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Ideals On Neutrosophic Crisp Supra Topological Spaces

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Abstract:

Ideals on neutrosophic crisp supra topology, neutrosophic crisp supra local functions, neutrosophic crisp supra L-open sets, L-continuity are introduced in this paper and some of its basic properties are investigated.

Keywords: NCS, NCSTS, NCSOS&NCSCS.

1. Introduction:

The concept of fuzzy set [17] was introduced by Zadeh in 1965. Generalization of fuzzy set intutionistic fuzzy set was introduced by K.Atanassov [3] in 1983. Neutrosophic set is a generalization of intutionistic fuzzy set. Neutrosophic set was proposed by Smarandache [13, 14] also its properties have been developed by salama et al. [12, 16, 9, 8, 10, 11, 1, 5, 6, 7]. Salama & alblowi [16] define neutrosophic crisp topological space and introduced some of its properties. Salama & Smarandache [15, 7, 14, 16] are introduced the concepts of neutrosophic crisp sets and they investigate some of its operators. The concept of neutrosophic crisp points and neutrosophic crisp ideals are introduced by [7] in 2013. Amarendra Babu & Rajasekhar [2] introduced the concept of neutrosophic crisp supra topology in 2020.In this paper we establish the concepts of neutrosophic crisp ideal in neutrosophic crisp supra topology, neutrosophic crisp supra local functions, neutrosophic crisp supra L-open sets, L-continuity and we verify some of its properties.

2. Preliminaries:

The authors [16] introduced the concepts and definitions of neutrosophic crisp set (NCS), neutrosophic crisp types of φ_N & X_N , neutrosophic crisp union & intersection, neutrosophic crisp subsets, neutrosophic crisp complement, family of union & intersection of neutrosophic crisp sets, image and pre image of a map in neutrosophic crisp sets and the authors [2] are introduced neutrosophic crisp supra topology (NCST), neutrosophic crisp supra open sets (NCSOS) and neutrosophic crisp supra closed sets (NCSCS).

2.1. Definition: [7] Let X be a non empty set and L be a non empty family of neutrosophic crisp sets. Then L is said to be a neutrosophic crisp ideal (NCL) on X if satisfies the following

(i) $\mathrm{A} \in L$ and $\mathrm{B} \subseteq \mathrm{A} \Rightarrow \mathrm{B} \in L$
(ii) $\mathrm{A} \in L, \mathrm{B} \in L \Rightarrow \mathrm{A} \bigcup \mathrm{B} \in L$.

3. IDEALS ON NEUTROSOPHIC CRISP SUPRA TOPOLOGICAL SPACES

3.1. Definition: Let (X, τ^{μ}) is a neutrosophic crisp supra topological space and L is a neutrosophic crisp ideal on X. Then (X, τ^{μ}, L) is said to be a neutrosophic crisp ideal supra topological spaces (NCLSTS).

3.2. Example: Let $X = \{\delta_1, \eta_2, \psi_3, \sigma_4\}$, $\tau^{\mu} = \{\varphi_N, X_N, L, M, N\}$, where $L =< \{\delta_1, \eta_2\}, \varphi, \{\psi_3\} >$, $M =< \{\delta_1, \eta_2\}, \varphi, \{\psi_3, \sigma_4\} >$, $N =< \{\eta_2\}, \varphi, \{\delta_1, \psi_3\} >$ then (X, τ^{μ}) is a NCSTS and $L = \{\varphi_N, \mathrm{A}, \mathrm{B}, C\}$ is NCL on X, where $\mathrm{A} =< \{\delta_1, \eta_2\}, \{\psi_3\}, \{\sigma_4\} >$, $\mathrm{B} =< \{\delta_1\}, \{\psi_3\}, \{\sigma_4\} >$, $C =< \{\eta_2\}, \{\psi_3\}, \{\sigma_4\} >$ .Hence (X, τ^{μ}, L) is NCLSTS.

3.3: Theorem: Let $\omega : (X, \tau^{\mu}) \to (Y, \sigma^{\mu})$ be a map and L_1 and L_2 are two NCLs on X and Yrespectively. Then

(i) $\omega(L_1) = \{\omega(\mathrm{A}) : \mathrm{A} \in L_1\}$ is NCL.

(ii) If ω is one-one then $\omega^{-1}(L_2)$ is NCL.

Proof:

(i) Now show that $\omega(L_1) = \{\omega(\mathrm{A}) : \mathrm{A} \in L_1\}$ is NCL.

Let $\omega(\mathrm{A})$ and $\omega(B)$ are two NCLs of $\omega(L_1)$, where A and B are NCLs of L_1.

That implies $\mathrm{A} \bigcup \mathrm{B} \in L_1$.Now show that $\omega(\mathrm{A}) \bigcup \omega(\mathrm{B}) \in \omega(L_1)$.

Now $\omega(\mathrm{A}) \bigcup \omega(\mathrm{B}) = \omega(\mathrm{A} \bigcup B) \in \omega(L_1)$ $(\because \mathrm{A} \bigcup \mathrm{B} \in L_1)$.

Therefore $\omega(L_1)$ is a NCL.

(ii) Given that ω is one-one. $\omega^{-1}(L_2)$ is NCL. Let A and B are two NCSs in $\omega^{-1}(L_2)$. $\mathrm{A} \in \omega^{-1}(L_2)$ and $B \in \omega^{-1}(L_2) \Rightarrow \omega(\mathrm{A}) \in L_2$ and $\omega(\mathrm{B}) \in L_2 \Rightarrow \omega(\mathrm{A}) \bigcup \omega(\mathrm{B}) \in L_2$

$\Rightarrow \omega^{-1}(\omega(\mathrm{A})) \bigcup \omega^{-1}(\omega(\mathrm{B})) \in \omega^{-1}(L_2) \Rightarrow \mathrm{A} \bigcup \mathrm{B} \in \omega^{-1}(L_2)$. Therefore $\omega^{-1}(L_2)$ is NCL.

3.4. Theorem: Let (X, τ^{μ}, L) be a NCLSTS. Then $L \bigcap (\tau^{\mu})^C$ = {A is NCS**:** There exists a NCSCS $\mathrm{B} \in L$ such that $\mathrm{A} \subseteq B$}is a NCL.

Proof:

(i) Let $T \in L \bigcap (\tau^{\mu})^C$, $R \subseteq T$. Since $T \in L \bigcap (\tau^{\mu})^C$ then there exists a NCSCS $B \in L$ such that $T \in B \Rightarrow R \subseteq B \Rightarrow R \in L \bigcap (\tau^{\mu})^C$.

(ii) Let $G, H \in L \bigcap (\tau^{\mu})^C$. Now show that $G \bigcup H \in L \bigcap (\tau^{\mu})^C$. By the definition of $L \bigcap (\tau^{\mu})^C$ there exists two NCSs T_1 and T_2 such that $G \subseteq T_1$ and $H \subseteq T_2$.

$T_1, T_2 \in L$ and $T_1, T_2 \in L \bigcap (\tau^{\mu})^C \Rightarrow G \bigcup H \subseteq T_1 \bigcup T_2 \in L$ and $T_1 \bigcup T_2 \in L \bigcap (\tau^{\mu})^C$

$\Rightarrow G \bigcup H \subseteq T_1 \bigcup T_2 \in L \bigcap (\tau^{\mu})^C \Rightarrow G \bigcup H \in L \bigcap (\tau^{\mu})^C$.

3.5. Definition: Let (X, τ^{μ}, L) be a neutrosophic crisp ideal supra topological space. For a subset A of X we define $NCSA^*(L, \tau^{\mu}) = \bigcup \{p_N \in X : A \bigcap U \notin L$ for every $U \in N(p_N)\}$, where

$N(p_N)=\{U\in\tau^{\mu}:p_N\in U\}$. Hence $NCSA^*(L,\tau^{\mu})$ is called neutrosophic crisp supra local function of A with respect to τ^{μ} & L.

3.6. Example: Let $X=\{\delta_1,\eta_2,\psi_3,\sigma_4\}$, $\tau^{\mu}=\{\varphi_N,X_N,L,M,N\}$, where $L=<\{\delta_1,\eta_2\},\varphi,\{\psi_3\}>$, $M=<\{\delta_1,\eta_2\},\varphi,\{\psi_3,\sigma_4\}>$, $N=<\{\eta_2\},\varphi,\{\delta_1,\psi_3\}>$
then (X,τ^{μ}) is a NCSTS and $L=\{\varphi_N,S,T,V\}$ is NCL on X, where $S=<\{\delta_1,\eta_2\},\{\psi_3\},\{\sigma_4\}>$, $T=<\{\delta_1\},\{\psi_3\},\{\sigma_4\}>$, $V=<\{\eta_2\},\{\psi_3\},\{\sigma_4\}>$. Hence (X,τ^{μ},L) is NCLSTS.
Let $\mathrm{A}=<\{\delta_1\},\varphi,\{\psi_3\}>$ is any NCS in X and $N(p_N)=U_1=<\{\delta_1\},\varphi,\{\psi_3\}>$, $U_2=<\{\eta_2\},\varphi,\{\psi_3\}>, U_3=<\{\delta_1\},\varphi,\{\sigma_4\}>, U_4=<\{\eta_2\},\varphi,\{\sigma_4\}>, U_5=<\{\eta_2\},\varphi,\{\delta_1\}>$, $U_6=<\{\delta_1,\eta_2\},\varphi,\{\psi_3\}>, U_7=<\{\delta_1,\eta_2\},\varphi,\{\psi_3,\sigma_4\}>, U_8=<\{\eta_2\},\varphi,\{\delta_1,\psi_3\}>$. Then
$\mathrm{A}\cap U_1\notin L, \mathrm{A}\cap U_2\notin L, \mathrm{A}\cap U_3\notin L, \mathrm{A}\cap U_4\notin L, \mathrm{A}\cap U_5\notin L, \mathrm{A}\cap U_6\notin L, \mathrm{A}\cap U_7\notin L, \mathrm{A}\cap U_8\notin L$.
Therefore $NCSA^*(L,\tau^{\mu})=<\{\delta_1,\eta_2\},\varphi,\{\psi_3,\sigma_4\}>$.

3.7. Theorem: Let (X,τ^{μ}) be a NCSTS and L_1,L_2 be two ideals in X. Then for any NCSs A and B on X the following are holds.

(i) $\mathrm{A}\subseteq\mathrm{B}\Rightarrow NCSA^*(L,\tau^{\mu})\subseteq NCSB^*(L,\tau^{\mu})$

(ii) $L_1\subseteq L_2\Rightarrow NCSA^*(L_2,\tau^{\mu})\subseteq NCSB^*(L_1,\tau^{\mu})$

(iii) $NCS(\mathrm{A}\cup\mathrm{B})^*(L,\tau^{\mu})=NCSA^*(L,\tau^{\mu})\cup NCSB^*(L,\tau^{\mu})$

Proof:

(i) Let $\mathrm{A}\subseteq\mathrm{B}$. Now show that $NCSA^*(L,\tau^{\mu})\subseteq NCSB^*(L,\tau^{\mu})$.

Let $p_N\in NCSA^*(L,\tau^{\mu})$. In a contrary way suppose that $p_N\notin NCSB^*(L,\tau^{\mu})$. Then $\exists\ U\in N(p_N)\ni B\cap U\in L$. Since $\mathrm{A}\subseteq\mathrm{B}\Rightarrow\mathrm{A}\cap U\subseteq\mathrm{B}\cap U\in L\Rightarrow\mathrm{A}\cap U\in L\Rightarrow p_N\notin NCSA^*(L,\tau^{\mu})$. A contradiction, so $p_N\in NCSB^*(L,\tau^{\mu})$.

(ii) Let $L_1\subseteq L_2$ and $p_N\in NCSA^*(L_2,\tau^{\mu})$. Now show that $p_N\in NCSB^*(L_1,\tau^{\mu})$. In a contrary way suppose that $p_N\notin NCSB^*(L_1,\tau^{\mu})$ $\exists\ U\in N(p_N)\ni\mathrm{B}\cap U\in L_1$. Since $L_1\subseteq L_2\Rightarrow\mathrm{A}\cap U\in L_2\Rightarrow p_N\notin NCSA^*(L_2,\tau^{\mu})$. A contradiction, so
$p_N\in NCSB^*(L_1,\tau^{\mu})$.

(iii) Let $p_N\in NCS(\mathrm{A}\cup\mathrm{B})^*(L,\tau^{\mu})\Leftrightarrow(\mathrm{A}\cup B)\cap U\notin L$ for any $p_N\in U\Leftrightarrow(\mathrm{A}\cap U)\cup(\mathrm{B}\cap U)\notin L\Leftrightarrow(\mathrm{A}\cap U)\notin L$ or $(\mathrm{B}\cap U)\notin L\Leftrightarrow p_N\in NCSA^*(L,\tau^{\mu})$ or
$p_N\in NCSB^*(L,\tau^{\mu})\Leftrightarrow p_N\in NCSA^*(L,\tau^{\mu})\cup p_N\in NCSB^*(L,\tau^{\mu})$.

3.8. Theorem: Let $\tau_1{}^{\mu},\tau_2{}^{\mu}$ be two neutrosophic crisp supra topologies on a non empty set X. Then for any NCL in X, $\tau_1{}^{\mu}\subseteq\tau_2{}^{\mu}\Rightarrow NCSA^*(L,\tau_2{}^{\mu})\subseteq NCSA^*(L,\tau_1{}^{\mu})$.

Proof: Let $\tau_1{}^{\mu}\subseteq\tau_2{}^{\mu}$ and $p_N\in NCSA^*(L,\tau_2{}^{\mu})$. Then $\mathrm{A}\cap U\notin L$ for $U\in N(p_N)$, where $N(p_N)=\{U\in\tau_2{}^{\mu}:p_N\in U\}$ .Since $\tau_1{}^{\mu}\subseteq\tau_2{}^{\mu}$ then $\mathrm{A}\cap U\notin L$ for $U\in N(p_N)$, where $N(p_N)=\{U\in\tau_1{}^{\mu}:p_N\in U\}$.Then $p_N\in NCSA^*(L,\tau_1{}^{\mu})$.

3.9. Definition: Let (X,τ^{μ},L) be a neutrosophic crisp ideal supra topological space. For a subset A of X we define $A^{\#}(\tau^{\mu},L)=\{x\in X : A\cap NCS\text{-}cl(U)\notin L$ for every NCSOS $U\}$ is denoted by $NCSA^{\#}(\tau^{\mu},L)$ is called neutrosophic crisp supra local closure function.

3.10. Example: Let $X=\{\delta_1,\eta_2,\psi_3,\sigma_4\}$, $\tau^{\mu}=\{\varphi_N,X_N,O,P,Q\}$, where $O=<\{\delta_1,\eta_2\},\varphi,\{\psi_3\}>$, $P=<\{\delta_1,\eta_2\},\varphi,\{\psi_3,\sigma_4\}>$, $Q=<\{\eta_2\},\varphi,\{\delta_1,\psi_3\}>$

then (X,τ^{μ}) is a NCSTS and $L=\{\varphi_N,S,T,V\}$ is NCL on X , where

$S=<\{\delta_1,\eta_2\},\{\psi_3\},\{\sigma_4\}>, T=<\{\delta_1\},\{\psi_3\},\{\sigma_4\}>$, $V=<\{\eta_2\},\{\psi_3\},\{\sigma_4\}>$.

Hence (X,τ^{μ},L) is NCLSTS.

Let $A=<\{\psi_3\},\{\eta_2\},\{\delta_1\}>$ and $U_1=O, U_2=P \,\&\, U_3=Q$ ($\because$ U is NCSOS).

Then $A\cap NCS\text{-}cl(U_1)\notin L$, $A\cap NCS\text{-}cl(U_2)\notin L$, $A\cap NCS\text{-}cl(U_3)\notin L$.

3.11. Lemma: Let (X,τ^{μ},L) be a NCLSTS. Then $NCSA^{*}(L,\tau^{\mu})\subseteq NCSA^{\#}(\tau^{\mu},L)$ for every $A\subseteq X$.

Proof: Let $p_N\in NCSA^{*}(L,\tau^{\mu})$.

Then $A\cap U\notin L$, for any $U\in N(p_N)$.

Since $A\cap U\subseteq A\cap NCS\text{-}cl(U)\Rightarrow NCS\text{-}cl(U)\notin L$

Hence $p_N\in NCSA^{\#}(\tau^{\mu},L)$.

3.12. Theorem: Let (X,τ^{μ},L) be a NCLSTS and A,B are any two NCSs on X.

Then $NCSA^{\#}(\tau^{\mu},L)\cup NCSB^{\#}(\tau^{\mu},L)=(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}$.

Proof: Let $NCSA^{\#}(\tau^{\mu},L)\cup NCSB^{\#}(\tau^{\mu},L)\subseteq(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}$.

Now it is enough to show that $(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}\subseteq NCSA^{\#}(\tau^{\mu},L)\cup NCSB^{\#}(\tau^{\mu},L)$.

Let $p_N\in(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}$.

$\Rightarrow p_N\in NCSA^{\#}(\tau^{\mu},L)$ and $p_N\in NCSB^{\#}(\tau^{\mu},L)$.

Therefore $\exists$ $U\,\&\,V\in\tau^{\mu}$ $\ni$ $A\cap$ NCS- $cl(U)\notin L$ and $B\cap$ NCS- $cl(U)\notin L$

$$=(A\cap NCS-cl(U))\cup(B\cap NCS-cl(V))$$
$$=(A\cap NCS-cl(U)\cup B)\cap(A\cap NCS-cl(U)\cup NCS-cl(V))$$
$$=(A\cup B)\cap(NCS-cl(U)\cup B)\cap(A\cup(NCS-cl(V))\cap(NCS-cl(U)\cup NCS-cl(V))$$

$\supseteq NCS-cl(U\cap V)\cap(A\cup B)\notin L$. Hence $p_N\in(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}$.

So $NCSA^{\#}(\tau^{\mu},L)\cup NCSB^{\#}(\tau^{\mu},L)=(NCSA(\tau^{\mu},L)\cup NCSB(\tau^{\mu},L))^{\#}$.

3.13. Definition: Let (X,τ^{μ},L) be a neutrosophic crisp ideal supra topological space.

Then A is called neutrosophic crisp L-supra open set (NCLSOS) if there exists $\Delta\in\tau^{\mu}\ni A\subseteq\Delta\subseteq NCSA^{*}(L,\tau^{\mu})$. The family of all neutrosophic crisp supra L-open sets are denoted by NCLSOS(X).

3.14. Definition: The complement of 3.13. Definition is called neutrosophic crisp L-supra closed sets (NCLSCS). The family of all neutrosophic crisp supra L-closed sets are denoted by NCLSCS(X).

3.15. Theorem: Let (X,τ^{μ},L) be a NCLSTS. Then $A\in NCLSOS(X)$ if and only if $A\subseteq NCS$ int ($NCSA^{*}(L,\tau^{\mu})$).

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Proof: Let $A \in NCLSOS(X)$ then $\exists\ \Delta \in \tau^{\mu} \ni A \subseteq \Delta \subseteq NCSA^{*}(L,\tau^{\mu})$ but NCS-int $(NCSA^{*}(L,\tau^{\mu})) \subseteq NCSA^{*}(L,\tau^{\mu})$ and $\Delta = NCS$-int $(NCSA^{*}(L,\tau^{\mu}))$ ($\because \Delta \in \tau^{\mu}$ i.e. Δ is NCSOS). Hence $A \subseteq NCS$ int $(NCSA^{*}(L,\tau^{\mu}))$.

Conversely $A \subseteq NCS$ int $(NCSA^{*}(L,\tau^{\mu})) \subseteq NCSA^{*}(L,\tau^{\mu})$ then $\exists\ \Delta = NCS$-int $(NCSA^{*}(L,\tau^{\mu})) \subseteq NCSA^{*}(L,\tau^{\mu}) \Rightarrow A \in NCLSOS(X)$.

3.16. Theorem: Let (X,τ^{μ},L) be a NCLSTS. If A, B be any NCSs in X and $A \in NCLSOS(X)$, $B \in \tau^{\mu}$ then $A \cap B \in NCLSOS(X)$.

Proof: Let $A \in NCLSOS(X) \Rightarrow A \subseteq NCS$ int $(NCSA^{*}(L,\tau^{\mu}))$.(from 3.15)

Then $A \cap B \subseteq NCS$ int $(NCSA^{*}(L,\tau^{\mu})) \cap B = NCS$ int $(NCSA^{*}(L,\tau^{\mu}) \cap B)$, we have $A \cap B \subseteq NCS$ int $(NCS(A \cap B)^{*}(L,\tau^{\mu})) \Rightarrow A \cap B \in NCLSOS(X)$ (from 3.15).

3.17. Definition: Let (X,τ^{μ},L) be a neutrosophic crisp ideal supra topological space and β is neutrosophic crisp set in X. Then the neutrosophic crisp supra ideal interior & closure of β defined as follows

(i) NCL-NCS-int $(\beta) = \bigcup\{\lambda : \lambda$ is NCLSOS in X & $\lambda \subseteq \beta\}$

(ii) NCL-NCS-cl $(\beta) = \bigcap\{\lambda^{*} : \lambda^{*}$ is NCLSCS in X & $\beta \subseteq \lambda^{*}\}$

3.18: Definition: A map $\omega : (X,\tau^{\mu}) \rightarrow (Y,\sigma^{\mu})$ with neutrosophic crisp ideal L in X is said to be neutrosophic crisp L-supra continuous (NCL-SCSM) if for every $\Delta \in \sigma^{\mu}$, $\omega^{-1}(\Delta) \in NCLSOS(X)$.

3.19. Theorem: A map $\omega : (X,\tau^{\mu}) \rightarrow (Y,\sigma^{\mu})$ with neutrosophic crisp ideal L in X is NCL-SCSM then

(i) The inverse image of each NCSCS in Y is a NCLSCS.

(ii) For a neutrosophic crisp point p_N in X and each $\Delta \in \sigma^{\mu}$ containing $\omega(p_N) \exists\ A \in NCLSOS(X)$ containing $p_N \ni \omega(A) \subseteq \sigma^{\mu}$.

Proof: **(i)** Given $\omega : (X,\tau^{\mu}) \rightarrow (Y,\sigma^{\mu})$ with neutrosophic crisp ideal L in X is NCL-SCSM. Let $\Delta \in Y$ is NCSCS then Δ^{C} is NCSOS,

by $\omega^{-1}(\Delta^{C}) = (\omega^{-1}(\Delta^{C})) \in NCLSOS(X)$ thus $\omega^{-1}(\Delta)$ is NCLSCS.

(ii) Since $\Delta \in \sigma^{\mu}$ containing $\omega(p_N)$ then $\omega^{-1}(\Delta) \in NCLSOS(X)$ ($\because \omega$ is NCL-SCSM).

By putting $A = \omega^{-1}(\Delta)$ we have $\omega(A) \subseteq \sigma^{\mu}$.

Conclusion: NCL in neutrosophic crisp supra topology, neutrosophic crisp supra local functions, NCLSOS, NCL-SCSM are introduced and some of its basic properties are investigated and finally there is new way for further research in this area related to neutrosophic crisp supra topology.

References:

1. Albowi.S.A. Salama.A.A. & Esia.Mohmed, "New concepts of Neutrosophic sets" International journal of Mathematics & computer application research (IJMCAR), vol.4,Issue 1,(2014),59-66.

2. Amarendra Babu.V & Rajasekhar .P "On neutrosophic crisp supra semi- α closed sets" International journal of advanced science and technology" vol.29, No.6.(2020) pp 2947-2954.
3. Atanassov.K, "Intutionistic fuzzy sets" Fuzzy sets & systems". 1986, 20: 87-96.
4. Bourbaki.N "General topology" part-I Addison wesly, Reading Mass, 1966.
5. Hanafy.I, Salama.A.A & Mahfouz.K "Correlation of neutrosophic data". International Refereed Journal of Engineering and science (IRJES), Vol.(1),Issue 2, (2012),39-43.
6. Hanafy.I, Salama.A.A & Mahfouz.K "Neutrosophic crisp Events and probability. International Journal of Mathematics and computer application Research (IJMCAR).vol.(3), Issue 1, Mar 2013, (2013),171-178.
7. Salama.A.A. "Neutrosophic crisp points & Neutrosophic crisp ideals". Neutrosophic sets & systems. Vol.1, no.1, (2013), 50-54.
8. Salama.A.A & Albowi.S.A, "Neutrosophic set & Neutrosophic topological spaces" ISORJ, Mathematics, vol.(3), Issue), (2012), 31-35.
9. Salama.A.A & Albowi.S.A, "Generalized Neutrosophic set and generalized neutrosophic topological spaces" Journal of computer sci.Engineering. vol.(2), No (7) , (2012), 51-60.
10. Salama.A.A & Albowi.S.A, "Intutionistic Fuzzy Ideals Topological Spaces". Advances in Fuzzy Mathematics, vol.1, No.1,(2013), 50-54.
11. Salama.A.A.& Elagamy.H, "Neutrosophic Filters". International Journal of Computer science Engineering and information Technology Research (IJCSEITR), Vol.3, Issue (1), March (2013),307-312.
12. Smarandache.F, "An introduction to the Neutrosophic probability applied in Quantum physics". International Conference on introduction Neutro-physics, Neutrosophic logic, set, Probability & Statistics, University of New Mexico. Gallup. NM 87301, USA 2-4, December (2011).
13. Samarandache. "A unifying field in logics, Neutrosophic logic, Neutrosophy, Neutrosophic set". Neutrosophic probability. American research press, Rehoboth, NM, (1999).
14. Samarandache. F, "Neutrosophy & Neutrosophic Logic ". First international conference on Neutrosophy, Neutrosophic logic, set, probability and statistics, USA (2002).
15. Salama.A.A & Samarandache. F, "Neutrosophic crisp set theory" Educational publisher, Columbus, USA, (2015).
16. Salama.A.A., Samarandache. F & Kroumov.V. "Neutrosophic crisp sets & neutrosophic crisp topological spaces". Neutrosophic sets & systems, 2013,1(1),34-38.
17. Zadeh.L.A, "Fuzzy sets". Inform. Control, vol8, (1965), 338-353.