

A Note On μ_N Disconnectedness

N.Raksha Ben¹, G.Helen Rajapushpam²

^{1,2} Assistant Professor of Mathematics, PG and Research Department of Mathematics, Nazareth Margoschis College at Pillaiyanmanai, Nazareth-628617

1,2. (Affiliated to Manonmaniam Sundaranar University, Tirunelveli-12, Tamil Nadu, India)

Correspondence email: raksha@nmcp.ac.in

Received: 12-11-2024

Accepted: 28-11-2024

Published: 07-12-2024

Abstract:

In this article, we are going to introduce a new concept in μ_N Disconnectedness and their types and various characters are to be discussed in detail. Also, we define μ_N Hyperconnectedness and its properties are also contemplated.

Keywords: μ_N Disconnectedness, μ_N connectedness, μ_N hyperconnected.

Introduction:

The idea of fuzzy set which plays a vital role in almost all sectors of mathematics. Belatedly C.L Chang brought out fuzzy topological space and after that several notions in general topology were extended and enhanced in fuzzy topological spaces. K.T Attansov published his idea of intuitionistic set and some research works came into the literature. The concept of neutrosophy and neutrosophic sets were put forth by Samarandache with his idea later on Salama and Albawi introduced neutrosophic crisp sets. The concept of resolvability and irresolvability in neutrosophic topology was brought out by Dhavaseelan et al.

Necessities:

Definition 2.1[13]:

Let X be a non-empty fixed set. A Neutrosophic set [NS for short] A is an object having the form $A = \{\langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle : x \in X\}$ where $\mu_A(x)$, $\sigma_A(x)$ and $\gamma_A(x)$ which represents the degree of membership function, the degree of indeterminacy and the degree of non-membership function respectively of each element $x \in X$ to the set A .

Remark 2.4.[13] Every intuitionistic fuzzy set A is a non empty set in X is obviously on Neutrosophic sets having the form $A = \{\langle \mu_A(x), 1 - \mu_A(x) + \sigma_A(x), \gamma_A(x) \rangle : x \in X\}$. Since our main purpose is to construct the tools for developing Neutrosophic Set and Neutrosophic topology, we must introduce the neutrosophic sets 0_N and 1_N in X as follows:

0_N may be defined as follows

$$(0_1)0_N = \{\langle x, 0, 1, 1 \rangle : x \in X\}$$

1_N may be defined as follows

$$(1_1)1_N = \{\langle x, 1, 0, 0 \rangle : x \in X\}$$

Definition 2.5.[13] Let $A = \{\langle \mu_A, \sigma_A, \gamma_A \rangle\}$ be a NS on X , then the complement of the set A [$C(A)$ for short] may be defined

$$(C_1) C(A) = \{\langle x, \gamma_A(x), 1 - \sigma_A(x), \mu_A(x) \rangle : x \in X\}$$

10.48047/jocaaa.2024.33.08.607

Definition 2.6.[13] Let X be a non-empty set and neutrosophic sets A and B in the form $A = \{\langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle : x \in X\}$ and $B = \{\langle x, \mu_B(x), \sigma_B(x), \gamma_B(x) \rangle : x \in X\}$.

$A \subseteq B$ may be defined as:

$$(A \subseteq B) \Leftrightarrow \mu_A(x) \leq \mu_B(x), \sigma_A(x) \geq \sigma_B(x), \gamma_A(x) \geq \gamma_B(x) \quad \forall x \in X$$

Proposition 2.7. [13] For any neutrosophic set A , the following conditions holds:

$$0_N \subseteq A,$$

$$A \subseteq 1_N$$

Definition 2.8. [13] Let X be a non-empty set and $A = \{\langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle : x \in X\}$, $B = \{\langle x, \mu_B(x), \sigma_B(x), \gamma_B(x) \rangle : x \in X\}$ are NSs. Then $A \cap B$ may be defined as:

$$(I_1) \quad A \cap B = \langle x, \mu_A(x) \wedge \mu_B(x), \sigma_A(x) \vee \sigma_B(x), \gamma_A(x) \vee \gamma_B(x) \rangle$$

$A \cup B$ may be defined as:

$$(I_1) \quad A \cup B = \langle x, \mu_A(x) \vee \mu_B(x), \sigma_A(x) \wedge \sigma_B(x), \gamma_A(x) \wedge \gamma_B(x) \rangle$$

Definition 2.9[12] A μ_N topology on a non - empty set X is a family of neutrosophic subsets in X satisfying the following axioms:

$$(\mu_{N_1}) 0_N \in \mu_N$$

$$(\mu_{N_2}) G_1 \cup G_2 \in \mu_N \text{ for any } G_1, G_2 \in \mu_N.$$

Remark 2.10.[12] The elements of μ_N are μ_N open sets and their complement is called μ_N closed sets.

Definition 2.11.[12] The μ_N -Closure of A is the intersection of all μ_N closed sets containing A .

Definition 2.12.[12] The μ_N -Interior of A is the union of all μ_N open sets contained in A .

Definition 2.13.[11] A neutrosophic set A in NTS is called neutrosophic dense if there exists no neutrosophic closed sets B in (X, T) such that $A \subset B \subset 1_N$.

Definition 2.14.[10] The neutrosophic topological spaces is said to be neutrosophic Baire's Space if $N \text{Int}(\bigcup_{i=1}^{\infty} G_i)$ where G_i 's are neutrosophic nowhere dense set in (X, T) .

Theorem 2.15.[10]: Let (X, μ_N) be a μ_N TS. Then the following are equivalent.

- (i) (X, μ_N) is μ_N Baire Space.
- (ii) $\mu_N \text{Int}(A) = 0_N$, for all μ_N first category set in (X, μ_N) .
- (iii) $\mu_N \text{Cl}(A) = 1_N$, μ_N Residual set in (X, μ_N) .

3. μ_N - Connectedness & μ_N - Disconnectedness

Definition 3.1: A μ_N Topological spaces (X, μ_N) is said to be μ_N disconnected if there exists μ_N open sets $A \neq 0, B \neq 0$ in (X, μ_N) such that $A \vee B = 1_N$ and $A \wedge B = 0_N$.

If (X, μ_N) is not μ_N disconnected then it is μ_N Connected.

Example 3.2: Let $X = \{a\}$ define neutrosophic sets $0_N = \{\langle 0, 11 \rangle\}$, $\delta_1 = \{\langle 0.3, 0.3, 0.5 \rangle\}$, $\delta_2 = \{\langle 0.1, 0.2, 0.3 \rangle\}$, $\delta_3 = \{\langle 0.3, 0.2, 0.3 \rangle\}$, $\delta_4 = \{\langle 0.3, 0.6, 0.2 \rangle\}$, $\delta_5 = \{\langle 0.3, 0.8, 0.5 \rangle\}$, $1_N = \{\langle 1, 0, 0 \rangle\}$ and we define a μ_N TS $\mu_N =$

10.48047/jocaaa.2024.33.08.607

$\{0_N, \delta_1, \delta_2, \delta_3\}$. Here $\delta_1 \neq 0_N, \delta_2 \neq 0_N, \delta_1 \vee \delta_2 = \{\langle 0.3, 0.2, 0.3 \rangle\} \neq 1_N$ and $\delta_1 \wedge \delta_2 = \{\langle 0.1, 0.3, 0.5 \rangle\}$. Hence (X, μ_N) is μ_N Connected.

Example 3.3: Let $X = \{a, b\}$ define neutrosophic sets $0_N = \{\langle 0, 1, 1 \rangle, \langle 0, 1, 1 \rangle\}$, $\alpha_1 = \{\langle 1, 0, 0 \rangle, \langle 0, 0, 1 \rangle\}$, $\alpha_2 = \{\langle 0, 1, 1 \rangle, \langle 1, 1, 0 \rangle\}$, $\alpha_3 = \{\langle 1, 0, 0 \rangle, \langle 1, 1, 1 \rangle\}$ and we define a $\mu_N TS$ as $\{0_N, \alpha_1, \alpha_2, \alpha_3\}$. Here, $\alpha_1 \neq 0_N, \alpha_2 \neq 0_N, \alpha_1 \vee \alpha_2 = \{\langle 1, 0, 0 \rangle, \langle 1, 0, 0 \rangle\} = 1_N, \alpha_1 \wedge \alpha_2 = \{\langle 0, 1, 1 \rangle, \langle 0, 1, 1 \rangle\} = 0_N$. Hence (X, μ_N) is μ_N disconnected.

Definition 3.4: Let (X, μ_N) be a μ_N Topological spaces. If there exists μ_N open sets A and B in X satisfying the following properties, then N is said to be $\mu_N C_n$ disconnected.

- a) $\mu_N C_1: N \leq A \vee B, A \wedge B \leq N^c, N \wedge A \neq 0_N, N \wedge B \neq 0_N$
- b) $\mu_N C_2: N \leq A \vee B, N \wedge A \wedge B = 0_N, N \wedge A \neq 0_N, N \wedge B \neq 0_N,$
- c) $\mu_N C_3: N \leq A \vee B, A \wedge B \leq N^c, A \not\leq N^c, B \not\leq N^c$
- d) $\mu_N C_4: N \leq A \vee B, N \wedge A \wedge B = 0_N, A \not\leq N^c, B \not\leq N^c$

N is said to be $\mu_N C_n$ connected ($n=1, 2, 3, 4$) if N is not $\mu_N C_n$ disconnected.

Remark 3.5: Clearly, we obtain the following implications between the four types of $\mu_N C_n$ connected ($n=1, 2, 3, 4$).

- a) Every $\mu_N C_1$ connected implies $\mu_N C_2$ connected.
- b) Every $\mu_N C_1$ connected implies $\mu_N C_2$ connected.
- c) Every $\mu_N C_3$ connected implies $\mu_N C_4$ connected.
- d) Every $\mu_N C_2$ connected implies $\mu_N C_4$ connected.

The following examples shows us that the converse implications need not be true

Example 3.6: Let $X = \{a, b\}, \mu_N = \{0_N, A, B, C\}$ where $A = \{\langle 0.4, 0.6, 0.6 \rangle, \langle 0.1, 0.9, 0.9 \rangle\}$, $B = \{\langle 0.5, 0.5, 0.5 \rangle, \langle 0.3, 0.9, 0.7 \rangle\}$, $C = \{\langle 0.3, 0.7, 0.7 \rangle, \langle 0.1, 0.9, 0.9 \rangle\}$. Here, C is $\mu_N C_2$ connected, $\mu_N C_3$ connected, $\mu_N C_4$ connected but $\mu_N C_1$ disconnected.

Example 3.7: Let $X = \{a, b\}, \mu_N = \{0_N, P, Q, R, S\}$ where $P = \{\langle 0.2, 0.6, 0.6 \rangle, \langle 0.8, 0.2, 0.2 \rangle\}$, $Q = \{\langle 0.8, 0.2, 0.2 \rangle, \langle 0.6, 0.2, 0.2 \rangle\}$, $R = \{\langle 0.8, 0.2, 0.2 \rangle, \langle 0.8, 0.2, 0.2 \rangle\}$, $S = \{\langle 0.1, 0.9, 0.9 \rangle, \langle 0.1, 0.9, 0.9 \rangle\}$. Here, S is $\mu_N C_4$ connected but $\mu_N C_3$ disconnected.

Definition 3.8: A μ_N Topological spaces (X, μ_N) is said to be $\mu_N C_5$ disconnected if there exists μ_N subset A in X which is both μ_N closed and μ_N open in (X, μ_N) such that $A \neq 0_N, A \neq 1_N$. If X is not $\mu_N C_5$ disconnected then it is said to be $\mu_N C_5$ connected.

Example 3.9: Let $X = \{a, b\}, \mu_N = \{0_N, A_1, A_2\}$ where $A_1 = \{\langle 0.3, 0.5, 0.9 \rangle, \langle 0.6, 0.5, 0.4 \rangle\}$, $A_2 = \{\langle 0.9, 0.5, 0.3 \rangle, \langle 0.4, 0.5, 0.6 \rangle\}$. Here, $A_1 \neq 0_N, A_1 \neq 1_N$ is both μ_N closed and μ_N open in (X, μ_N) . Thus (X, μ_N) is $\mu_N C_5$ disconnected.

Theorem 3.10: $\mu_N C_5$ disconnectedness implies μ_N connected.

10.48047/jocaaa.2024.33.08.607

Proof: Suppose there exists a non-empty μ_N open sets A and B such that $A \vee B = 1_N$ and $A \wedge B = 0_N$. Then $\mu_A \vee \mu_B = 1_N$, $\sigma_A \wedge \sigma_B = 0_N$, $\gamma_A \wedge \gamma_B = 0_N$ and $\mu_A \vee \mu_B = 0_N$, $\sigma_A \wedge \sigma_B = 1_N$, $\gamma_A \wedge \gamma_B = 1_N$. In other words, $B^c = A$. Hence, A is μ_N clopen which yields us that X is μ_N connected.

But the reversal statement of the above theorem need not be true.

Example 3.11: Let $X = \{a, b\}$, $\mu_N = \{0_N, R_1, R_2\}$ where $R_1 = \{\langle 0.7, 0.3, 0.8 \rangle \langle 0.5, 0.8, 0.9 \rangle\}$, $R_2 = \{\langle 0.8, 0.2, 0.1 \rangle \langle 0.7, 0.2, 0.4 \rangle\}$. Here, $R_1 \vee R_2 = \{\langle 0.8, 0.2, 0.1 \rangle \langle 0.7, 0.2, 0.4 \rangle\} \neq 1_N$ and $R_1 \wedge R_2 = \{\langle 0.7, 0.3, 0.8 \rangle \langle 0.5, 0.8, 0.9 \rangle\} \neq 0_N$. Hence, (X, μ_N) is μ_N connected.

Theorem 3.12: Let $\pi: (X, \mu_N) \rightarrow (Y, \sigma_N)$ be a μ_N irresolute surjection in (X, μ_N) then (Y, σ_N) is μ_N Connected.

Proof: Assume that (Y, σ_N) is not μ_N connected then there exists a non-empty μ_N open sets M and N in (Y, σ_N) such that $M \vee N = 1_N$ and $M \wedge N = 0_N$. Since π is μ_N irresolute mapping, $A = \pi^{-1}(M) \neq 0_N$, $B = \pi^{-1}(N) \neq 0_N$ which are μ_N open sets in (X, μ_N) and $\pi^{-1}(M) \vee \pi^{-1}(N) = \pi^{-1}(1_N) = 1_N$. Also, $\pi^{-1}(M) \wedge \pi^{-1}(N) = \pi^{-1}(0_N) = 0_N$ which gives us $M \vee N = 1_N$ and $M \wedge N = 0_N$. Thus, (X, μ_N) is μ_N disconnected which is a contradiction to our hypothesis. Hence (Y, σ_N) is μ_N Connected.

Theorem 3.13: A μ_N Topological spaces (X, μ_N) is $\mu_N C_5$ connected if and only if there exists no non-empty μ_N open sets U and V in (X, μ_N) such that $U = V^c$.

Proof: Assume (X, μ_N) is $\mu_N C_5$ connected. Suppose U and V are μ_N open sets in (X, μ_N) such that $U \neq 0_N$, $V \neq 0_N$ and $U = V^c$. Since $U = V^c$, V^c is μ_N open in (X, μ_N) which implies that V is μ_N closed in (X, μ_N) and $U \neq 0_N$ implies $V \neq 1_N$. Hence, V is both μ_N open and μ_N closed in (X, μ_N) such that $V \neq 0_N$ and $V \neq 1_N$ that implies us that V is $\mu_N C_5$ disconnected which is a contradiction to (X, μ_N) is $\mu_N C_5$ connected. Hence there is no non empty μ_N open sets U and V in (X, μ_N) such that $U = V^c$.

Conversely, we assume that there is no non empty μ_N open sets U and V in (X, μ_N) such that $U = V^c$. Let V be μ_N closed in (X, μ_N) and U be both μ_N open and μ_N closed in (X, μ_N) such that $U \neq 0_N$, $U \neq 1_N$. Now take $U^c = V$ is a μ_N open set and $V \neq 1_N$ which implies us that $U^c = V \neq 0_N$. Hence we get $V \neq 1_N$ which is a contradiction to our assumption. Hence (X, μ_N) is $\mu_N C_5$ connected.

Theorem 3.14: A μ_N Topological spaces (X, μ_N) is μ_N connected space if and only if there exists no non-empty μ_N open sets U and V in (X, μ_N) such that $U = V^c$.

Proof: Assume (X, μ_N) is μ_N connected. Suppose U and V are μ_N open sets in (X, μ_N) such that $U \neq 0_N$, $V \neq 0_N$ and $U = V^c$. Since $U = V^c$, V^c is μ_N open in (X, μ_N) which implies that V is μ_N closed in (X, μ_N) and $U \neq 0_N$ implies $V^c \neq 1_N$. Hence, V is a proper μ_N subset which is both μ_N open and μ_N closed in (X, μ_N) that implies us that X is μ_N disconnected which is a contradiction to (X, μ_N) is μ_N connected. Hence there is no non zero μ_N open sets U and V in (X, μ_N) such that $U = V^c$.

Conversely, we assume that there is no non zero μ_N open sets U and V in (X, μ_N) such that $U = V^c$. Let V be μ_N closed in (X, μ_N) and U be both μ_N open and μ_N closed in (X, μ_N) such that $U \neq 0_N$, $U \neq 1_N$. Now take $U^c = V$ is a

μ_N open set and $V \neq 1_N$ which implies us that $U^c = V \neq 0_N$. Hence we get that there is non-empty μ_N open sets U and V such that $U = V^c$ which is a contradiction to our assumption. Hence (X, μ_N) is μ_N connected.

Theorem 3.15: A μ_N Topological spaces (X, μ_N) is μ_N connected space if and only if there exist no non-zero μ_N subsets U and V in (X, μ_N) such that $U = V^c, V = (\mu_N Cl U)^c$ and $U = (\mu_N Cl V)^c$.

Proof: Let U and V be two μ_N subsets in (X, μ_N) such that $U \neq 0_N, V \neq 0_N$ and $U = V^c, V = (\mu_N Cl U)^c$ and $U = (\mu_N Cl V)^c$. Since, $(\mu_N Cl U)^c$ and $(\mu_N Cl V)^c$ are μ_N open sets in X . U and V are μ_N open sets in X . This implies X is not μ_N connected which is a contradiction. Therefore there exists no μ_N open sets in X such that $U = V^c, V = (\mu_N Cl U)^c$ and $U = (\mu_N Cl V)^c$.

Sufficiency: Let U be both μ_N open and μ_N closed sets in X such that $U \neq 0_N, U \neq 1_N$. By taking $V = U^c$ which is a contradiction to our hypothesis. Hence, (X, μ_N) is μ_N connected.

Theorem 3.16: Let $f: (X, \tau) \rightarrow (Y, \sigma)$ be a μ_N surjection and X be μ_N connected. Then Y is also μ_N connected.

Proof: Assume Y is not μ_N connected then there exists non-empty μ_N open sets U and V in Y such that $UVV = 1_N, U \wedge V = 0_N$. Since f is μ_N surjection, $A = f^{-1}(U) \neq 0_N, B = f^{-1}(V) \neq 0_N$ which are μ_N open in X and $f^{-1}(U) \vee f^{-1}(V) = f^{-1}(1_N) = 1_N$ which implies $A \vee B = 1_N$. Also, $f^{-1}(U) \wedge f^{-1}(V) = f^{-1}(0_N) = 0_N$ that yields that $A \wedge B = 0_N$ which is a contradiction to X is μ_N disconnected to our assumption. Hence, Y is also μ_N connected.

4. μ_N – Hyperconnected

Definition 4.1: A μ_N TS is said to be μ_N hyperconnected if every non-empty μ_N open subset of (X, μ_N) is μ_N dense in (X, μ_N) .

Example 4.2: Let $X = \{a\}$ define neutrosophic sets $0_N = \{\langle 0, 1, 1 \rangle\}, \delta_1 = \{\langle 0.3, 0.3, 0.5 \rangle\}, \delta_2 = \{\langle 0.1, 0.2, 0.3 \rangle\}, \delta_3 = \{\langle 0.3, 0.2, 0.3 \rangle\}, \delta_4 = \{\langle 0.3, 0.6, 0.2 \rangle\}, \delta_5 = \{\langle 0.3, 0.8, 0.5 \rangle\}, 1_N = \{\langle 1, 0, 0 \rangle\}$ and we define a μ_N TS $\mu_N = \{0_N, \delta_1, \delta_2, \delta_3\}$. Here $\delta_1, \delta_2, \delta_3, \overline{\delta_4}, \overline{\delta_5}, 1_N$ are μ_N dense sets in (X, μ_N) . Here every μ_N open subset of (X, μ_N) is μ_N dense in (X, μ_N) . Thus, (X, μ_N) is μ_N hyperconnected.

Remark 4.3: Every μ_N hyperconnected is μ_N connected. The contrary statement of the above theorem need not be true.

Example 4.4: Let $X = \{a\}$ define neutrosophic sets $0_N = \{\langle 0, 1, 1 \rangle\}, \vartheta_1 = \{\langle 0.7, 0.8, 0.9 \rangle\}, \vartheta_2 = \{\langle 0.3, 0.4, 0.6 \rangle\}, \vartheta_3 = \{\langle 0.9, 0.7, 0.6 \rangle\}, 1_N = \{\langle 1, 0, 0 \rangle\}$ and we define a μ_N TS $\mu_N = \{0_N, \vartheta_1, \vartheta_3\}$. Here, ϑ_1 and ϑ_3 are μ_N open sets in (X, μ_N) but they are not μ_N dense in (X, μ_N) . Hence (X, μ_N) is not μ_N hyperconnected. But (X, μ_N) is μ_N connected.

Theorem 4.5: (X, μ_N) is μ_N hyperconnected if and only if every μ_N subset of (X, μ_N) is either μ_N dense or μ_N nowhere dense their in.

Proof: Let (X, μ_N) be a μ_N hyperconnected space. Let A be any μ_N subsets such that $A \subseteq 1_N$. Suppose A is not μ_N nowhere dense. Then $\mu_N Cl(X - \mu_N Cl A) = X - \mu_N Int(\mu_N Cl A) \neq 1_N$. Since $\mu_N Int(\mu_N Cl A) \neq 1_N$. By our assumption we get A is μ_N dense.

10.48047/jocaaa.2024.33.08.607

Conversely, let A be non-empty μ_N open in X . Now for any non-empty μ_N open set we have $A \subseteq \mu_N \text{Int}(\mu_N \text{Cl} A)$ which implies that A is not μ_N nowhere dense but by hypothesis we have A is μ_N dense. Hence the theorem.

BIBLIOGRAPHY

- [1] Atanassov.K. T, *Intuitionistic fuzzy sets*, Fuzzy Sets and Systems, 20(1986), 87–96.
- [2] Chang.C. L, *Fuzzy topological spaces*, Journal of Mathematical Analysis and Application, 24(1968), 183–190.
- [3] Al-Omeri, W.; Smarandache, F. New Neutrosophic Sets via Neutrosophic Topological Spaces. In Neutrosophic Operational Research; Smarandache, F., Pramanik, S., Eds.; Pons Editions: Brussels, Belgium, 2017; Volume I, pp. 189–209
- [4] Dhavaseelan.R and Jafari, *Generalized Neutrosophic closed sets*, *New trends in Neutrosophic theory and applications*, 2(2018), 261–273.
- [5] Dogan Coker, *An introduction to intuitionistic fuzzy topological spaces*, Fuzzy Sets and Systems, 88(1997), 81–89
- [6] FloretinSmarandache, *Neutrosophy and Neutrosophic Logic*, First International Conference on Neutrosophy, Neutrosophic Logic, Set, Probability, and Statistics University of New Mexico, Gallup, NM 87301, USA, 2002.
- [7] FloretinSmarandache, *NeutrosophicSet: - A Generalization of Intuitionistic Fuzzy set*, Journal of DefenseResources Management, 1(2010),107–116.
- [8] FloretinSmarandache, *A Unifying Field in Logic: Neutrosophic Logic. Neutrosophy, Neutrosophic set, Neutrosophic Probability*. Ameican Research Press, Rehoboth, NM,1999.
- [9] Iswarya .P,Dr.K.Bageerathi,*A Study on neutrosophic Frontier and neutrosophic semi frontier in Neutrosophic topological spaces*.Neutrosophic sets and systems, vol . 16,2017.
- [10] Raksha Ben. N, Hari Siva Annam.G,*Generalized Topological Spaces via Neutrosophic Sets*,*J.Math.Comput.Sci.*,11(2021),
- [11] Salama A.A and Alblowi S.A, *Neutrosophic set and Neutrosophic topological space*,ISOR J. Mathematics, 3(4)(2012), 31–35.
- [12] Salama.A.A and Alblowi.S.A, *Generalized Neutrosophic Set and Generalized Neutrosophic Topological Spaces*, Journal computer Sci. Engineering, 2(7)(2012), 12–23.
- [13] SalamaA.A, FlorentinSmarandache and Valeri Kroumov, *Neutrosophic Closed set and Neutrosophic Continuous Function*, Neutrosophic Sets and Systems,4(2014), 4–8.
- [14] Wadel Faris Al-omeri and FlorentinSmarandache, *New Neutrosophic Sets via Neutrosophic Topological Spaces*, New Trends in Neutrosophic Theory and Applications, Vol (2) June 2016.
- [15] Zadeh.L.A, Fuzzy set, Inform and Control, 8(1965), 338– 353.