN set in τ is called as BPN open set in X. The complement of BPN open set is BPN closed set.

3.14 Example

Let X = {p, q}. Then the bipolar pentapartitioned neutrosophic subsets A and B of X can be given as follows.

$$A = \begin{cases} < p, (0.5,0.7,0.6,0.2,0.4, -0.1, -0.8, -0.5, -0.7, -0.7) > \\ < q, (0.4,0.6,0.7,0.8,0.3, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

$$B = \begin{cases} < p, (0.9,0.2,0.4,0.7,0.5, -0.7, -0.7, -0.5, -0.8, -0.1) > \\ < q, (0.5,0.8,0.3,0.6,0.4, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

$$C = \begin{cases} < p, (0.9,0.7,0.4,0.2,0.4, -0.7, -0.8, -0.5, -0.7, -0.1) > \\ < q, (0.5,0.8,0.3,0.6,0.3, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

Then $\tau = \{ 0_X, 1_X, A, B, C\}$ is a bipolar pentapartitioned neutrosophic topology on X

3.15 Definition

Let (X, τ) be a BPN topological space and A = $\{T_A^+, C_A^+, G_A^+, U_A^+, F_A^+, T_A^-, C_A^-, G_A^-, U_A^-, F_A^-\}$ be a BPN set in X. Then the closure and interior of A is defined as

Int(A) = $\cup$ {F: F is a BPN open set in X and F $\subseteq$A}

Cl (A) = $\cap${F: F is a BPN closed in X and F $\subseteq$ A}

Here Cl(A) is BPN closed set and Int(A) is a BPN open set in X.

(a) A is BPN open set in X iff Int(A) = A

(b) A is BPN closed set in X iff Cl(A) = A

3.16 Example

Let X = {p, q} and $\tau = \{ 0_X, 1_X, A, B, C\}$ where

$$A = \begin{cases} < p, (0.5,0.7,0.6,0.2,0.4, -0.1, -0.8, -0.5, -0.7, -0.7) > \\ < q, (0.4,0.6,0.7,0.8,0.3, -0.2, -0.5, -0.7, -0.8, -0.3) > \end{cases}$$

$$B = \begin{cases} < p, (0.9,0.2,0.4,0.7,0.5, -0.7, -0.7, -0.5, -0.8, -0.1) > \\ < q, (0.5,0.8,0.3,0.6,0.4, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

$$C = \begin{cases} < p, (0.9,0.7,0.4,0.2,0.4, -0.7, -0.8, -0.5, -0.7, -0.1) > \\ < q, (0.5,0.8,0.3,0.6,0.3, -0.3, -0.8, -0.3, -0.5, -0.2) > \end{cases}$$

Consider the BPN set D of X as

$$D = \begin{cases} < p, (0.7,0.8,0.3,0.1,0.2, -0.3, -0.9, -0.2, -0.7, -0.7) > \\ < q, (0.5,0.9,0.4,0.7,0.1, -0.4, -0.6, -0.4, -0.8, -0.3) > \end{cases}$$

Then Int(D) = A and Cl(D) = $!_X$.

3.17 Theorem

Let (X, τ) be a BPN topological space and S,T be BPN set in X. Then

1) Int (S) $\subseteq$ S and S $\subseteq$ Cl(S)
2) S$\subseteq T$ Int(S) $\subseteq Int(T)$
3) S $\subseteq$ T Cl(S) $\subseteq$ Cl(T)
4) Int(Int(S)) = Int(S)
5) Cl(Cl(S)) = Cl(S)
6) Int (S T) = Int(S) Int(T)
7) Cl(S T) = Cl(S) Cl(T)
8) $Int(1_X) = 1_X$
9) $Cl(0_X) = 0_X$.

4. Bipolar Pentapartitioned Neutrosophic Generalized Semi-closed Sets

4.1 Definition

Let *A* be bipolar pentapartitioned neutrosophic (BPN) set of a bipolar pentapartitioned neutrosophic topological space [*B*PNTS] X. Then *A* is said to be bipolar pentapartitioned neutrosophic semi-open set [BPNSO set] of X if there exists a set BPNO such that BPNO(A) ⊆ A ⊆ BPNCl(BPNO(A))

4.2 Definition

A subset *A* in a BPNTS X is *B*PNSO set if and only if A⊆ BPNCl(BPNInt(A))

4.3 Definition

A BPNS *A* is called Bipolar Pentapartitioned neutrosophic semi-closed set [BPNSC set] if the complement of C (A) is a BPNSO set.

4.4 Definition

Let (R,τ) be a BPNTS and L be a BPNSet in R. Then the BPN semi-interior and BPN semi-Closure of R denoted by

BPNSCl(L) = ⋂{K: K is a BPNSCS in R and L⊆ K}.

BPNSInt(L) = ⋃{G: G is a BPNSOS in R and G⊆ L}.

4.5 Definition

A Bipolar Pentapartitioned neutrosophic set [BPNS] A of a Bipolar Pentapartitioned neutrosophic topological space (R,τ) is called a Bipolar Pentapartitioned neutrosophic generalized semi-closed set [BPNGSC set] if BPNSCl(A) ⊆ U, whenever A⊆ U and U is a Bipolar Pentapartititioned neutrosophic open set.

4.6 Example

Let R = {a} with $\tau = \{0_R$, A, B, C, D, E, F, $1_R\}$ where A = {-0.2,-0.6,-0.5,-0.2,-0.6,0.2,0.6,0.5,0.2,0.6}, B = {-0.5,-0.6,-0.1,-0.2,-0.4,0.5,0.6,0.1,0.2,0.4}, C = {-0.5,-0.1,-0.5,-0.6,-0.4,0.5,0.1,0.5.0.6,0.4}, D = {-0.2,-0.4,-0.7,-0.5,-0.6,0.2,0.4,0.7,0.5,0.6}, E = {-0.5,-0.6,-0.5,-0.2,-0.4,0.5,0.6,0.5,0.2,0.4} and F = {-0.5,-0.4,-0.5,-0.5,-0.4,0.5,0.4,0.5,0.5,0.4}. Then the Bipolar Pentapartitioned Neutrosophic Semi-open sets are 0_R, A, B, C, D, E, F, C(A) ,C(D),C(F) ,1_R. Let us take M = {-0.4,-0.2,-0.5,-0.1,-0.3,0.4,0.2,0.5,0.1,0.3}. Then M is Bipolar Pentapartitioned neutrosophic generalized semi-closed set.

4.7 Definition

A BPNS A in R is called Bipolar Pentapartitioned neutrosophic generalized semi-open set [BPNGSO set] in R if complement of A[C(A)] is BPNGSC set in R.

That is, U⊆BPNSInt(A), whenever A⊆ U and U is a BPN closed set.

4.8 Definition

Let (R,τ) be a BPN topological space. Then a BPN subset A of the BPN topological space R is said to beBipolar Pentapartitioned neutrosophic regular open if A = BPNInt(BPNCl(A)) and Bipolar Pentapartitioned neutrosophic regular closed if A = BPNCl(BPNInt(A))

4.9 Theorem

Every Bipolar Pentapartitioned neutrosophic closed set in Bipolar Pentapartitioned neutrosophic topological space (R, τ) is a bipolar pentapartitioned neutrosophic generalized semi-closed set.

Proof :

Let *A* be a bipolar pentapartitioned neutrosophic closed set in bipolar pentapartitioned neutrosophic topological space (R, τ) . Let *A*⊆ U and U be a bipolar pentapartitioned neutrosophic open set in R. Then by Definition, A = BPNCl(A). We know that BPNSCl(A) ⊆ *B*PNCl(A), then we get BPNSCl(A) ⊆BPNCl(A) = A⊆ U. Hence *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in R.

Note

The converse of the above theorem is not true as shown by the following example.

4.10 Example

From Example 2.2, M is bipolar pentapartitioned neutrosophic generalized semi-closed set. but not bipolar pentapartitioned neutrosophic closed set.

4.11 Theorem

Every bipolar pentapartitioned neutrosophic semi-closed set in the bipolar pentapartitioned neutrosophic topological space (R, τ) is a bipolar pentapartitioned neutrosophic generalized semi-closed set.

Proof :

Let *A* be a bipolar pentapartitioned neutrosophic semi-closed set in the bipolar pentapartitioned neutrosophic topological space R. Let A ⊆ U and U be a bipolar pentapartitioned neutrosophic open set in R. Since *A* is bipolar pentapartitioned neutrosophic semi-closed set, BPNInt (BPNCl(A)) ⊆ A. Therefore BPNSCl(A) ⊆ U, A ⊆ Uand U is a bipolar pentapartitioned neutrosophic open set. Hence *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in X.

The converse of the above theorem is not true as shown by the following example.

4.12 Example

From Example 2.2, M is bipolar pentapartitioned neutrosophic generalized semi-closed set but not bipolar pentapartitioned neutrosophic semi-closed set.

4.13 Theorem

If A and B are bipolar pentapartitioned neutrosophic generalized semi-closed sets, then A ∩ B is also a bipolar pentapartitioned neutrosophic generalized semi-closed set.

Proof :

Let *A* and *B* are bipolar pentapartitioned neutrosophic generalized semi-closed sets.If A ∩ B⊆ U and U is bipolar pentapartitioned neutrosophic open set, then A⊆ U and B ⊆ U. Since A and B are bipolar pentapartitioned neutrosophic generalized semi-closed sets, BPNSCl(A) ⊆ U and BPNSCl(B) ⊆ U. Hence BPNSCl(A) ∩BPNSCl(B) ⊆ U. By theorem, BPNCl(A ∩ B) ⊆BPNSCl(A) ∩BPNSCl(B) ⊆ U. Thus A ∩ B is bipolar pentapartitioned neutrosophic generalized semi-closed set.

4.14 Remark

Union of any two bipolar pentapartitioned neutrosophic generalized semi-closed sets in (X, τ) need not be a bipolar pentapartitioned neutrosophic generalized semi-closed set, as seen from the following example.

4.15 Example

From Example 2.2, B^C and D arebipolar pentapartitioned neutrosophic generalized semi-closed sets but their union S is not bipolar pentapartitioned neutrosophic generalized semi-closed set.

4.16 Theorem

If *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in X and *A*⊆*B*⊆BPNSCl(A), then *B* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in X.

Proof :

Let U be a bipolar pentapartitioned neutrosophic generalized semi-open set in X such that *B*⊆ U. Since *A*⊆*B*, *A*⊆U. Again since *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set, BPNSCl(A) ⊆ U. By hypothesis, *B*⊆BPNSCl(A). Then BPNSCl(B) ⊆BPNSCl (BPNSCl(A)) = BPNSCl(A). That is BPNSCl(B) ⊆*B*PNSCl(A). This implies that BPNSCl(B) ⊆ U. Hence *B* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in X.

4.17 Theorem

A bipolar pentapartitioned neutrosophic set *A* of a bipolar pentapartitioned neutrosophic topological space (X, τ) is a bipolar pentapartitioned neutrosophic generalized semi-closed set if and only if B$PNSCl(A)$ ⊆B where *B* is a bipolar pentapartitioned neutrosophic open set and$A$⊆B.

Proof :

Assume that *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set in X. Let *B* be a bipolar pentapartitioned neutrosophic open set in X such that *A*⊆*B*. Then C (*B*) is a bipolar pentapartitioned neutrosophic closed set in X such that C (*B*) ⊆ C (*A*). Since C (*A*) is a bipolar pentapartitioned neutrosophic generalized semi-open set, C (*B*) ⊆BPNSInt (C (*A*)). Then BPNSInt (C (*A*)) = C (B*PNSCl* (*A*)). Therefore C (*B*) ⊆ C (BPNSCl(A)) implies that BPNSCl(A) ⊆*B*. Conversely, assume that BPNSCl(A) ⊆*B* where *B* is a bipolar pentapartitioned neutrosophic open set and *A*⊆*B*. Then C (*B*) ⊆ C (BPNSCl(A)) where C (*B*) is a bipolar pentapartitioned neutrosophic closed set and C (*B*) ⊆BPNSInt (C (*A*)). Therefore C (*A*) is a Bipolar pentapartitioned neutrosophic generalized semi-open set. This implies that *A* is a bipolar pentapartitioned neutrosophic generalized semi-closed set.

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