Neutrosophic Sets and Systems, Vol. 29, 2019
University of New Mexico

Neutrosophic gb-closed Sets and Neutrosophic gb-Continuity

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Abstract: Smarandache introduced and developed the new concept of Neutrosophic set from the Intuitionistic fuzzy sets. A.A. Salama introduced Neutrosophic topological spaces by using the Neutrosophic crisp sets. Aim of this paper is we introduce and study the concepts Neutrosophic generalized b closed sets and Neutrosophic generalized b continuity in Neutrosophic topological spaces and its Properties are discussed details.

Keywords: Neutrosophic gb closed sets, Neutrosophic gb continuity, Neutrosophic continuity mapping, Neutrosophic gb continuity mapping.

1. Introduction

Smarandache's neutrosophic system have wide range of real time applications for the fields of Computer Science ,Information Systems, Applied Mathematics , Artificial Intelligence, Mechanics, decision making. Medicine, Electrical & Electronic, and Management Science etc. [20-25]. Topology is a classical subject, as a generalization topological spaces many type of topological spaces introduced over the year. Smarandache [9] defined the Neutrosophic set on three component Neutrosophic sets (T Truth, F -Falsehood, I- Indeterminacy). Neutrosophic topological spaces (N-T-S) introduced by Salama [17] et al., R.Dhavaseelan [6], Saied Jafari are introduced Neutrosophic generalized closed sets. Neutrosophic b closed sets are introduced C. Maheswari[14] et al.Aim of this paper is we introduce and study about Neutrosophic generalized b closed sets and Neutrosophic generalized b continuity in Neutrosophic topological spaces and its properties and Characterization are discussed with details.

2. Preliminaries

In this section, we recall needed basic definition and operation of Neutrosophic sets and its fundamental Results

Definition 2.1 *[9]* Let X be a non-empty fixed set. A Neutrosophic set P is an object having the form
$\mathrm{P} = \{< x, \mu_{\mathrm{P}}(\mathrm{x}), \sigma_{\mathrm{P}}(\mathrm{x}), \gamma_{\mathrm{P}}(\mathrm{x}) >: x \in X\}$,
$\mu_{\mathrm{P}}(\mathrm{x})$-represents the degree of membership function
$\sigma_{\mathrm{P}}(\mathrm{x})$-represents degree indeterminacy and then
$\gamma_{\mathrm{P}}(\mathrm{x})$-represents the degree of non-membership function

Definition 2.2 *[9].* Neutrosophic set $P = \{< x, \mu_P(x), \sigma_P(x), \gamma_P(x) >: x \in X\}$, on X and $\forall x \in X$ then complement of P is $P^C = \{< x, \gamma_P(x), 1 - \sigma_P(x), \mu_P(x) >: x \in X\}$

Definition 2.3 *[9].* Let P and Q are two Neutrosophic sets, $\forall x \in X$

$P = \{< x, \mu_P(x), \sigma_P(x), \gamma_P(x) >: x \in X\}$

$Q = \{< x, \mu_Q(x), \sigma_Q(x), \gamma_Q(x) >: x \in X\}$

Then $P \subseteq Q \Leftrightarrow \mu_P(x) \leq \mu_Q(x), \sigma_P(x) \leq \sigma_Q(x) \& \gamma_P(x) \geq \gamma_Q(x)\}$

Definition 2.4 *[9].* Let X be a non-empty set, and Let P and Q be two Neutrosophic sets are

$P = \{< x, \mu_P(x), \sigma_P(x), \gamma_P(x) >: x \in X\}$, $Q = \{< x, \mu_Q(x), \sigma_Q(x), \gamma_Q(x) >: x \in X\}$Then

1. $P \cap Q = \{< x, \mu_P(x) \cap \mu_Q(x), \sigma_P(x) \cap \sigma_Q(x), \gamma_P(x) \cup \gamma_Q(x) >: x \in X\}$
2. $P \cup Q = \{< x, \mu_P(x) \cup \mu_Q(x), \sigma_P(x) \cup \sigma_Q(x), \gamma_P(x) \cap \gamma_Q(x) >: x \in X\}$

Definition 2.5 *[17].* Let X be non-empty set and τ_N be the collection of Neutrosophic subsets of X satisfying the following properties:

1.$0_N, 1_N \in \tau_N$

2. $T_1 \cap T_2 \in \tau_N$ for any $T_1, T_2 \in \tau_N$

3. $\cup T_i \in \tau_N$ for every $\{T_i: i \in j\} \subseteq \tau_N$

Then the space (X, τ_N) is called a Neutrosophic topological space(N-T-S).

The element of τ_N are called Neu-OS (Neutrosophic open set)

and its complement is Neu-CS(Neutrosophic closed set)

Example 2.6. Let X ={x} and $\forall x \in X$

$A_1 = \langle x, \frac{6}{10}, \frac{6}{10}, \frac{5}{10} \rangle$, $A_2 = \langle x, \frac{5}{10}, \frac{7}{10}, \frac{9}{10} \rangle$

$A_3 = \langle x, \frac{6}{10}, \frac{7}{10}, \frac{5}{10} \rangle$,$A_4 = \langle x, \frac{5}{10}, \frac{6}{10}, \frac{9}{10} \rangle$

Then the collection $\tau_N = \{0_N, A_1, A_2, A_3, A_4, 1_N\}$ is called a N-T-S on X.

Definition 2.7. Let (X, τ_N)be a N-T-S and $P = \{< x, \mu_P(x), \sigma_P(x), \gamma_P(x) >: x \in X\}$ be a Neutrosophic set in X. Then P is said to be

1. Neutrosophic b closed set [14] (Neu-bCS in short) if Neu-cl(Neu-int(P))∩Neu-int(Neu-cl(P))⊆P,
2. Neutrosophic α-closed set [2] (Neu- αCS in short) if Neu-cl(Neu-int(Neu-cl(P)))⊆P,
3. Neutrosophic pre-closed set [20] (Neu-Pre-CS in short) if Neu-cl(Neu-int(P))⊆P,
4. Neutrosophic regular closed set [9] (Neu-RCS in short) if Neu-cl(Neu-int(P)) = P,
5. Neutrosophic semi closed set [11] (Neu-SCS in short) if Neu-int(Neu-cl(P))⊆P,
6. Neutrosophic generalized closed set [6] (Neu-GCS in short) if Neu-cl(P⊆H whenever P⊆H and H is an Neu-OS,
7. Neutrosophic generalized pre closed set [13] (Neu-GPCS in short) if Neu-Pcl(P) ⊆ H whenever P ⊆ H and H is an Neu-OS,
8. Neutrosophic α generalized closed set [12] (Neu- αGCS in short) if Neu α-cl(P)⊆H whenever P ⊆ H and H is an Neu-OS,
9. Neutrosophic generalized semi closed set [19](Neu-GSCS in short) if Neu-Scl(P)⊆H whenever P⊆H and H is an Neu-OS.

Definition 2.8 [*9]* (X, τ_N)be a N-T-S and $P = \{< x, \mu_P(x), \sigma_P(x), \gamma_P(x) >: x \in X\}$ be a Neutrosophic set in X.Then

Neutrosophic closure of P is Neu-Cl(P)=∩{H:H is a Neu-CS in X and P⊆H}

Neutrosophic interior of P is Neu-Int(P)=∪{M:M is a Neu-OS in X and M⊆P}.

Definition 2.9 *[14]*Let (X,τ_N) be a N-T-S and $P=\{<x,\mu_P(x),\sigma_P(x),\gamma_P(x)>:x\in X\}$ be a Neutrosophic set in X. Then the Neutrosophic b closure of P (Neu-bcl(P)in short) and Neutrosophic b interior of P (Neu-bint(P) in short) are defined as Neu-bint(P)= ∪{ G/G is a Neu-bOS in X and G⊆P}, Neu-bcl(P)= ∩{ K/K is a Neu-bCS in X and P⊆K }.

Proposition 2.10 Let (X,τ_N) be any N-T-S. Let P and Q be any two Neutrosophic sets in (X,τ_N).Then the Neutrosophic generalized b closure operator satisfies the following properties.

1. Neu-bcl(0_N)=0_N and Neu-bcl(1_N) = 1_N,
2. P⊆Neu-bcl(P),
3. Neu-bint(P)⊆P,
4. If P is a Neu-bCS then P=Neu-bcl(Neu-bcl(P)),
5. P⊆Q⇒Neu-bcl(P) ⊆Neu-bcl(Q),
6. P⊆Q⇒Neu-bint(P)⊆Neu-bint(Q).

3. Neutrosophic Generalized b Closed Sets

Definition 3.1. A Neutrosophic set P in a N-T-S (X,τ_N) is said to be a Neutrosophic generalized b closed set(Neu-GbCS in short) if Neu-bcl(P) ⊆H whenever P⊆H and H is a Neu-OS in (X,τ_N).The family of all Neu-GbCSs of a N-T-S (X,τ_N) is denoted by Neu-gbC(X).

Example 3.2. Let $X=\{p_1,p_2\}$ $\tau_N=\{0_N,E_1,1_N\}$ is be a N.T.on X where $E_1=\langle x,\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$. Then the Neutrosophic set $P=\langle x,\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right)\rangle$is a Neu-GbCS in X.

Example 3.3. Let $X=\{p_1,p_2\}$ $\tau_N=\{0_N,E_1,1_N\}$ isbe a N.T.on X. where $E_1=\langle x,\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$. Then the Neutrosophic set $P=\langle x,\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$is not a Neu-GbCS in X.

Theorem 3.4. Every Neu-CS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X,τ_N). Since P is a Neu-CS and Neu-bcl(P) ⊆Neu-cl(P), Neu-bcl(P) ⊆Neu-cl(P)=P⊆H. Therefore P is a Neu-GbCS in X.

Example 3.5. Let $X=\{p_1,p_2\}$ $\tau_N=\{0_N,E_1,1_N\}$ is be a N.T. on X .where $E_1=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$. Then the Neutrosophic set $P=\langle x,\left(\frac{5}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-CS in X, since Neu-cl(P)=E_1≠P

Theorem 3.6. Every Neu-αCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X,τ_N). Since P is a Neu-αCS, Neu-αcl(P)= P. Therefore Neu-bcl(P) ⊆Neu-αcl(P)=P⊆H. Hence P is a Neu-GbCS in X.

Example 3.7. Let $X=\{p_1,p_2\}$ $\tau_N=\{0_N,E_1,1_N\}$ is be a N.T. on X .where $E_1=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right)\rangle$. Then the Neutrosophic set $P=\langle x,\left(\frac{5}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-αCS in X, since Neu-cl(Neu-int(Neu-cl(P)))= ${E_1}^C \not\subseteq$ P.

Theorem 3.8. Every Neu-Pre-CS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N).Since P is a Neu-Pre-CS,Neu-cl(Neu-int(P)) ⊆P. Therefore Neucl(Neu-int(P))∩Neu-int(Neu-cl(P) ⊆Neu-cl(P)∩Neu-cl(Neu-int(P) ⊆P. This implies Neu-bcl(P)
⊆H. Hence P is a Neu-GbCS in X.

Example 3.9.Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X.where $E_1 = \langle x, \left(\frac{9}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$. Then the Neutrosophic set $P = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-pre closed set in X, since Neu-cl(Neu-int(P))= $E_1{}^C \nsubseteq$ P.

Theorem 3.10. Every Neu-bCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N). Since P is a Neu-bCS,Neu-bcl(P)=P. Therefore Neu-bcl(P)=P ⊆ H. Hence P is a Neu-GbCS in X.

Example 3.11 Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X .where $E_1 = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right), \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-bCS in X, since Neu-cl (Neu-int(P))∩ Neu-int(Neu-cl(P))=$1_N \nsubseteq$ P.

Theorem 3.12. Every Neu-RCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N). Since P is a Neu-RCS , Neu-cl(Neu-int(P))=P. This implies Neu-cl(P)=Neu-cl(Neu-int(P)). Therefore Neu-cl(P)=P. Hence P is a Neu-CS in X. By theorem 3.4, P is a Neu-GbCS in X.

Example 3.13.Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-RCS in X, since Neu-cl(Neu-int(P))=$E_1{}^C \neq$ P.

Theorem 3.14. Every Neu-GCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N). Since P is a Neu-GCS, Neu-cl(P) ⊆H. Therefore Neu-bcl(P) ⊆Neu-cl(P), Neu-bcl(P)⊆H. Hence P is a Neu-GbCS in X.

Example 3.15 Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X. where $E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{1}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-GCS in X, since Neu-cl(P)= $E_1^C \nsubseteq E_1$.

Theorem 3.16. Every Neu-αGCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N).Since P is a Neu-αGCS, Neu-αcl(P)⊆H.Therefore Neubcl(P) ⊆ Neu-αcl(P), Neu-bcl(P)⊆H. Hence P is a Neu-GbCS in X.

*Example 3.17.*Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X. where $E_1 = \langle x, \left(\frac{5}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-αGCS in X, since Neu-cl(Neu-int(Neu-cl(A)))= $1_N \nsubseteq E_1$

Theorem 3.18. Every Neu-GPCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N). Since P is a Neu-GPCS, Neu-Pcl(P)⊆H. Therefore Neubcl(P) ⊆ Neu-Pcl(P), Neu-bcl(P) ⊆ H. Hence P is a Neu-GbCS in X.

Example 3.19. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, E_2, 1_N\}$ is be a N.T.on X.where $E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$, $E_2 = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ Then the Neutrosophic set $P = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-Gp closed set in X, since Neu-Pcl(P)= $E_2^C \nsubseteq E_2$.

Theorem 3.20. Every Neu-SCS is a Neu-GbCS but not conversely.

Proof. Let P⊆H and H is a Neu-OS in (X, τ_N).Since P is a Neu-SCS, Neu-bcl(P) ⊆ Neu-Scl(P) ⊆ H. Therefore P is a Neu-GbCS in X.

Example 3.21. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X

where $E_1 = \langle x, \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-SCS in X, since Neu-int(Neu-cl(P))=$1_N \nsubseteq P$

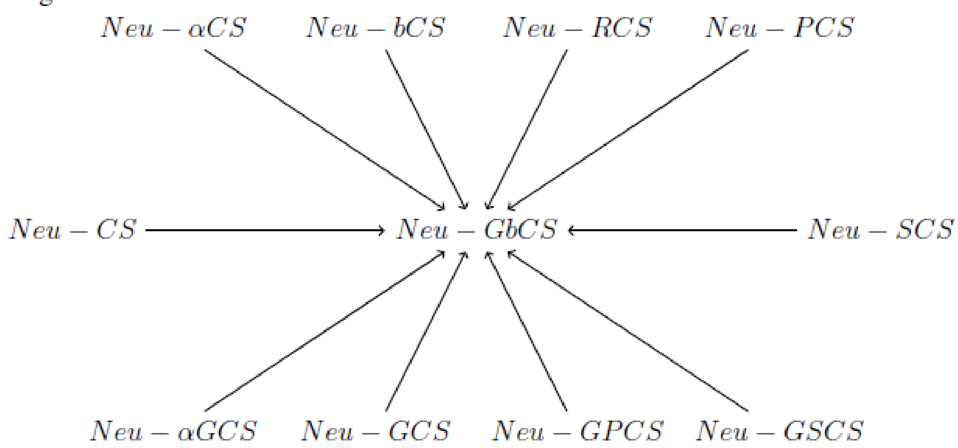
Theorem 3.22. Every Neu-GSCS is a Neu-GbCS but not conversely.

Proof. Obivious

Example 3.23.Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X

where $E_1 = \langle x, \left(\frac{8}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{0}{10}, \frac{5}{10}, \frac{1}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$ is a Neu-GbCS but not a Neu-GSCS in X, since Neu-int(Neu-cl(P))=$1_N \nsubseteq P$ The following implications are true:

Diagram:I



Theorem 3.24. The union of any two Neu-GbCSs need not be a Neu-GbCS in general as seen from the following example.

Example 3.25. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{1}{10}, \frac{5}{10}, \frac{9}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$,

$Q = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$ is a are Neu-GbCSs but P∩Q is not a Neu-GbCS in X, since Neu-bcl(P∩Q) =$1_N \nsubseteq E_1$

Theorem 3.26. `If P is a Neu-GbCS in (X, τ_N).such that P⊆Q⊆Neu-bcl(P) then Q is a Neu-GbCS in (X, τ_N).

Proof. Let Q be a Neutrosophic set in a N-T-S (X, τ_N).such that Q⊆H and H is a Neu-OS in X. This implies P ⊆ H. Since P is a Neu-GbCS, Neu-bcl(P)⊆H. By hypothesis, we have Neu-bcl(Q)⊆Neu-bcl(Neu-bcl(P))= Neu-bcl(P)⊆H. Hence Q is a Neu-GbCS in X.

Theorem 3.27. If P is Neutrosophic b open and Neutrosophic generalized b closed in a N-T-S (X, τ_N).then P is Neutrosophic b closed in (X, τ_N).

Proof. Since P is Neutrosophic b open and Neutrosophic generalized b closed in (X, τ_N)., Neu-bcl(P)⊆P. but P ⊆ Neu-bcl(P). Thus Neu-bcl(P)=P and hence P is Neutrosophic b closed in (X, τ_N).

4. Neutrosophic generalized b open sets

In this section, we introduce Neutrosophic generalized b open sets in Neutrosophic topological space and study some of their properties.

Definition 4.1. A Neutrosophic set P is said to be a Neutrosophic generalized b open set (Neu-GbOS in short)in (X, τ_N).if the complement P^C is a Neu-GbCS in X. The family of all Neu-GbOSs of a N-T-S (X, τ_N) is denoted by Neu-GbO (X).

Example 4.2.Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X ,where $E_1 = \langle x, \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbOS in X.

Theorem 4.3. For any N-T-S (X, τ_N)., we have the following:

1. Every Neu-OS is a Neu-GbOS.
2. Every Neu-bOS is a Neu-GbOS.
3. Every Neu-αOS is a Neu-GbOS.
4. Every Neu-GOS is a Neu-GbOS.
5. Every Neu-GPOS is a Neu-GbOS.

Proof. Straight forward.

The converse part of the above results need not be correct in common as seen from using following **examples.**

Example 4.4. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{4}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{4}{10}, \frac{6}{10}, \frac{6}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbOS but not a Neu-OS in X.

Example 4.5. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{1}{10}, \frac{5}{10}, \frac{9}{10}\right)\rangle$ is a Neu-GbOS but not a Neu-bOS in X.

Example 4.6. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{3}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is a Neu-GbOS but not a Neu-bOS in X.

Example 4.7. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X

where $E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{7}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$.Then the Neutrosophic set $P = \langle x, \left(\frac{8}{10}, \frac{5}{10}, \frac{0}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$ is a Neu-GbOS but not a Neu-GOS in X.

Example 4.8. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, E_2, 1_N\}$ is be a N.T.on X where

$E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$, $E_2 = \langle x, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ .Then the Neutrosophic set $P = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is a Neu-GbOS but not a Neu-GPOS in X.

The intersection of any two Neu-GbOSs need not be a Neu-GbOS in general

Example 4.9. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X

where $E_1 = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$, .Then the Neutrosophic sets $P = \langle x, \left(\frac{6}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right)\rangle$

and $Q = \langle x, \left(\frac{7}{10}, \frac{5}{10}, \frac{2}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$are Neu-GbOSs but P∩Q is not a Neu-GbOS in X.

Theorem 4.10. A Neutrosophic set P of a N-T-S (X, τ_N)., is a Neu-GbOS if and only if H⊆Neu-bint(P) whenever H is a Neu-CS and H⊆P.

Proof. Necessity: Suppose P is a Neu-GbOS in X. Let G be a Neu-CS and H⊆P. Then F^C is a Neu-OS in X such that $P^C \subseteq H^C$. Since P^C is a Neu-GbCS, Neu-bcl(P^C) ⊆H^C.Hence (Neu-bint(P))^C ⊆H^C . This implies H⊆Neu-bint(P).

Sufficiency: Let P be any Neutrosophic set of X and let H⊆Neu-bint(P) whenever H is a Neu-CS and H⊆P.Then P⊆H^C and H^C is a Neu-OS. By hypothesis, (Neu-bint(P))^C⊆H^C . Hence Neu-bcl(P^C) ⊆H^C . Hence P is a Neu-GbOS in X.

Theorem 4.11. If P is a Neu-GbOS in (X, τ_N)., such that Neu-bint(P) ⊆Q⊆P then Q is a Neu-GbOS in (X, τ_N)

Proof. By hypothesis, we have Neu-bint(P)⊆Q⊆P. This implies $P^C \subseteq Q^C \subseteq$(Neu-bint(P)) ^{C}. That is, $P^C \subseteq Q^C \subseteq$Neubcl($P^C$). Since P^C is a Neu-GbCS, by theorem 3.26, Q^C is a Neu-GbCS. Hence Q is a Neu-GbOS in X.

5. Applications of Neutrosophic Generalized b Closed Sets

In this section, we introduce Neutrosophic $bU_{1/2}$ spaces, Neutrosophic $gbU_{1/2}$ spaces and Neutrosophic gbU_b spaces in Neutrosophic topological space and study some of their properties.

Definition *5.1.* A N-T-S (X, τ_N)., is called a Neutrosophic $bU_{1/2}$ space (Neu- $bU_{1/2}$space in short) if every Neu-bCS in X is a Neu-CS in X.

Definition *5.2.* A N-T-S (X, τ_N)., is called a Neutrosophic $gbU_{1/2}$ space (Neu-$gbU_{1/2}$ space in short) if every Neu-GbCS in X is a Neu-CS in X.

Definition 5.3. A N-T-S (X, τ_N)., is called a Neutrosophic gbU_b space (Neu- gbU_b space in short) if every Neu-GbCS in X is a Neu-bCS in X.

Theorem 5.4. Every Neu-$gbU_{1/2}$ space is a Neu- gbU_b space.

Proof. Let (X, τ_N)be a Neu-$gbU_{1/2}$ space and let P be a Neu-GbCS in X. By hypothesis, P is a Neu-CS in X.Since every Neu-CS is a Neu-bCS, P is a Neu-bCS in X. Hence (X, τ_N)., is a Neu- gbU_b space.

The converse of the above theorem need not be true in general as seen from the following example.

Example 5.5. Let $X = \{p_1, p_2\}$ $\tau_N = \{0_N, E_1, 1_N\}$ is be a N.T.on X where $E_1 = \langle x, \left(\frac{9}{10}, \frac{5}{10}, \frac{9}{10}\right), \left(\frac{1}{10}, \frac{5}{10}, \frac{1}{10}\right)\rangle$,.Then the Neutrosophic set

$P = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$ is a Neu- gbU_bspace but not a Neu-$gbU_{1/2}$space,

Theorem 5.6. Let (X, τ_N) ., be a N-T-S and (X, τ_N) .,a Neu- $gbU_{1/2}$ space. Then the following statements hold.

1. Any union of Neu-GbCS is a Neu-GbCS.
2. Any intersection of Neu-GbOS is a Neu-GbOS.

Proof. 1. Let $\{A_i\}_{i\in j}$ be a collection of Neu-GbCS in a Neu-$gbU_{1/2}$space (X, τ_N)., Therefore every Neu-GbCS is a Neu-CS. but the union of Neu-CS is a Neu-CS. Hence the union of Neu-GbCS is a Neu-GbCS in X.

2. It can be proved by taking complement in (1).

Theorem 5.7. A N-T-S (X, τ_N)., is a Neu- gbU_b space if and only if Neu-Gb(X)=Neu-bO(X).

Proof. Necessity: Let P be a Neu-GbOS in X. Then P^C is a Neu-GbCS in X. By hypothesis, P^C is a Neu-bCS in X. Therefore P is a Neu-bOS in X. Hence Neu-GbO (X)=Neu-bO(X).

Sufficiency: Let P be a Neu-GbCS in X. Then P^C is a Neu-GbOS in X. By hypothesis, P^C is a Neu-bOS in X. Therefore P is a Neu-bCS in X. Hence(X, τ_N)., is a Neu- gbU_b space.

Theorem 5.8. A N-T-S (X, τ_N) is a Neu-$gbU_{1/2}$ space if and only if Neu-GbO(X) = Neu-O(X).

Proof. Necessity: Let P be a Neu-GbOS in X. Then P^C is a Neu-GbCS in X. By hypothesis, P^C is a Neu-CS in X. Therefore P is a Neu-OS in X. Hence Neu-GbO(X)=Neu-O(X).

Sufficiency: Let P be a Neu-GbCS in X.Then P^C is a Neu-GbOS in X. By hypothesis, P^C is a Neu-OS in X. Therefore P is a Neu-CS in X. Hence (X, τ_N) is a Neu-$gbU_{1/2}$space.

6. Neutrosophic generalized b continuity mapping

In this section we have introduced Neutrosophic generalized b continuity mapping and studied some of its properties.

Definition 6.1. A mapping $f: (X, \tau_N) \to (Y, \sigma_N)$is called a Neutrosophic generalized b continuity (Neu-Gbcontinuity in short) if $f^{-1}(Q)$ is a Neu-Gb CS in $(X, \tau_N)$for every Neu-CS Q of (Y, σ_N).

Example 6.2. Let $X = \{p_1, p_2\}, Y = \{q_1, q_2\}, E_1 = \langle x, \left(\frac{2}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$ $E_2 = \langle x, \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$, $\tau_N = \{0_N, E_1, 1_N\}$ and $\sigma_N = \{0_N, E_2, 1_N\}$ are N-T-S on X and Y respectively. Define a mapping $f: (X, \tau_N) \to (Y, \sigma_N)$ by $f(p_1)=q_1$ and $f(p_2)=q_2$ .Then f is a Neu-Gb continuity mapping.

Theorem 6.3. Every Neutrosophic continuity mapping is a Neu-Gb continuity mapping but not conversely.

Proof. Let $f: (X, \tau_N) \to (Y, \sigma_N)$ be a Neutrosophic continuity mapping. Let P be a Neu-CS in Y. Since f is Neutrosophic continuity mapping, $f^{-1}(P)$ is a Neu-CS in X. Since every Neu-CS is a Neu-GbCS, $f^{-1}(P)$ is a Neu-Gb CS in X. Hence f is a Neu-Gb continuity mapping

Example 6.4. Let $X=\{p_1,p_2\}, Y=\{q_1,q_2\}, E_1=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$ $E_2=\langle x,\left(\frac{4}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right)\rangle$, $\tau_N=\{0_N,E_1,1_N\}$ and $\sigma_N=\{0_N,E_2,1_N\}$ are N-T-S on X and Y respectively. Define a mapping $f:(X,\tau_N)\to(Y,\sigma_N)$ by f(p1)=q1 and f(p2)=q2 .The Neutrosophic set $P=\langle x,\left(\frac{5}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is Neu-CS in Y. Then $f^{-1}(P)$ is Neu-GbCS in X but not Neu-CS in X. Therefore, f is a Neu-Gb continuity mapping but not a Neutrosophic continuity mapping.

Theorem 6.5. Every Neu-α continuity mapping is a Neu-Gb continuity mapping but not conversely.

Proof. Let $f:(X,\tau_N)\to(Y,\sigma_N)$ be a Neu- α continuity mapping. Let P be a Neu-CS in Y. Then $f^{-1}(P)$ is a Neu-αCS in X. Since every Neu-αCS is a Neu-GbCS, $f^{-1}(P)$ is a Neu-GbCS in X. Hence, f is a Neu-Gb continuity mapping.

Example 6.6. Let $X=\{p_1,p_2\}, Y=\{q_1,q_2\}, E_1=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right)\rangle$ $E_2=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{6}{10}\right)\rangle$, $\tau_N=\{0_N,E_1,1_N\}$ and $\sigma_N=\{0_N,E_2,1_N\}$ are N-T-S on X and Y respectively. Define a mapping

$f:(X,\tau_N)\to(Y,\sigma_N)$ by f(p1)=q1 and f(p2)=q2 .The Neutrosophic set $P=\langle x,\left(\frac{5}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is Neu-CS in Y. Then $f^{-1}(P)$ is Neu-Gb CS in X but not Neu- αCS in X. Then f is Neu-Gb continuity mapping but not a Neu- α continuity mapping.

Theorem 6.7. Every Neu-R continuity mapping is a Neu-Gb continuity mapping but not conversely.

Proof. Let $f:(X,\tau_N)\to(Y,\sigma_N)$ be a Neu-R continuity mapping. Let P be a Neu-CS in Y. Then by hypothesis $f^{-1}(P)$ is a Neu-RCS in X. Since every Neu-RCS is an Neu-GbCS, $f^{-1}(P)$ is a Neu-Gb CS in X. Hence, f is a Neu-Gb continuity mapping.

Example 6.8. Let $X=\{p_1,p_2\}, Y=\{q_1,q_2\}, E_1=\langle x,\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right)\rangle$ $E_2=\langle x,\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$, $\tau_N=\{0_N,E_1,1_N\}$ and $\sigma_N=\{0_N,E_2,1_N\}$ are N-T-S on X and Y respectively. Define a mapping $f:(X,\tau_N)\to(Y,\sigma_N)$ by f(p1)=q1 and f(p2)=q2 .The Neutrosophic set $P=\langle x,\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$ is Neu-CS in Y. Then $f^{-1}(P)$ is Neu-Gb CS in X but not Neu-RCS in X. Then f is Neu-Gb continuity mapping but not a Neu-R continuity mapping

Theorem 6.9. Every Neu-GS continuity mapping is a Neu-Gb continuity mapping but not conversely.

Proof. Let $f:(X,\tau_N)\to(Y,\sigma_N)$ be a Neu-GS continuity mapping. Let P be a Neu-CS in Y. Then by hypothesis $f^{-1}(P)$ is a Neu-GCS in X. Since every Neu-GSCS is a Neu-Gb CS, $f^{-1}(P)$ is a Neu-GbCS in X. Hence f is a Neu-Gb continuity mapping

Example 6.10. Let $X=\{p_1,p_2\}, Y=\{q_1,q_2\}, E_1=\langle x,\left(\frac{5}{10},\frac{5}{10},\frac{2}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$ $E_2=\langle x,\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$, $\tau_N=\{0_N,E_1,1_N\}$ and $\sigma_N=\{0_N,E_2,1_N\}$ are N-T-S on X and Y respectively. Define a mapping $f: (X, \tau_N) \to (Y, \sigma_N)$ by f(p1)=q1 and f(p2)=q2 .The Neutrosophic set $P = \langle x, \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is Neu-CS in Y. Then $f^{-1}(P)$ is Neu-Gb CS in X but not Neu-GSCS in X. Then f is Neu-Gb continuity mapping but not a Neu-GS continuity mapping.

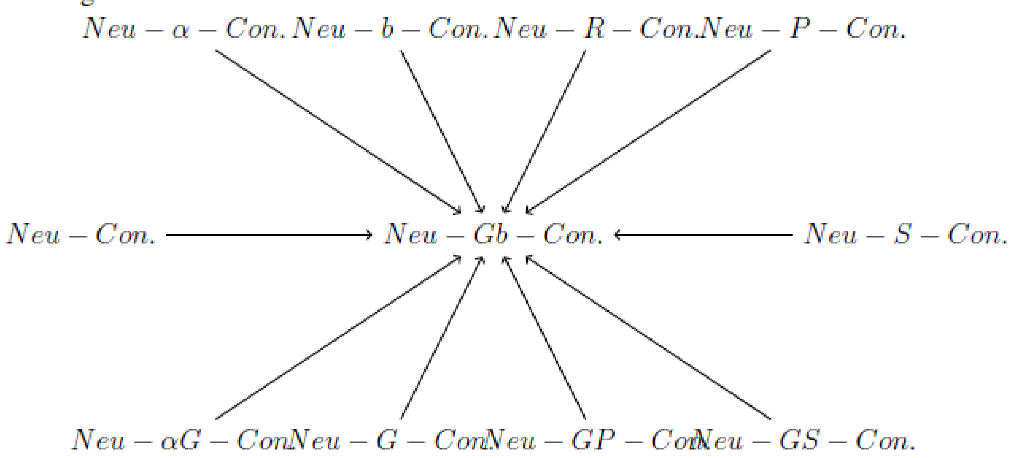
Theorem 6.11. Every Neu-αG continuity mapping is a Neu-Gb continuity mapping but not conversely.

Proof. Let $f: (X, \tau_N) \to (Y, \sigma_N)$ be anNeu-αG continuity mapping. Let P be a Neu-CS in Y. Then, by hypothesis $f^{-1}(P)$ is a Neu- αgcs in X. Since, every Neu- αGCS is a Neu-GSCS and every Neu-GSCS is a Neu-GbCS, $f^{-1}(P)$ is a Neu-Gb CS in X. Hence f is a Neu-Gb continuity mapping.

Example 6.12. Let $X = \{p_1, p_2\}, Y = \{q_1, q_2\}, E_1 = \langle x, \left(\frac{5}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ $E_2 = \langle x, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$, $\tau_N = \{0_N, E_1, 1_N\}$ and $\sigma_N = \{0_N, E_2, 1_N\}$ are N-T-S on X and Y respectively. Define a mapping $f: (X, \tau_N) \to (Y, \sigma_N)$ by f(p1)=q1 and f(p2)=q2 .The Neutrosophic set $P = \langle x, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$ is Neu-CSin Y. Then $f^{-1}(P)$ is Neu-Gb CS in X but not Neu-αGCS in X. Then f is Neu-Gb continuity mapping but not an Neu-αG continuity mapping.

The following implications are true:

Diagram-II



Theorem 6.13. A mapping $f: X \to Y$ is Neu-Gb continuity then the inverse image of each Neu-OS in Y is a Neu-αGOS in X.

Proof. Let P be a Neu-OS in Y. This implies P^C is Neu-CS in Y. Since f is Neu-Gb continuity, $f^{-1}(P^C)$ is Neu-Gb CS in X. Since $f^{-1}(P^C)=(f^{-1}(P))^C$, $f^{-1}(P)$ is a Neu-Gb OS in X.

Theorem 6.14. Let $f: (X, \tau_N) \to (Y, \sigma_N)$ be a Neu-Gb continuity mapping, then f is a Neutrosophic continuity mapping if X is a Neu-$bU_{1/2}$ space.

Proof. Let P be a Neu-CS in Y. Then $f^{-1}(P)$ is a Neu-Gb CS in X, since f is a Neu-Gb Continuity. Since X is a Neu-$bU_{1/2}$ space, $f^{-1}(P)$ is a Neu-CS in X. Hence f is a Neutrosophic continuity mapping.

Theorem 6.15. Let $f: (X, \tau_N) \to (Y, \sigma_N)$ be a Neu-Gb continuity function, then f is a Neu-G continuity mapping if X is a Neu-gb$U_{1/2}$space

Proof. Let P be a Neu-CS in Y. Then $f^{-1}(P)$ is a Neu-GbCS in X, by hypothesis. Since X is a Neu-gb$U_{1/2}$ space, $f^{-1}(P)$ is a Neu-GCS in X. Hence f is a Neu-G continuity mapping.

Theorem 6.16. Let $f: (X, \tau_N) \to (Y, \sigma_N)$ be a Neu-Gb continuity mapping and $g: (X, \tau_N) \to (Z, \rho_N)$ is Neutrosophic continuity, then gof: $(X, \tau_N) \to (Z, \rho_N)$is a Neu-Gb continuity.

Proof. Let P be a Neu-CS in Z. Then, $g^{-1}(P)$ is a Neu-CS in Y, by hypothesis. Since, f is a Neu-Gb continuity mapping, $f^{-1}(g^{-1}(P))$ is a Neu-Gb CS in X. Hence, g of is a Neu-Gb continuity mapping.

7 .Conclusion

Many different forms of closed sets have been introduced over the years. Various interesting problems arise when one considers openness. Its importance is significant in various areas of mathematics and related sciences, in this paper we have introduced Neutrosophic generalized b closed sets in Neutrosophic Topological Spaces and then we presented Neutrosophic generalized b continuity mapping and studied some of its properties. Also we investigate the relationships between the other existing Neutrosophic continuity functions. This shall be extended in the future Research with some applications

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Received: May 20, 2019. Accepted: October 09, 2019