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Separation Axioms in Neutrosophic Crisp Topological Spaces

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Abstract. The main idea of this research is to define a new neutrosophic crisp points in neutrosophic crisp topological space namely [NCP$_N$], the concept of neutrosophic crisp limit point was defind using [NCP$_N$], with some of its properties, the separation axioms >-î$_i$-space, i = 0,1,2] were constructed in neutrosophic crisp topological space using [NCP$_N$] and examine the relationship between them in details.
Keywords: Neutrosophic crisp topological spaces, neutrosophic crisp limit point, separation axioms.

Introduction

Smarandache [1,2,3] introduced the notions of neutrosophic theory and introduced the neutrosophic components $6, +, ($ which represent the membership, indeterminacy, and non membership values respectively, where]í0,1$^+$[is a non standard unit interval. In [4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20] many scientists presented the concepts of the neutrosophic set theory in their works. Salama et al. [21,22] provided natural foundations to put mathematical treatments for the neutrosophic pervasively phenomena in our real world and for building new branches of neutrosophic mathematics.

Salama et al. [23,24] put some basic concepts of the neutrosophic crisp set and their operations, and because of their wide applications and their grate flexibility to solve the problem, we used these concepts to define new types of neutrosophic points, that we called neutrosophic crisp points [NCP$_N$].

Fainally, we used these points [NCP$_N$] to define the concept of neutrosophic crisp limit point, with some of its properties and constructe the separation axioms >-î$_i$-space, i=0,1,2] in neutrosophic crisp topological and examine the relationship between them in details.

Throughout this paper (N, NCTS) means a neutrosophic crisp topological space. Also, simply we denote neighborhood by • Š ‡.

1 Basic Concepts

1.1 Definition [25]

Let ò be a non-empty fixed set. A neutrosophic crisp set [NCS for short] B is an object having the form B = < B_1, B_2, B_3 > where B_1, B_2 and B_3 are subsets of ò.

1.2 Definition [25]

The object having the form B = < B_1, B_2, B_3 > is called:

1. A neutrosophic crisp set of Type 1 [NCS/Type1] if satisfying B_1 ˆ B_2 = î, B_1 ˆ B_3 = î and B_2 ˆ B_3 = î.
2. A neutrosophic crisp set of Type 2 [NCS/Type2] if satisfying B_1 ˆ B_2 = î, B_1 ˆ B_3 = î and B_2 ˆ B_3 = î, B_1 , B_2 , B_3 = ò.
3. A neutrosophic crisp set of Type 3 [NCS/Type3] if satisfying B_1 ˆ B_2 ˆ B_3 = î, B_1 , B_2 , B_3 = ò.

1.3 Definition [25]

Types of NCSs î$_R$ ¬ ò$_R$ in ò as follows:

1. î$_R$ may be defined in many ways as a NCS as follows:
   1. Type1 : î$_R$ = < î , î , ò >
   2. Type2: î$_R$ = < î , ò , ò >
   3. Type3: î$_R$ = < î , ò, î >
   4. Type4: î$_R$ = < î , î , î >
2. ò$_R$ may be defined in many ways as a NCS as follows:
   1. Type1: ò$_R$ = < ò, î , î >

2. Type2: ò$_R$= ò, ò, î !
3. Type3: ò$_R$= ò, î , ò !
4. Type4: ò$_R$= ò, ò , ò !

1.4 Definition [25]

Let ò be a non-empty set and the NCSs C & D in the form C_1,C_2,C_3> , D_1,D_2,D_3> then we may consider two possible definitions for subsets C CD, may be defined in two ways :

1. C CD ž C_1 CD_1 , C_2 CD_2 and D_3 CC_3
2. C CD ž C_1 CD_1 , D_2 CC_2 and D_3 CC_3

1.5 Definition [25]

Let ò be a non-empty set and the NCSs C & D in the form C_1,C_2,C_3> , D_1,D_2,D_3> then:

1. C • D may be defined in two ways as a NCS as follows :
   - x C • D = [C_1 • D_1] , [C_2 , D_2] , [C_3 , D_3]
   - x C • D = [C_1 • D_1] , [C_2 • D_2] , [C_3 , D_3]
2. C , D may be defined in two ways as a NCS as follows :
   - x C , D = [C_1 , D_1] , [C_2 , D_2] , [C_3 • D_3]
   - x C , D = [C_1 , D_1] , [C_2 • D_2] , [C_3 • D_3]

1.6 Definition [25]

A neutrosophic crisp topology (NCT) on a non-empty set ò is a family î of neutrosophic crisp subsets in ò satisfying the following axioms:

1. Î$_R$ áò$_R$ Đ î
2. • Đ î á ‘ ”ƒ • › á Đ î
3. The union of any number of sets in î belongs to î

The pair (ò á î ; is said to be a neutrosophic crisp topological space (NCTS) in ò. Moreover The elements in î are said to be neutrosophic crisp open sets (NCOS), a neutrosophic crisp set F is closed (NCCS) iff its complement ^{G} is an open neutrosophic crisp set.

1.7 Definition [25]

Let ò be a non-empty set and the NCS D in the form D_1,D_2,D_3> .Then ^{a} may be defined in three ways as a NCS as follows :

^{a} $\overset{a}{5}$ $\overset{a}{6}$ $\overset{a}{7}$> , ^{a} D_3,D_2,D_1> or ^{a} D_3, $\overset{a}{6}$ D_1>

1.8 Definition [25]

Let (ò á î ; be neutrosophic crisp topological space (NCTS). A be neutrosophic crisp set then The intersection of any neutrosophic crisp closed sets contained A is called neutrosophic crisp closure of A (NC-Cl(A) for short) .

2 Neutrosophic crisp limit point :

In this section, we will introduce the neutrosophic crisp limit points with some of its properties. This work contains an adjustment for the above-mentioned definitions 1.4 & 1.5, this was necessary to homogeneous suitable results for the upgrade of this research.

2.1 Definition

Let ò be a non-empty set and the NCSs C & D in the form C_1,C_2,C_3> , D_1,D_2,D_3> then the additional new ways for the intersection , union and inclusion between ƒ ” ‡

C • D = [C_1 • D_1] , [C_2 • D_2] , [C_3 • D_3]

C , D = [C_1 , D_1] , [C_2 , D_2] , [C_3 , D_3]

C CD ž C_1 CD_1 , C_2 CD_2 and C_3 CD_3

2.2 Definition

For all x, y, z belonging to a non-empty set ò. Then the neutrosophic crisp points related to x, y, z are defined as follows

x šR {x}, Î, Î >, is called a neutrosophic crisp point (C R) in ò.

x ›R Î, <› =, Î >, is called a neutrosophic crisp point (C R) in ò.

x œR/ Î, Î á<œ=>, is called a neutrosophic crisp point (C R/) in ò.

The set of all neutrosophic crisp points : C R , C R á C R/ ; is denoted by C R.

2.3 Definition

Let ò be to a non-empty set and x á › á œ Then the neutrosophic crisp point:

x šR is belonging to the neutrosophic crisp set B B_1,B_2,B_3>, denoted by šR Ð , if š Ð 5, wherein šR does not belong to the neutrosophic crisp set B denoted by šR Ñ , if š Ñ 5 ä

x ›R is belonging to the neutrosophic crisp set B B_1,B_2,B_3>, denoted by ›R Ð , if › Ð 6. In contrast ›R does not belong to the neutrosophic crisp set B, denoted by ›R Ñ , if › Ñ 6.

x œR/ is belonging to the neutrosophic crisp set B B_1,B_2,B_3>, denoted by œR/ Ð , if œ Ð 7. In contrast œR/ does not belong to the neutrosophic crisp set B , denoted by œR/ Ñ , if œ Ñ 7.

2.4 Remark

If B_1,B_2,B_3> is a NCS in a non-empty set ò then:

B 3šR L O 5 3<š=á 6 á 7 P. B 3šR means that the component B doesn't contain šR.

B 3›R L O 5 á 6 3<› =á 7 P. B 3›R means that the component B doesn't contain ›R.

B 3œR/ L O 5 á 6 á 7 3<œ= P. B 3œR/ means that the component B doesn't contain œR/.

2.5 Example

If B = O <ƒ á „ =, <..á „ =á<..á ƒ => is an NCS in ò L <ƒ á „ á ..=, then:

B 3ƒR L O < „ =á <..á „ =á <..á ƒ = P

B 3„R L O <ƒ á „ = á <..=á <..á ƒ= P

B 3.R/ L O <ƒ á „ = á <..á „ =á < „ = P

2.6 Remark

If B_1,B_2,B_3> is a NCS in a non-empty set ò then:

B , ^ šR ã šR Ð ` , , ^ ›R ã ›R Ð ` , • ^ œR/ ã œR/ Ð `

, ^O <š =á Î á Î P ÷ š Ð ò ` , , ^O Î á <› =á Î P ÷ › Ð ò ` , • ^O Î á Î á <œ=P ÷ œ Ð ò `

or B , ^ šR ã šR Ð ` , , ^ ›R ã ›R Ð ` , , ^ œR/ ã œR/ Ð `

, ^O <š =á Î á Î P ã š Ð ò ` , , ^O Î á <› =á Î P ã › Ð ò ` , , ^O Î á Î á <œ=P ã œ Ð ò `

2.7 Definition

Let (ò á î ; be NCTS á Ð C R < • ò á a neutrosophic crisp set B_1,B_2,B_3> Ð î is called neutrosophic crisp open nhd of in (ò á î ; if Ð .

2.8 Definition

Let (ò á î ; be NCTS á Ð C R < • ò á a neutrosophic crisp set B_1 , B_2 , B_3 > Ð î is called neutrosophic crisp nhd of in (ò á î ; á if there is neutrosophic crisp open set A A_1, A_2, A_3 > containing P such that C .

2.9 Note

Every neutrosophic crisp open nhd of any point Ð C R < • ò is neutrosophic crisp nhd of , but in general the inverse is not true, the following example illustrates this fact.

2.10 Example

If ò L <š á › á œ=, î L <ò R á î R á á á =,

A <š =, Î , Î > , B <› =, Î , Î > , G <T á U=, Î , Î >

If we take U <T á U=, <œ=á Î >.

Then G <T á U=, Î , Î > is an open set containing L šR <š =, Î , Î > and G C . That is U is a neutrosophic crisp nhd of in (ò á î ;, while it is not a neutrosophic crisp open nhd of .

2.11 Definition

Let (ò áî ; be NCTS and B_1 , B_2 , B_3 > be NCS of ò. A neutrosophic crisp point P Đ C R in ò is called a neutrosophic crisp limit point of B_1 ,B_2 ,B_3 > iff every neutrosophic crisp open set containing P must contains at least one neutrosophic crisp point of B different from P. It is easy to say that the point is not neutrosophic crisp limit point of if there is a neutrosophic crisp open set of and ê : 3 ; L Î R.

2.12 Definition

The set of all neutrosophic crisp limit points of a neutrosophic crisp set is called neutrosophic crisp derived set of , denoted by : ;.

2.13 Example

If ò L <šáœ, î L <òR áî R á á á ; A <š ;, Î , Î > , B <› ;, Î , Î > , G <Tá U; Î , Î > . If we take D <TáU;Î, Î>, Then P= <R < ;Î, Î> is the only neutrosophic crisp limit point of D. i.e. : ; L{ <R }

2.14 Remarks

- Let B be any neutrosophic crisp set of ò , If P= { x }, Î, Î> Đî in any NCT space (ò, î), then P Đ : ;.
- Let B be any neutrosophic crisp set of ò , the following facts is true:
  : ; A , A : ;, and sometimes : ; êB = Î R or : ; êB MÎ R.
- In any NCT space (ò áî ;, we have :Î ; L Î R .

2.15 Theorem

Let (ò áî ; be NCTS and B_1 ,B_2 ,B_3 > be a neutrosophic crisp set of ò, then B is neutrosophic crisp closed set (NCCS for short) iff : ; C

Proof

Let be NCCS, then :ò 3 ; is neutrosophic crisp open set (NCOS for short) this implies that for each neutrosophic crisp point Đ R ‹ • :ò 3 ; á Ñ , there is a neutrosophic crisp open set of P and C : ò 3 ; ä

Since ê : ò 3 ; L Î Ç , then is not neutrosophic crisp limit point of , thus ê L Î Ç ,which implies that Ñ : ;. Hence : ; C

Conversely, assume that Ñ : ;, implis that is not neutrosophic crisp limit point of , hence, there is a neutrosophic crisp open set of P and ê L Î Ç which means that C : ò 3 ; and since : ò 3 ; is a neutrosophic crisp open set Hence ‹ •• ‡ — – " ' • ' '.Š ‹ ‹.•.' Ž ' •• ‡ ‡ä ä

2.16 Theorem

Let (ò áî ; be NCTS, B G be a neutrosophic crisp sets of ò , then the following properties hold:

(1) kÎ Ç o L Î Ç

(2) If C , then : ; C : ;

(3) : ê ; C : ; ê : ;

(4) : ë ; L : ; ë : ;

Proof (1) the proof is, directly.

Proof (2)

Assume that : ; be a neutrosophic crisp set containing a neutrosophic crisp point Đ R, then by definition 2.11, for each neutrosophic crisp open set of , we have ê 3 MÎ Ç, but C , hence ê 3 MÎ Ç, this means that Đ : ; ä ‡ • …á‡ : ; C : ;

Proof (3)

Since ê C , then by (2) : ê ; C : ; (1)

ê C , implies : ê ; C : ; (2)

From (1) & (2) : ê ; C : ; ê : ;

Proof (4)

Let Đ R • — –Šƒ Ñ : ; ë : ; , then either Ñ : ; and Ñ : ;, then there is a neutrosophic crisp open set of and ê 3 L Î Ç and ê 3 L Î Ç, this implies that (ë ; ê 3 L Î Ç, i.e Ñ : ë ;, hence : ë ; C : ; ë : ; :u;

Conversely since C ë , C ë ,then by property (2) : ; C :$ ë) ; and : ; C (B ëG) , thus : ë ; D : ; ë : ; :v; from (3) and (4) we have : ë ; L : ; ë : ;.

2.17 Remark

In general, the inverse of property 2 & 3 in Th.(2.16) is not true. The following examples act as an evidence to this claim.

2.18 Example

If ò L <šá áœ; î L <ò$_R$ áî $_R$á ;B î, <T;î> . If we take A î á< T ; î >, G î á< U ;î >
Notes that; : ; L O î á< UáV ;áî Pá : ; L O î á< Uá V ;áî P ƒ • † : ; C : ;, but A AG.

2.19 Example

If ò L <šá áœ; î L <ò$_R$ áî $_R$á ;B î, <T;î> . If we take A î á<T;î>, G î á<U;î> .
Notes that; : ê ; B : ; ê : ;.

2.20 Theorem

For any neutrosophic crisp set over the universe ò, then NC-Cl(B) = ë : ;

Proof

Let us first prove that ë : ; is a neutrosophic crisp closed set that is ò$_R$ 3k ë : ; o L : ò$_R$ 3 ; ê kò$_R$ 3 : ; o is a neutrosophic crisp open set.
Now for a neutrosophic crisp point Ð kò$_R$ 3: ; o ê kò$_R$ 3 : ; o, then Ð : ò$_R$ 3 : ; ; ƒ • † Ð ò$_R$ 3 : ;, thus Ñ and Ñ : ;. So by definition 2.12, there is a neutrosophic crisp set of S.t ê L î$_R$, hence C ò$_R$ 3 .
Now for each $_5$ Ð , then $_5$ Ñ : ; á then ê : ; L î$_R$, this implies that C ò$_R$ 3 : ; [i.e C : ò$_R$ 3 ; ê k ò$_R$ 3 : ; o?Thus : ò$_R$ 3 ; ê k ò$_R$ 3 : ; o is a neutrosophic crisp nhd of all its elements and hence ò$_R$ 3 ; ê kò$_R$ 3 : ; o is a neutrosophic crisp open set and thus ë : ; is a neutrosophic crisp closed set containing , therefore NC-Cl(B) C ë : ;.
Since NC-Cl(B) is a neutrosophic crisp closed set (see definition 2.12) and NC-Cl(B) contains all its neutrosophic crisp limits points .Thus : ; C NC-Cl(B) and C NC-Cl(B), hence NC-Cl(B) = ë : ;.

3 Separation Axioms In a neutrosophic Crisp Topological Space

3.1 Definition

A neutrosophic crisp topological space (ò áî ; is called:

- $_5$- î$_0$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G in ò containing one of them but not the other.
- $_6$- î$_0$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G in ò containing one of them but not the other .
- $_7$- î$_0$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G in ò containing one of them but not the other .
- $_5$- î$_1$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G_1 , G_2 in ò such that š$_R$ • G_1 , ›$_R$ • G_1 and š$_R$ • G_2 , ›$_R$ • G_2
- $_6$- î$_1$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G_1 , G_2 in ò such that š$_R$ • G_1 , ›$_R$ • G_1 and š$_R$ • G_2 , ›$_R$ • G_2
- $_7$- î$_1$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G_1 , G_2 in ò such that š$_R$ • G_1 , ›$_R$ • G_1 and š$_R$ • G_2 , ›$_R$ • G_2
- $_5$- î$_2$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G_1 , G_2 in ò such that š$_R$ • G_1 , ›$_R$ • G_1 and š$_R$ • G_2 , ›$_R$ • G_2 with G_1 êG_2 L î ä
- $_6$- î$_2$-space if Ê š$_R$ z ›$_R$ • ò Ì a neutrosophic crisp open set G_1 , G_2 in ò such that š$_R$ • G_1 , ›$_R$ • G_1 and š$_R$ • G_2 , ›$_R$ • G_2 with G_1 êG_2 L î ä

- $_7$ î$_2$-space if Ê š$_{R/}$ z ›$_{R/}$ • ò Ì a neutrosophic crisp open set G$_1$, G$_2$ in ò such that š$_{R/}$ • G$_1$, ›$_{R/}$ • G$_1$ and š$_{R/}$ • G$_2$, ›$_{R/}$ • G$_2$ with G$_1$ ê G$_2$ L Î ä

3.2 Definition

A neutrosophic crisp topological space (ò á î ; is called:

- - î$_o$-space if (ò á î ; is $_5$ î$_o$-space , $_6$ î$_o$-space ƒ • † $_7$ î$_o$-space
- - î$_1$-space if (ò á î ; is $_5$ î$_1$-space , $_6$ î$_1$-space ƒ • † $_7$ î$_1$-space
- - î$_2$-space if (ò á î ; is $_5$ î$_2$-space , $_6$ î$_2$-space ƒ • † $_7$ î$_2$-space

3.3 Remark

For a neutrosophic crisp topological space (ò á î ;

- Every - î$_o$-space is $_5$ î$_o$-space
- Every - î$_0$- space is $_6$ î$_0$-space
- Every - î$_0$- space is $_7$ î$_0$-space

Proof the proof is directly from definition 3.2.

The inverse of remark 3.3 is not true, the following example explain this state.

3.4 Example

If ò L <šá›= , î$_5$ L <ò$_R$ á î$_R$ á = , î$_6$ L <ò$_R$ á î$_R$ á = á î$_7$ L <ò$_R$ á î$_R$ á = A {x}, Î, Î>, B Î,{y}, Î> , G Î, Î,{x}> , Then (ò, î$_5$) is $_5$ î$_o$-space but it is not - î$_o$-space, (ò, î$_6$) is $_6$ î$_o$-space but it is not - î$_o$-space, (ò, î$_7$) is $_7$ î$_o$-space but it is not - î$_o$-space

3.5 Remark

For a neutrosophic crisp topological space (ò á î ;

- Every - î$_1$-space is $_5$ î$_1$-space
- Every - î$_1$- space is $_6$ î$_1$-space
- Every - î$_1$- space is $_7$ î$_1$-space

Proof the proof is directly from definition 3.2.

The inverse of remark (3.5) is not true as it is shown in the following example,

3.6 Example

If ò L <šá›= , î$_5$ L <ò$_R$ á î$_R$ á á = á î$_6$ L <ò$_R$ á î$_R$ á á = A {x}, <= , Î>, B <= ,{x}, Î>, G Î, Î,{x}> , F Î, Î,{y}> , Then (ò, î$_5$) is $_5$ î$_1$-space but it is not - î$_1$-space (ò, î$_5$) is $_6$ î$_1$-space but it is not - î$_1$-space (ò, î$_6$) is $_7$ î$_1$-space but it is not - î$_1$-space

3.7 Remark

For a neutrosophic crisp topological space (ò á î ;

- Every - î$_2$-space is $_5$ î$_2$-space
- Every - î$_2$-space is $_6$ î$_2$-space
- ˜ ‡ ” › - î$_2$-space is $_7$ î$_2$-space

Proof the proof is directly from definition 3.2.

The inverse of remark (3.7) is not true as it is shown in the example (3.6).

3.8 Remark

For a neutrosophic crisp topological space (ò á î ;

- Every - î$_1$-space is - î$_0$-space
- Every - î$_2$-space is - î$_1$-space

Proof the proof is directly.

The inverse of remark (3.8) is not true as it is shown in the following example:

3.9 Example

If L <š á› = , î L <ò$_R$ á î$_R$ á á á =

A { x }, Î , Î > , B Î, { y }, Î > , G Î , Î ,{ x } > ,

Then (ò, î) is - î$_o$-space but not - î$_1$-space

Conclusion

- We defined a new neutrosophic crisp points in neutrosophic crisp topological space
- We introduced the concept of neutrosophic crisp limit point, with some of its properties
- We constructed the separation axioms $\tilde{T}_i$-space, i= 0,1,2] in neutrosophic crisp topological and examine the relationship between them in details

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References

[1] F. Smarandache. Neutrosophy and Neutrosophic Logic, First International Conference on Neutrosophy, Neutro sophic Logic, Set, Probability, and Statistics, University of New Mexico, NM 87301, USA (2002)

[2] F. Smarandache. A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability, American Re- search Press, Rehoboth, NM, (1999)

[3] F. Smarandache. An introduction to the Neutrosophy probability applied in Quantum Physics, International Conference on introduction Neutrosophic Physics, Neutrosophic Logic, Set, Probability, and Statistics, University of New Mexico, Gallup, NM 87301, USA 2-4 December (2011)

[4] A. A. Salama. Basic Structure of Some Classes of Neutrosophic Crisp Nearly Open Sets and Possible Application to GIS Topology. Neutrosophic Sets and Systems, Vol.(7),(2015),18-22.

[5] W. Al-Omeri, Neutrosophic crisp Sets via Neutrosophic crisp Topological Spaces NCTS, Neutrosophic Sets and Systems, Vol.13, 2016, pp.96-104

[6] A. A. Salama and F. Smarandache. Filters via Neutrosophic Crisp Sets, Neutrosophic Sets and Systems, Vol. 1, Issue 1, (2013), 34-38.

[7] A. A. Salama and H. Elagamy. Neutrosophic Filters. International Journal of Computer Science Engineering and Information Technology Research (IJCSEITR), Vol.3, Issue 1, (2013), 307-312

[8] A. A. Salama and S.A. Alblowi. Intuitionistic Fuzzy Ideals Topological Spaces. Advances in Fuzzy Mathematics, Vol.(7), Issue 1, (2012), 51-60

[9] A. A. Salama and S. A. Alblowi. Neutrosophic set and neutrosophic topological space. ISORJ, Mathematics, Vol. (3), Issue 4, (2012), 31-35

[10] D. Sarker. Fuzzy ideal theory, Fuzzy local function and generated fuzzy topology. Fuzzy Sets and Systems 87, (1997), 117-123

[11] H. E. Khalid, "An Original Notion to Find Maximal Solution in the Fuzzy Neutrosophic Relation Equations (FNRE) with Geometric Programming (GP)", Neutrosophic Sets and Systems, vol.7,2015,pp.3-7.

[12] I. Hanafy, A. A. Salama and K. Mahfouz. Correlation of neutrosophic data, International Refereed Journal of Engineering and Science (IRJES), Vol.(1), Issue 2 , (2012), 39-43

[13] S. A. Alblowi, A. A. Salama and Mohmed Eisa. New concepts of neutrosophic sets. International Journal of Mathematics and Computer Applications Research (IJMCAR), Vol. (4), Issue 1, (2014), 59-66.

[14] A. A. Salama, I.M.Hanafy, Hewayda Elghawalby, M.S.Dabash. Neutrosophic Crisp Closed Region and Neutrosophic Crisp Continuous Functions. In F. Smarandache, & S. Pramanik (Eds.), New trends in neutrosophic theory and applications (pp. 403-412). Brussels: Pons Editions (2016).

[15] M. Abdel-Basset, M. Saleh, A. Gamal, F.Smarandache. An approach of TOPSIS technique for developing supplier selection with group decision making under type-2 neutrosophic number, Applied Soft Computing, Volume 77, April 2019, Pages 438-452

[16] M. Abdel-Basset, G. Manogaran, A. Gamal, F. Smarandache, A Group Decision Making Framework Based on Neutrosophic TOPSIS Approach for Smart Medical Device Selection. J. Medical Systems 43(2): (2019), 38:1-38:13 .

[17] M. Abdel Basset, V. Chang, A. Gamal, F. Smarandache, An integrated neutrosophic ANP and VIKOR method for achieving sustainable supplier selection: A case study in importing field. Computers in Industry, 106: (2019), 94-110.

[18] M. Parimala, M. Karthika, S. Jafari , F. Smarandache 4, R.Udhayakumar 5, Neutrosophic Nano ideal topological structure, Neutrosophic Sets and Systems, Vol. 24, (2019), 70-76

[19] S. Saranya and M.Vigneshwaran, Neutrosophic b_g -Closed Sets, Neutrosophic Sets and Systems, Vol. 24, (2019), 90-99

[20] A. B. AL-Nafee, R. D. Ali. On Idea of Controlling Soft Gem-Set in Soft Topological Space, Jour of Adv Research in Dynamical & Control Systems, Vol. 10, 13-Special Issue, (2018) ,606-615

http://jardcs.org/backissues/abstract.php?archiveid=6022

[21] A. A. Salama and S. A. Alblowi. Generalized Neutrosophic Set and Generalized Neutrosophic Topological Spaces, Journal computer Sci. Engineering, Vol. (2) , Issue 7, (2012), 29-32.

[22] A. A. Salama and S. A. Alblowi. Intuitionistic Fuzzy Ideals Topological Spaces, Advances in Fuzzy Mathematics, Vol.(7), Issue 1, (2012), 51-60

[23] I. M. Hanafy, A. A. Salama and K.M. Mahfouz. Neutrosophic crisp events and its probability. International Journal of Mathematics and Computer Applications Research (IJMCAR), Vol.(3), Issue 1, (2013), 171-178.

[24] A. A. Salama. Neutrosophic Crisp Points and Neutrosophic Crisp Ideals. Neutrosophic Sets and Systems, Vol.1, Issue 1, (2013), 50-54.

[25] A. A. Salama, F. Smarandache and Valeri Kroumov. Neutrosophic Crisp Sets and Neutrosophic Crisp Topological Spaces, Neutrosophic Sets and Systems, Vol. (2), (2014), 25-30.

[26] A. B. Al-Nafee, L.A. Al-Swidi,. "Separation Axioms Using Soft Turing Point of a Soft Ideal in Soft Topological Space". Journal of New Theory (2018): 29-37

[27] A. AL-Nafee, "On *Soft Turing Point with Separation Axioms", JUBPAS, vol. 26, no. 7, 2018, pp. 200–209.

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