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Research Article

ON NEUTROSOPHIC MILDLY GENERALIZED SEMI STAR α - CLOSED SETS IN NEUTROSOPHIC TOPOLOGICAL SPACES

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Abstract

The Neutrosophic mildly generalized semi star α- closed sets in Neutrosophic topological spaces are a novel class of sets that we present in this study (briefly Neu - mgs* α - closed sets). Here, we study the concepts and discuss the properties of Neu - mgs* α - closed sets.

Keywords: Neutrosophic set, Neutrosophic topological space, Neutrosophic Mildly Generalized Semi Star α - closed sets, Neutrosophic mildly generalized semi star α - open sets, Neutrosophic mildly generalized semi star α – Neighbourhoods..

Introduction

Since Zadeh introduced the fuzzy set notation in 1965, it has spread to practically all areas of mathematics. Chang (1968) proposed and developed the idea of fuzzy topological space, and since then, To create fuzzy topological spaces, numerous concepts from classical topology have been used. Initially, the intuitionistic fuzzy set's concept was proposed in 1988 by Atanassov. Thakur and Chaturvedi (2006) established and extended the concept behind the generalized intuitionistic fuzzy closed set. After Smarandache (2000) proposed and expanded the notions of the neutrosophic set along with neutrosophy.

This article covers the concepts of mildly generalized semi Star α - closed sets and several interesting properties and some theorems are also discussed.

Preliminaries

Here, we review several essential Neutrosophic set findings as well as their basic operation and definition.

Definition 2.1

Non-empty fixed set S must be S. Neutrosophic sets M is the object in following form:

$$M = \{\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle; s \in S\}$$

With,

i. $\mu_M(s)$ is the membership function degree
ii. $\sigma_M(s)$ is the indeterminacy degree
iii. $\gamma_M(s)$ is the non-membership function degree

Remark 2.2

The Neutrosophic sets M = $\{\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle; s \in S\}$ may be identified as an ordered triple M = $\langle \mu_M, \sigma_M, \gamma_M\rangle$in] -0, 1+ [on Y.

Remark 2.3

We can denote, the Neutrosophic sets "M = $\{\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle; s \in S\}$ as M = $\{\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle\}$

Definition 2.4

Every non -empty Intuitionistic fuzzy set in S is called the Neutrosophic set. Where the topological space we may define O_N and I_N as follows:

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For all $s \in S$

$$O_1 = \langle s, 1,0,0\rangle \qquad N_1 = \langle s, 1,0,0\rangle$$
$$O_2 = \langle s, 1,0,1\rangle \qquad N_2 = \langle s, 1,0,1\rangle$$
$$O_3 = \langle s, 1,1,0\rangle \qquad N_3 = \langle s, 1,1,0\rangle$$
$$O_4 = \langle s, 1,1,1\rangle \qquad N_4 = \langle s, 1,1,1\rangle$$

Definition 2.5

For all $s \in S$, the complement of Neutrosophic sets M [shortly C - M] is expressed as

C – M = $\{\langle s, \gamma_M(s), 1 - \sigma_M s, \mu_M(s)\rangle\}$

Definition 2.6

For all $s \in S$, the two Neutrosophic sets M & P are given by

$$M = \langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle$$
$$P = \langle s, \mu_P(s), \sigma_P(s), \gamma_P(s)\rangle$$

Then, the subset $(M \subseteq P)$ is $M \subseteq P \Leftrightarrow \mu_M(s) \leq \mu_P(s), \sigma_M(s) \leq \sigma_P(s), \gamma_M(s) \leq \gamma_P(s)$

Proposition 2.7

Any Neutrosophic set M meets the under given requirements

i. $O_N \subseteq M, O_N \subseteq O_N$
ii. $M \subseteq I_N, I_N \subseteq I_N$

Definition 2.8

For any non-empty set M the intersection and union of any 2 Neutrosophic sets M and P, where

E = $\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle$ and F = $\langle s, \mu_P(s), \sigma_P(s), \gamma_P(s)\rangle$ is given by

i. $M \cup P = \langle s, \mu_M(s) \wedge \mu_P(s), \sigma_M(s) \wedge \sigma_P(s), \gamma_M(s) \wedge \gamma_P(s)\rangle$
ii. $M \cap P = \langle s, \mu_M(s) \vee \mu_P(s), \sigma_M(s) \vee \sigma_P(s), \gamma_M(s) \vee \gamma_P(s)\rangle$ respectively

Proposition 2.9

The two Neutrosophic sets M and P are subject to the following criteria.

i. $C - (M \cap P) = C - M \cup C - P$
ii. $C - (M \cup P) = C - M \cap C - P$

Definition 2.10

A family $\tau_N$of Neutrosophic subsets in Neutrosophic topological set S holds the following axioms

i. $O_N, I_N \in \tau_N$
ii. $for\ any\ Q_1, Q_2 \in \tau_N, Q_1 \cap Q_2 \in \tau_N$
iii. $for\ each\ \{Q_i; i \in J\} \subseteq \tau_N, \cup\ Q_I \in \tau_N$

The pair $(S, \tau_N)$is thus referred to as neutrosophic topological space. Neutrosophic open sets are the constituents of Neutrosophic topological spaceτ_N, while Neutrosophic closed sets works as complements of open sets.

Definition 2.11

The Neutrosophic closure and interior of a family (S, τ_N) Neutrosophic topological space for a Neutrosophic set

M = $\{\langle s, \mu_M(s), \sigma_M(s), \gamma_M(s)\rangle; s \in S\}$ in S is defined by

Neu – cl (M) = $\cap \{G: G\ is\ a\ Neutrosophic\ closed\ set\ in\ Sand\ M \subseteq G\}$

Neu – Int (M) = ∪ $\{J: J\ is\ a\ Neutrosophic\ open\ set\ in\ S\ and\ M \subseteq J\}$ respectively and it holds the following conditions

i. M is Neutrosophic open set if, M = Neu-Int (M)
ii. M is Neutrosophic closed set if, M = Neu-cl (M)

Proposition 2.12

For any Neutrosophic set M of a family (S, τ_N) Neutrosophic topological space, we've

i. Neu-cl(C - M) = C – (Neu – Int(M))
ii. Neu-Int(C - M) = C – (Neu – cl(M))

Proposition 2.13

Any two M and P Neutrosophic sets have the aforementioned characteristics in Neutrosophic topological space (S, τ_N)

i. $Neu - Int(M) \subset M$
ii. $M \subseteq Neu - cl(M)$
iii. $M \subseteq P \Rightarrow Neu - Int(M) \subseteq Neu - Int(P)$
iv. $M \subseteq P \Rightarrow Neu - cl(M) \subseteq Neu - cl(P)$
v. $Neu - Int\big(Neu - Int(M)\big) = Neu - Int(M)$
vi. $Neu - cl\big(Neu - cl(M)\big) = Neu - cl(M)$
vii. $Neu - Int(M \cap P) = Neu - Int(M) \cap Neu - Int(P)$
viii. $Neu - cl(M \cup P) = Neu - cl(M) \cap Neu - cl(P)$
ix. $Neu - Int(O_N) = O_N$
x. $Neu - Int(I_N) = I_N$
xi. $Neu - cl(O_N) = O_N$
xii. $Neu - cl(I_N) = I_N$
xiii. $M \subseteq P \Rightarrow C - M \subseteq C - P$
xiv. $Neu - cl(M \cap P) \subseteq Neu - cl(M) \cap Neu - cl(P)$
xv. $Neu - Int(M \cup P) \supseteq Neu - Int(M) \cap Neu - Int(P)$

Definition 2.14

A subset M of a Neutrosophic topological space (S, τ_N) is known as a generalized Neutrosophic closed if $Neu - cl(M) \subseteq U, whenever\ M \subseteq U$and U is Neutrosophic closed set.

Neutrosophic Mildly Generalized Semi Star α - closed sets

We present and explore the novel idea of Neutrosophic slightly generalised semi star α - closed sets in Neutrosophic topological spaces in this part.

Definition 3.1

Neutrosophic slightly generalised semi star $\boldsymbol{\alpha}$ closed sets are a Neutrosophic subset M of a Neutrosophic topological space(S, τ_N) (shortly Neu – mgs$^*\boldsymbol{\alpha}$ **-** closed) if $Neu - Jcl(M) \subseteq U\ whenever\ M \subseteq U$and U is Neutrosophic mildly generalised semi open (Neu – mgs – open) in Neutrosophic set M.

Theorem 3.2

Every set that is Neu-closed is Neu - mgs*$\boldsymbol{\alpha}$ - closed.

Proof:

Now consider any Neutrosophic closed-set M and $M \subseteq U$,
Where, U is Neutrosophic mildly generalized semi open (Neu – mgs – open)
Since, M is Neutrosophic closed (Neu-closed) $Neu - Jcl(M) \subseteq Neu - cl(M)$
Therefore, $Neu - Jcl(M) \subseteq M \subseteq M \subseteq U$
Hence, M is Neu – mgs$^*\boldsymbol{\alpha}$ **-** closed in S.

Remark 3.3

i. Finite union of Neu – mgs*$\boldsymbol{\alpha}$ **-** closed need not be Neu – mgs$^*\boldsymbol{\alpha}$ **-** closed
ii. Finite intersection of Neu – mgs$^*\boldsymbol{\alpha}$ **-** closed need not be Neu – mgs$^*\boldsymbol{\alpha}$–closed

Definition 3.4

The intersection of all Neu - mgs*α - closed sets including a given subset M of "Neutrosophic topological space"(S, τ_N) is referred to as Neu - mgs*α - closure of E and we can denote it by Neu – mgs*α -cl(M).

Symbolically, $Neu -$ mgs* α - cl(M) =∩ {K: $M \subset K$, K is $Neu -$ mgs*$\alpha -$ closed in S}

Remark 3.5

The following conditions hold for a subsets M and P of Neutrosophic topological space

i. $Neu -$ mgs* α - cl$(\varphi) = \varphi andNeu -$ mgs* α - cl$(X) = X$
ii. $M \subset P \Rightarrow Neu -$ mgs* α - cl$(M) \subset Neu -$ mgs* α - cl(P)
iii. $M \subset P \Rightarrow Neu -$ mgs* α - cl $\left(Neu -\right.$ mgs* α - cl$\left.(M)\right)$= $Neu -$ mgs* α - cl(M)
iv. $Neu -$ mgs* α - cl$(M \cup P) \supseteq Neu -$ mgs* α - cl$(P) \cup Neu -$ mgs* α - cl(P)
v. $Neu -$ mgs* α - cl$(M \cap P) \subseteq Neu -$ mgs* α - cl$(M) \cap Neu -$ mgs* α - cl(P)

Neutrosophic mildly generalized semi star α - open sets and Neutrosophic mildly generalized semi star α – Neighbourhoods

Here we introduced the notion of Neutrosophic mildly generalized semi star $\boldsymbol{\alpha}$ - open sets and by using it we obtain the characterizations of Neutrosophic mildly generalized semi star $\boldsymbol{\alpha}$ - neighbourhoods.

Definition 4.1

The term Neutrosophic moderately generalized semi star $\boldsymbol{\alpha}$ -open set refers to a subset P of a Neutrosophic topological space. If C - E is $Neu -$ mgs* α -closed in Y, then (briefly $Neu -$ mgs* α -open). All Neutrosophic family mildly generalized semi star $\boldsymbol{\alpha}$ - open sets can be denoted by $Neu -$ mgs $* \alpha(S, \tau_N)$

Remarks 4.2

i. Finite union of Neu – mgs*$\boldsymbol{\alpha}$ - open sets require not be Neu – mgs*$\boldsymbol{\alpha}$ - open
ii. Finite intersection of Neu – mgs*$\boldsymbol{\alpha}$ - open sets require not be Neu – mgs*$\boldsymbol{\alpha}$–open

Definition 4.3

Any point in the Neutrosophic topological space S will do as y. If and only if a Neu - mgs*α - open set R exists such that$y \in R \subseteq T$, a subset T of Y is said to be a Neu - mgs*α - neighbourhood of S.

Definition 4.4

A subset T of a topological space with neutrosophic properties Y is referred to as a Neu - mgs*α - $M \subset Y$neighbourhood if there exists a Neu – mgs*α - open set N such that $M \subseteq R \subseteq T$

Remark 4.5

Each neighbourhood M of $s \in S$ is a Neu – mgs*α - neighbourhood of s

Definition 4.6

The Neu - mgs*α - neighbourhood system at s for every point s in a Neutrosophic topological space S is the collection of all Neu - mgs*α - neighbourhoods, and it is denoted by Neu - mgs*α - M (s).

Theorem 4.7

For all $s \in S$ and S be a Neutrosophic topological space, let Neu – mgs*α - M(s) be the collection of all Neu – mgs*α - neighbourhood of s, then it holds the following conditions

i. $\forall s \in S$,Neu - mgs* - T$(s) \neq \varphi$
ii. $T \in$ Neu - mgs* - T$(s) \Rightarrow y \in T$
iii. $T \cup \in$ Neu - mgs* - T$(s), R \supset T \Rightarrow R \in$ Neu - mgs* - T(s)
iv. $T \in$ Neu - mgs* - T$(s) \Rightarrow \exists$ R $\in$ Neu - mgs* - T$(s) \ni R \subset TandR \in$ Neu - mgs* - T$(z) \forall z \in R$

Definition 4.8

Suppose M represent a subset of Neutrosophic space S. If there is a Neu - mgs*α -open set R such that$y \in R \subseteq M$, a $s \in S$ point is said to be a Neu - mgs*- internal point of M. The term Neu - mgs*α - interior of M refers to the set of all Neu - mgs*α - interior points of M and we can denote it by Neu – mgs*α - int(M)

Theorem 4.9

The following assertions are valid, for subsets M and P of Neutrosophic topological space S,

i. $Neu - \text{mgs*}\alpha - int(M)$ is union of all $Neu - \text{mgs*}\alpha$ −open M subsets.
ii. $M = Neu - \text{mgs*}\alpha - int(M)\ if\ M\ isNeu - \text{mgs*}\alpha - open$
iii. $Neu - \text{mgs*}\alpha - int(Neu - \text{mgs*}\alpha - int(M)) = Neu - \text{mgs*}\alpha - int(M)$
iv. $Neu - \text{mgs*}\alpha - int(M) = M\backslash Neu - D_{\text{mgs*}\alpha}(S\backslash M)$
v. $S\backslash Neu - \text{mgs*}\alpha - int(M) = Neu - \text{mgs*}\alpha - cl(S\backslash M)$
vi. $S\backslash Neu - \text{mgs*}\alpha - cl(M) = Neu - \text{mgs*}\alpha - int(Y\backslash M)$
vii. $M \subseteq P \Rightarrow Neu - \text{mgs*}\alpha - int(M) \subseteq Neu - \text{mgs*}\alpha - int(P)$
viii. $Neu - \text{mgs*}\alpha - int(M) \cup Neu - \text{mgs*}\alpha - int(P) \subseteq Neu - \text{mgs*}\alpha - int(M \cup P)$
ix. $Neu - \text{mgs*}\alpha - int(M \cup P) \subseteq Neu - \text{mgs*}\alpha - int(M) \cap Neu - \text{mgs*}\alpha - int(P)$

Definition 4.10

The $Neu - \text{mgs*}\alpha$ - border and the $Neu - \text{mgs*}\alpha$ - frontier of M; M is any subset of the Neutrosophic topological space S is given by the set $\text{Neu} - b_{\text{mgs*}\alpha}(M) = M\backslash Neu - \text{mgs*}\alpha - int(M)$ and the set $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = Neu - \text{mgs*}\alpha - cl(M)\backslash Neu - \text{mgs*}\alpha - int(M)$ respectively.

Remarks 4.11

$\text{Neu} - b_{\text{mgs*}\alpha}(M) = \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$if E is an $Neu - \text{mgs*}\alpha$ - closed subset of Neutrosophic topological space S

Theorem 4.12

Mentioned below are the conditions hold for any subset E of the Neutrosophic topological space S

i. $M = Neu - \text{mgs*}\alpha - int(M) \cup \text{Neu} - b_{\text{mgs*}\alpha}(M)$
ii. $Neu - \text{mgs*}\alpha - int(M) \cap \text{Neu} - b_{\text{mgs*}\alpha}(M) = \varphi$
iii. $\text{Neu} - b_{\text{mgs*}\alpha}(M) = \varphi\ if\ M\ is\ an\ Neu - \text{mgs*}\alpha - open\ set$
iv. $\text{Neu} - b_{\text{mgs*}\alpha}(Neu - \text{mgs*}\alpha - int(M)) = \varphi$
v. $Neu - \text{mgs*}\alpha - int\left(\text{Neu} - b_{\text{mgs*}\alpha}(M)\right) = \varphi$
vi. $\text{Neu} - b_{\text{mgs*}\alpha}\left(\text{Neu} - b_{\text{mgs*}\alpha}(M)\right) = \text{Neu} - b_{\text{mgs*}\alpha}(M)$
vii. $\text{Neu} - b_{\text{mgs*}\alpha}(M) = M \cap Neu - \text{mgs*}\alpha - cl(S\backslash M)$
viii. $\text{Neu} - b_{\text{mgs*}\alpha}(M) = M \cap Neu - D_{\text{mgs*}\alpha}(S\backslash M)$

Theorem 4.13

The following assertions are valid, for subsets M of Neutrosophic topological space S,

i. $Neu - \text{mgs*}\alpha - cl(M) = Neu - \text{mgs*}\alpha - int(M) \cup \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$
ii. $Neu - \text{mgs*}\alpha - int(M) \cup \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = \varphi$
iii. $\text{Neu} - b_{\text{mgs*}\alpha}(M) \subseteq \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$
iv. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = \text{Neu} - b_{\text{mgs*}\alpha}(M) \cup \text{Neu} - D_{\text{mgs*}\alpha}(M)\backslash Neu - \text{mgs*}\alpha - int(M)$
v. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = \text{Neu} - b_{\text{mgs*}\alpha}(Y\backslash M) ifE\ is\ an\ Neu - \text{mgs*}\alpha - openset$
vi. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = Neu - \text{mgs*}\alpha - cl(M) \cap Neu - \text{mgs*}\alpha - cl(S\backslash M)$
vii. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) = \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(S\backslash M)$
viii. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M) isNeu - \text{mgs*}\alpha - closed$
ix. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}\left(\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)\right) \subseteq \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$
x. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(Neu - \text{mgs*}\alpha - int(M)) \subseteq \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$
xi. $\text{Neu} - \text{Fr}_{\text{mgs*}\alpha}\left(Neu - \text{mgs*}\alpha - cl(M)\right) \subseteq \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$
xii. $Neu - \text{mgs*}\alpha - int(M) = M\backslash \text{Neu} - \text{Fr}_{\text{mgs*}\alpha}(M)$

Definition 4.14

The $Neu -$ mgs*α $-$exterior of M; M is any subset of S given by $Neu -$ mgs*α $-$the interior of S\M and we can be denoted by $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M)$. That is, $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) = Neu - \mathrm{mgs}*\alpha - int(S\backslash M)$

Theorem 4.15

The following assertions are valid, for subsets M and P of Neutrosophic topological space S,

i. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) = Neu - \mathrm{mgs}*\alpha - open$
ii. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) = S\backslash Neu - \mathrm{mgs}*\alpha - cl(M)$
iii. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}\left(\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M)\right) = Neu - \mathrm{mgs}*\alpha - int\big(Neu - \mathrm{mgs}*\alpha - cl(M)\big) \supseteq Neu - \mathrm{mgs}*\alpha - int(M)$
iv. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(P) \subseteq \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) if M \subseteq P$
v. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M \cup P) \subseteq \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) \cap \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(P)$
vi. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M \cap P) \supseteq \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) \cup \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(P)$
vii. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(S) = \varphi$
viii. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(\varphi) = S$
ix. $\mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) = \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}\left(S\backslash \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M)\right)$
x. $Y = Neu - \mathrm{mgs}*\alpha - int(M) \cup \mathrm{Neu} - \mathrm{Ext}_{\mathrm{mgs}*\alpha}(M) \cup \mathrm{Neu} - \mathrm{Fr}_{\mathrm{mgs}*\alpha}(M)$

Conclusion

In this paper, we defined some new classes of Neutrosophic Mildly Generalized Semi Star α - closed sets and studied some of their basic properties. Finally we have introduced Neutrosophic mildly generalized semi star α - open sets and Neutrosophic mildly generalized semi star α – Neighbourhoods in Neutrosophic topological space and studied some their properties.

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