mT-ORDERING ON NEUTROSOPHIC FUZZY MATRICES

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Abstract

The objective of this article is to learn about the mT-ordering on Neutrosophic Fuzzy Matrices (NSFM) as a disentanglement of the T-requesting on fuzzy frameworks. A few identical circumstances for this ordering utilizing m-Moore Penrose inverse are inferred. Further, that's what we demonstrate on the off chance that any two NSFMs are under mT-ordering, its membership(T), non- membership (F) and indeterminancy(I) fuzzy matrices are likewise under mT-order. Further, we demonstrate that mT - ordering is indistinguishable for specific class of neutrosophic fuzzy matrices.

Keywords: Fuzzy Matrix, Neutrosophic Fuzzy Matrix, T-ordering, mT -ordering, m-g Inverse.

1. Introduction

Analysts in endless ample fields choose with the vague, estimated and exceptionally lacking proof of showing vague information. As a result, fuzzy set hypothesis was acquainted by L. A. Zadeh[[1]. Then, at that point, the intuitionistic fuzzy sets were laid out by M. A. Atanassov [2, 3] [2]. Appraisal of non-participation values is additionally not drearily workable for the unclear explanation as in the event of enrolment esteems thus, there exists an indeterministic segment whereupon reluctance continues. As an impact, Smarandache [4] et al. has declared the idea of Neutrosophic Set (NS) which is an outline of customary sets, fuzzy set, intuitionistic fuzzy set and so forth.

The issues in regard to a few minds of hesitations can't settled by the traditional network hypothesis. That sort of issues are broken by utilizing fuzzy matrices. Fuzzy matrices concurrences with just participation values. These matrices can't contract non enrolment values. Intuitionistic fuzzy matrices (IFMs) reported first time by Khan, Shyamal and Pal [4]

In [6], Kim and Roush have perceived a model for fuzzy matrices identical to that for Boolean Matrices by spreading the max.min procedure on fuzzy variable based math Ғ =[0,1]. In [7], Meenakshi have determined different sorts of requesting on ordinary fuzzy matrices. Fuzzy matrices concurred with just participation values. These matrices can't contract non enrolment values. In [8], Poongodi et.al have given the new portrayal on Neutrosophic fuzzy matrices. In this paper, we declared mT-ordering on Neutrosophic Fuzzy Matrices (NSFM) as an understanding of the T-ordering on fuzzy matrices.

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2. Preliminaries:

In this part, a few rudimentary definitions and results wanted are given.

Definition 2.1.

A matrix $C \in F_n$ is known as to be regular that there exist a matrix $U \in F_n$, to such an extent that C U C =C. Then, at that point, U is called g-reverse of C. Let C{1} = { U / CUC = C}. F_n signifies the arrangement of all fuzzy matrices of order nxn.

Definition 2.2.

A matrix $C \in F_n$ is known as right m – regular, assuming there exist a matrix $U \in F_n$, to such an extent that $C^m U C = C^m$, for some sure whole number m. U is named as right m - g inverse of C. Let $C_r\{1^m\} = \{ U / C^m U C = C^m \}$.

Definition 2.3.

A matrix $C \in F_n$ is known as left m – regular, assuming there exist a matrix $V \in F_n$, to such an extent that $C V C^m = C^m$, for some sure whole number m. V is named as left m - g inverse of C. Let C = $\{ V / C V C^m = C^m \}$.

Definition 2.4.

A matrix $A \in F_n$ is known as left m – regular if there exist a matrix $Y \in F_n$, such that $A Y A^m = A^m$, for some positive integer m. Y is termed as left m – g inverse of A. Let $A_\ell\{1^m\} = \{ Y / A Y A^m = A^m \}$.

Definition 2.5

A matrix $C \in F_n$ is said to have a {1 , 2, 3,4}inverse if there is a matrix $U \in F_n$ to such an extent that

(i) CUC=C
(ii) UCU=C
(iii) $(CU)^T$=CU
(iv) $(UC)^T$=UC

Then U is termed as {1 , 2, 3,4}inverse of A and it is symbolized by C_r^+. The Moore-Penrose inverse of C is symbolized by C^+.

Definition 2.6.

The T ordering on any two fuzzy matrices C and D is well-defined as $C \overset{T}{\leq} D$ iff $CC^T = DC^T$ and $C^TC = C^TD$

Definition 2.7

An neutrosophic fuzzy matrix (NSFM) C of order m × n is defined as C= $[X_{ab}, <c_{(ab)T}, c_{(ab)F}, c_{(ab)I}>]_{mxn}$, where $c_{(ab)T}, c_{(ab)F}\ c_{(ab)I}$ are called enrollment work (T), the non-participation (F) work and the indeterminancy work (I) of U_{ab} in C, which sustaining the condition $0 \leq (c_{(ab)T} + c_{(ab)F} + c_{(ab)I}) \leq 3$. For simplicity, we write C = $[c_{ab}]_{mxn}$ where c_{ab} = < $c_{(ab)T,}$ $c_{(ab)F,}$ $c_{(ab)I}$ >. Let $\mathcal{N}_n$ symbolizes the arrangement of all nxn NSFM.

Let C and D be any two NSFMs. The accompanying activities are characterized for any two-component c_{ab} ∈ C and d_{ab} ∈ D, where c_{ab} = [$c_{(ab)T,}$ $c_{(ab)F,}$ $c_{(ab)I}$] and d_{ab} = [$d_{(ab)T,}$ $d_{(ab)F,}$ $d_{(ab)I}$] are in [0,1] with the end goal that $0 \leq (c_{(ab)T} + c_{(ab)F,} + c_{(ab)I}) \leq 3$ and $0 \leq (d_{(ab)T,} + d_{(ab)F,} + d_{(ab)I}) \geq 3$, thenab

$$c_{ab} + d_{ab} = [\max\{c_{(ab)T,}, d_{(ab)T}\}, \max\{c_{(ab)F}, d_{(ab)F}\}, \min\{c_{(ab)I}, d_{(ab)I}\}]$$

$$c_{ab} \,.\, d_{ab} = [\min\{c_{(ab)T,}, d_{(ab)T}\}, \min\{c_{(ab)F}, d_{(ab)F}\}, \max\{c_{(ab)I,} d_{(ab)I}\}]$$

Here we shall track the elementary operations on NSFM.

For C = (c_{ab}) =[$c_{(ab)T,}$ $c_{(ab)F,}$ $c_{(ab)I}$] and D = (d_{ab}) =[$d_{(ab)T,}$ $d_{(ab)F,}$ $d_{(ab)I}$] of order mxn, their total indicated as C + D is characterized as,

$$C + D = (c_{ab} + d_{ab}) = [(c_{(ab)T,} + d_{(ab)T}), (c_{(ab)F} + d_{(ab)F}), (c_{(ab)I} + d_{(ab)I}])] \quad ....(2.1)$$

For C = $(c_{ab})_{mxn}$ and D = $(d_{ab})_{nxp}$ their product indicated as CD is characterized as,

$$CD = (e_{ab}) = \sum_{k=1}^{n} c_{bk} \,.\, d_{kb}$$

$$= \sum_{k=1}^{n}\left(c_{(ak)T,} \,.\, d_{(kb)T}\right), \sum_{k=1}^{n}\left(c_{(ak)F} \,.\, d_{(kb)F}\right), \sum_{k=1}^{n} c_{(ak)I} \,.\, d_{(kb)I} \quad ...(2.2)$$

Lemma 2.8

For C, D ∈ $\mathcal{N}_{mn}$

(i) If the row space of D contained in the row space of C then which is equivalent to D = UC for some U ∈ $\mathcal{N}_m$

i.e. R(D) ⊆ R(C) ⇔ D = UC for some U ∈ $\mathcal{N}_m$

(ii) If the column space of D contained in the column space of C then which is equivalent to D = CV for some V ∈ $\mathcal{N}_n$

i.e. C(D) ⊆ C(D) ⇔ D = CV for some V ∈ $\mathcal{N}_n$

Lemma 2.9

For C ∈ $\mathcal{N}_{mn}$ and D ∈ $\mathcal{N}_{nm}$, the following hold.

(i) The row space of CD, which is contained in the row space of C, i.e. R(CD) ⊆ R(C)

(ii) The column space of CD, which is contained in the column space of D , i.e. C(CD) ⊆ C(D)

Lemma: 2.10

For C=[C_T, C_F, C_I] ∈ $\mathcal{N}_{mn}$ and D=[D_T, D_F, D_I] ∈ $\mathcal{N}_{nm}$, the following hold.

(i) $C^T = [C_T{}^T, C_F{}^T, C_I{}^T]$

(ii) $CD = [C_TD_T, C_FD_F, C_ID_I]$

3. mT -Ordering on Nuetrosophic Fuzzy Matrices

In this segment**,** we deliberate mT-ordering on neutrosophic fuzzy matrices (NSFM) as a simplificationofthe T-ordering on fuzzy matrices. Also we prove that if any two NSFMs are under mT- ordering then its membership, non-membership and indeterminancy fuzzy matrices are also under mT-order. For this ordering some equivalent conditions using m-Moore Penrose inverses are derived. Further, we prove that mT –ordering is indistinguishable for certain class of neutrosophic fuzzy matrices.

Definition 3.1.

For C, D∈ $\mathcal{N}_n$, The mT ordering $C \overset{mT}{<} D$ is defined as $C \overset{mT}{<} D$ iff

$(C^m)^T C^m = (C^m)^T D^m$ and

$C^m (C^m)^T = D^m (C^m)^T$

Definition 3.2.

A matrix C=[C_T, C_F, C_I] ∈ $\mathcal{N}_n$ is said to have a{1^m_r , 2^m, 3^m, 4^m}inverse assuming there exists a matrix U ∈ $\mathcal{N}_n$ with the end goal that

$C^m U C = C^m$

$U C^m U = U$

$(C^m U)^T = C^m U$

$(U C^m)^T = U C^m$ for some positive integer m.

Then U is termed {1^m_r , 2^m, 3^m,4^m } inverse of C and it is symbolized byC_r^+. Also C_r^+ is termed it as the Right Moore-Penrose Inverse of C.

Definition 3.3.

A matrix C=[C_T, C_F, C_I] ∈ $\mathcal{N}_n$ is said to have a{1^m_ℓ , 2^m, 3^m,4^m}inverse assuming there exists a matrix U∈ $\mathcal{N}_n$ with the end goal that

$C U C^m = C^m$

$U C^m U = U$

$(C^m U)^T = C^m U$

$(U C^m)^T = U C^m$ for some positive integer m.

Then U is termed {1^m_ℓ , 2^m, 3^m,4^m} inverse of C and it is symbolized by C_l^+. Also C_l^+ is termed it as the Left Moore-Penrose Inverse of C.

Lemma: 3.4

Let C=[C_T, C_F, C_I] ∈ $\mathcal{N}_n$ and D=[D_T, D_F, D_I] ∈ $\mathcal{N}_n$ then $C \overset{mT}{<} D$ ⇔ $C_T \overset{mT}{<} D_T$, $C_F \overset{mT}{<} D_F$ and $C_I \overset{kT}{\leq} D_I$

Proof:

Let C= [C_T, C_F, C_I] ∈ $\mathcal{N}_n$ and D= [D_T, D_F, D_I] ∈ $\mathcal{N}_n$.

$C \overset{mT}{<} D$ *iff* $C^m)^T C^m = (C^m)^T D^m$ and

$C^m (C^m)^T = D^m (C^m)^T$ [By definition (3.1)

$(C^m)^T C^m = (C^m)^T D^m \Leftrightarrow [C_T^m, C_F^m, C_I^m]^T [C_T^m , C_F^m, C_I^m] = [C_T^m , C_F^m, C_I^m]^T [D_T^m , D_F^m, D_I^m]$

$\Leftrightarrow [(C_T^m)^T, (C_F^m)^T, (C_I^m)^T][C_T^m , C_F^m, C_I^m] = [(C_T^m)^T, (C_F^m)^T, (C_I^m)^T][D_T^m , D_F^m, D_I^m]$

$\Leftrightarrow [(C_T^m)^T C_T^m, (C_F^m)^T C_F^m, (C_I^m)^T C_I^m] = [(C_T^m)^T D_T^m, (C_F^m)^T D_F^m, (C_I^m)^T D_I^m]$

$\Leftrightarrow (C_T^m)^T C_T^m = (C_T^m)^T D_T^m, \quad (C_F^m)^T C_F^m = (C_F^m)^T D_F^m, \ (C_I^m)^T C_I^m = (C_I^m)^T D_I^m$

Correspondingly, we have,

$C^m (C^m)^T = D^m (C^m)^T \Leftrightarrow C_T^m (C_T^m)^T = D_T^m (C_T^m)^T, \quad C_F^m (C_F^m)^T = D_F^m (C_F^m)^T,$

$C_I^m (C_I^m)^T = (C_I^m)^T D_I^m$

Hence $C \overset{mT}{<} D \Leftrightarrow C_T \overset{mT}{<} D_T$, $C_F \overset{mT}{<} D_F$ and $C_I \overset{mT}{<} D_I$

Theorem: 3.5

Let $C=[C_T, C_F, C_I] \in \mathcal{N}_n$, $D=[D_T, D_F, D_I] \in \mathcal{N}_n$ and C^+ exists. Then the succeeding conditions are comparable:

(i) $C \overset{mT}{<} D$

(ii) $C_T \overset{mT}{<} D_T$, $C_F \overset{mT}{<} D_F$ and $C_I \overset{mT}{<} D_I$

(iii) $C^+C^m = C^+D^m$ and $C^m C^+ = D^m C^+$

(iv) $C^m = D^mC^+C = CC^+D^m$

Proof :

(i)$\Leftrightarrow$ (ii) holds by Lemma (3.4)

(i) $\Rightarrow$(iii) Since $C \overset{mT}{\leq} D \Leftrightarrow (C^m)^TC^m = (C^m)^TD^m$ and

$$C^m(C^m)^T = D^m(C^m)^T$$

$$\begin{aligned} C^+C^m = C^+C^m C^+ C^m &= C^+(C^+)^T(C^m)^TC^m \\ &= C^+(C^+)^T(C^m)^TD^m \quad \text{(By Definition 3.1)} \\ &= (C^+C^m C^+)D^m \\ &= C^+D^m \end{aligned}$$

Similarly we have to prove $C^mC^+ = D^mC^+$

(iii) $\Rightarrow$ (iv) $C^mC^+ = D^mC^+ \Rightarrow C^m = C^m C^+C = D^mC^+C$

$$C^+C^m = C^+D^m \Rightarrow C^m = CC^+C^m = CC^+D^m$$

Corollary : 3.6

Let $C, D \in \mathcal{N}_n$. If $D \overset{T}{\leq} C$ and $C \overset{mT}{\leq} D$ then $D_r^+ \subseteq C_r^+$.

Proof:

Since $D \overset{T}{\leq} C \Leftrightarrow D^TD = D^TC$ and $DD^T = CD^T$ and

$$C \overset{mT}{\leq} D \Leftrightarrow (C^m)^TC^m = (C^m)^T D^m \text{ and}$$

$$C^m(C^m)^T = D^m(C^m)^T$$

To prove $D_r^+ \subseteq C_r^+$ its enough to prove $C^mD^+C = C^m$

$$\begin{aligned} \text{Consider, } C^mD^+C &= CC^+D^m (D^+C) \\ &= CC^+ (D^mD^+D) \\ &= CC^+D^m \\ &= C^m \end{aligned}$$

Hence $D_r^+ \subseteq C_r^+$.

Corollary : 3.7

Let $C, D \in N_n$. If $D \overset{T}{\leq} C$ and $C \overset{mT}{\leq} D$ then $D_l^+ \subseteq C_l^+$.

Since $D \overset{T}{\leq} C \Leftrightarrow D^TD = D^TC$ and $DD^T = CD^T$ and

$$C \overset{mT}{\leq} D \Leftrightarrow (C^m)^TC^m=(C^m)^TD^m \text{ and}$$

$$C^m(C^m)^T = D^m(C^m)^T$$

To prove $D_l^+ \subseteq C_l^+$ its enough to prove $CD^+C^m = C^m$

Consider, $CD^+C^m = CD^+D^m(C^+C)$
$= DD^+(D^mC^+C)$
$= D^mC^+C$
$= C^m$

Hence $D_l^+ \subseteq C_l^+$.

Theorem: 3.8

Let $C, D \in \mathcal{N}_n$. If C^+ and D^+ both exist, then the following conditions are holds hood:

(i) $C \overset{mT}{\leq} D$

(ii) $C_T \overset{mT}{\leq} D_T$, $C_F \overset{mT}{\leq} D_F$ and $C_I \overset{mT}{\leq} D_I$

(iii) $C^+C^m = D^+C^m$ and $C^mC^+ = C^mD^+$.

(iv) $D^+C^mC^+ = C^+ = C^+C^m D^+$.

(v) $(C^T)^mD D^+ = (C^T)^m = D^+D(C^T)^m$.

Proof:

Proof of (i) and (ii) holds from Lemma (3.4)

(iii) $C^+C^m = D^+C^mC^+C^m = D^+C^m$ and

$C^mC^+ = C^mC^+ C^mD^+ = C^mD^+$

(iv)Since $C^+C^m = D^+C^m$ and $C^mC^+ = C^mD^+$

Consider $C^+ = C^+C^mC^+ = D^+C^mC^+$

Consider $C^+ = C^+C^mC^+ = C^+C^mD^+$

(v) $(C^T)^mC^m = (C^T)^mD^m$
$= (C^T)^m D^mD^+B$
$= D^+D (C^T)^mD^m$
$= D^+D(C^T)^mC^m$
$(C^T)^m = D^+D(C^T)^m$
Similarly $(C^T)^m = (C^T)^mD D^+$

Theorem 3.9. For $C=[C_T, C_F, C_I]$, $D=[D_T, D_F, D_I] \in (\mathcal{N})_n^{(m)}$, if $C \overset{mT}{\leq} D$ then $\mathcal{R}(C^m) \subseteq \mathcal{R}(D^m)$, $\mathcal{C}(C^m) \subseteq \mathcal{C}(D^m)$ and $C^mD^+D = C^m = DD^+ C^m$ for each $D^+ \in D^+\{1^m_r\}$ and for each $D^+ \in D^+\{1^m_\ell\}$.

Proof: If $C \overset{mT}{\leq} D \Rightarrow C^m = CD^+D^m = D^mD^+C$ (By Lemma (3.6))

$\Rightarrow C^m = VD^m = D^mU$, where V = CY and U = X C

$\Rightarrow R(C^m) \subseteq R(D^m)$ and $C(C^m) \subseteq C(D^m)$ (By Lemma (2.9))

$\Rightarrow C^mXD = C^m = DD^+C^m$ for each $D^+ \in D\{1^m_r\}$ and for each $D^+ \in D\{1^m_\ell\}$ (By Lemma 3.8)

Theorem 3.10. *For* $C=[C_T, C_F, C_I]$, $D=[D_T, D_F, D_I] \in (\mathcal{N})_n^{(m)}$, the following hold.

(i) $C \overset{mT}{\leq} C$

(ii) $C \overset{mT}{\leq} D$ and $D \overset{mT}{\leq} C$ then $C^m = D^m$

(iii) $C \overset{mT}{\leq} D$ and $D \overset{mT}{\leq} C$ then $C \overset{mT}{\leq} E$

Proof :

(i) $C \overset{mT}{\leq} C$ is trivial.

(ii) $C \overset{mT}{\leq} D \Rightarrow C^m = D^m C_r^+ C$ for $C_r^+ \in C^+\{1_r^k\}$ (By Lemma 3.5)

$D \overset{mT}{\leq} C \Rightarrow D^m = DC_l^+ C^m$ for $C_l^+ \in C^+\{1_\ell^k\}$ (By Lemma 3.5)

Now, $C^m = D^m C_r^+ C = (DC_l^+ C^m) C_r^+ C = DC_l^+ (C^m C_r^+ C) = DC_l^+ C^m = D^m$

Hence, $C \overset{mT}{\leq} D$ and $D \overset{mT}{\leq} C \Rightarrow C^m = D^m$

(iii) $C \overset{mT}{\leq} D \Rightarrow C^m = C^m D^+ D = DD^+ C^m$ (By Theorem (3.9))

$D \overset{mT}{\leq} E \Rightarrow D^m = E^m D^+ D = DD^+ E^m$ (By Theorem (3.9))

Let us consider $(C^m)^T = D^+ D (C^m)^T$ for $D^+ \in D^+\{1_r^k\}$

Since $C \overset{mT}{\leq} D$ and $D \overset{mT}{\leq} E$, then we have

$$
\begin{aligned}
C^m (C^m)^T &= C^m (D^+ D (C^m)^T \\
&= (C^m D^+ D)(C^m)^T \\
&= C^m (C^m)^T && \text{(By Theorem (3.9))} \\
&= D^m (C^m)^T && \text{(By Definition (3.1))} \\
&= (E^m D^+ D)(C^m)^T && \text{(By Theorem (3.9))} \\
&= E^m (D^+ D (C^m)^T) \\
&= E^m (C^m)^T
\end{aligned}
$$

and $(C^m)^T C^m = (C^m)^T E^m$ for some $(C^m)^T = D^+ D (C^m)^T$

Hence, $(C^m)^T = D^+ D (C^m)^T$ with $C^m (C^m)^T == E^m (C^m)^T$ and $(C^m)^T C^m = (C^m)^T E^m$

Therefore $C \overset{mT}{\leq} E$

Theorem.3.11. For $C=[C_T, C_F, C_I]$, $D=[D_T, D_F, D_I] \in (\mathcal{N})_n^{(m)}$, $C \overset{mT}{\leq} D \Leftrightarrow (C^m)^T \overset{mT}{\leq} (D^m)^T$

Proof.

$C \overset{mT}{\leq} D \Leftrightarrow C^m (C^m)^T = D^m (C^m)^T$

and $(C^m)^T C^m = (C^m)^T D^m$

Consider, $C^m (C^m)^T = D^m (C^m)^T$

$\Leftrightarrow [C^m (C^m)^T]^T = [D^m (C^m)^T]^T$

$\Leftrightarrow (C^m)(C^m)^T = (C^m)(D^m)^T$

Similarly, $(C^m)^T C^m = (C^m)^T D^m \Leftrightarrow (C^m)^T (C^m) = (D^m)^T (C^m)$

Hence $C \overset{mT}{\leq} D \Leftrightarrow (C^m)^T \overset{mT}{\leq} (D^m)^T$

Theorem.3.12. $C=[C_T, C_F, C_I]$, $D=[D_T, D_F, D_I] \in (\mathcal{N})_n^{(m)}$, if $C \overset{mT}{\leq} D$ then $RC^m R^T \overset{mT}{\leq} RD^m R^T$ for some permutation matrix R.

Proof:

$$
\begin{aligned}
\text{Now, } [(RCR^T)^m]^T (RCR^T)^m &= [(R^m C^m (R^T)^m]^T (R^m C^m (R^T)^m \\
&= R(C^m)^T R^T R C^m R^T \\
&= R(C^m)^T (R^T R) C^m R^T \\
&= R(C^m)^T C^m R^T \\
&= R((C^m)^T D^m) R^T \\
&= R((C^m)^T R^T R D^m) R^T \\
&= (R((C^m)^T R^T)(RD^m) R^T) \\
&= [(RCR^T)^m]^T (RDR^T)^m
\end{aligned}
$$

Hence $[(RCR^T)^m]^T (RCR^T)^m = [(RCR^T)^m]^T (RDR^T)^m$

Similarly, $(RCR^T)^m [(RCR^T)^m]^T = (RDR^T)^m [(RCR^T)^m]^T$

Hence $C \overset{mT}{\leq} D \Rightarrow RC^m R^T \overset{mT}{\leq} RD^m R^T$

Conclusion:

Ordering moralities are decisive for classifying and grading real world problems. This article affords a distinct type of ordering named mT-ordering which has extensive application in neutrosophic fuzzy matrices. This paper is an simplification of T ordering in regular fuzzy matrices to mT-ordering on m-regular neutrosophic fuzzy matrices.

References

[1] *M. Atanassov, "Intuitionistic fuzzy sets", Fuzzy Sets and Systems. Vol.20, (1986), pp.87-96.*

[2] *M. Atanassov, "Operations over interval-valued intuitionistic fuzzy sets", Fuzzy Sets and Systems. Vol. 64 (1994), pp.159-174.*

[3] *Kim, M.H; Roush, F.W. "Generalized fuzzy matrices", Fuzzy sets and systems. Vol. 4,(1980),pp. 293 – 315.*

[4] *Mamouni Dhar, Said Broumi, and Florentin Smarandache, "A Note on Square Neutrosophic Fuzzy Matrices", Neutrosophic Sets and Systems. Vol. 3, (2014).*

[5] *Meenakshi, AR. "Fuzzy Matrix, Theory and Applications", MJP Publishers, Chennai,(2008).*

[6] *M. Pal, S. M. Khan and A. M. Shyamal" Intuitionistic fuzzy matrices", Notes on Intuitionistic Fuzzy Sets. Vol. 8(2), (2002), pp.51-62.*

[7] *Poongodi P and S.Princy Christinal Esther and M.M.Shanmugapriya, "On Regular Neutrosophic Fuzzy Matrices", Indian Journal of Natural Sciences, Vol.13,No.71, (2022),pp:40932 – 40938..*

[8] *Rakhal Das, Florentin, Smarandache, Binod Chandra Tripathy, "Neutrosophic Fuzzy Matrices and Some Algebraic Operations", Neutrosophic sets and systems, Vol 32,(2020), pp:401- 409 .*

[9] *F. Smarandache, "Neutrosophic set, A generalization of the intuitionistic fuzzy sets", Inter. J. Pure Appl. Math. Vol. 24, (2005),pp.287-297..*

[10] *Zadeh, L.A.. "Fuzzy sets, Information and Control", 8 😟1965), pp.338 – 353.*