A Common Fixed Point for Two Mappings Satisfying Generalized Neutrosophic Contraction On Neutrosophic Metric Space

Manish Kumar
(Department of Mathematics)
(*Government Degree College Nanauta,Saharanpur*)

Abstract: Kirişci M, Simsek N, Akyigit M[21] and Kumar M[31] have established fixed point result for neutrosophic Banach Contraction. The aim of this paper is to prove a common fixed point theorem for two mappings satisfying a generalized neutrosophic contraction mapping.This result extends the theorem due to Kumar M [31]

Key Words: Fixed Point, Neutrosophic Contraction, Generalized Neutrosophic Contraction, Neutrosophic Metric Space.

Introduction:

The concept of Fuzzy Sets introduced by Zadeh [1] has attracted all the scientific fields since its starting. It is seen that this concept remained failed for real-life situations, to provide enough solution to some problems in time.Atanassov [2] put the idea of Intuitionistic fuzzy sets for such cases. Neutrosophic set (NS) is a new version of the idea of the classical set which is defined by Smarandache [3]. Some of other generalizations are FS [1] interval-valued FS [4], IFS [2], interval-valued IFS [5], the sets paraconsistent, dialetheist, paradoxist, and tautological [6], Pythagorean fuzzy sets [7].

Combining the concepts Probabilistic metric space and fuzziness, fuzzy metric space (FMS) is introduced in [8]. Kaleva and Seikkala [9] have defined the fuzz metric as the nearness between two points with respect to a real number to be a non-negative fuzzy number. In [10] some basic properties of FMS studied and the Baire Category Theorem for FMS proved. Further, some properties of metric structure like separability, countabilityetc are given and Uniform Limit Theorem is proved in [11]. Afterward, FMS has used in the applied sciences such as fixed point theory, image and signal processing, medical imaging, decision-making et al. After itroduction of the intuitionistic fuzzy set (IFS), it was used in all areas where FS theory was studied. Park [12] defined IF metric space (IFMS), which is a generalization of FMSs. Park used George and Veeramani's [10] idea of applying t-norm and t-conorm to the FMS meanwhile defining IFMS and studying its basic features. Fixed point theorem for fuzzy contraction mappings is initiated by Heilpern [13]. Bose and Sahani [14] extended the Heilpern's study. Alaca et al. [15] are given fixed point theorems related to intuitionistic fuzzy metric spaces(IFMSs). Fixed point results for fuzzy metric spaces and IFMSs are studied by many researchers [16], [17], [18], [19], [20].

Kirisci et al. [21, 23] defined neutrosophic contractive mapping and gave a fixed point results in complete neutrosophic metric spaces. In [22], Mohamad studied fixed point approach in intuitionistic fuzzy metric spaces. Definitions and results of this paper is an extension of Kumar M[31] and a generalizations of Kirisci et al. [21] for a generalized Neutrosophic contraction.

Preliminaries: Triangular norms (t-norms) (TN) were initiated by Menger [27]. In the problem of computing the distance between two elements in space, Menger offered using probability distributions instead of using numbers of distance. TNs are used to generalize with the probability distribution of triangle inequality in metric space conditions. Triangular conforms (t-conorms) (TC) know as dual operations of TNs. TNs and TCs are very significant for fuzzy operations (intersections and unions).

Definition 2.1. Give an operation $\odot$:[0,1]×[0,1]→[0,1]. If the operation $\odot$ is satisfying the following conditions, then it is called that the operation $\odot$ is continuous TN (CTN): For s,,,∈[0,1],

i) $s\odot 1=s$,

ii) If $s\leq u$ and $t\leq v$, than $s\odot t\leq u\odot v$,

iii)$\odot$ is commutative and associate,

iv)$\odot$ is continuous.

Definition 2.2. Give an operation $\boxdot$:[0,1]×[0,1]→[0,1]. If the operation $\boxdot$ is satisfying the following conditions, then it is called that the operation $\boxdot$ is continuous TC (CTC):

i)$s\boxdot 0=s$,

ii) If $s\leq u$ and $t\leq v$, than $s\boxdot t\leq u\boxdot v$,

iii)$\boxdot$ is commutative and associate,

iv) $\boxdot$ is continuous.

Remark 2.3. [23] Take $\odot$ and $\boxdot$ are CTN and CTC, respectively. For s,,,∈[0,1],

a. If $s>t$, then there are u, such that $s\odot u\geq t$ and $s\geq t\boxdot v$.

b. There are p, such that $t\odot t\geq s$ and $s\geq p\boxdot p$.

Definition 2.4. [28] Take F be an arbitrary set,$\Omega=\{\langle a,H_U(a), M_U(a),S_U(a)\rangle:a\in F\}$ be a NS such that $\Omega:F\times F\times\mathbb{R}_+\to[0,1]$. Let $\odot$ and $\boxdot$ show the CTN and CTC, respectively. The four tuple $V=(F, \Omega,\odot,\boxdot)$ is called neutrosophic metric space(NMS) when the following conditions are satisfied. $\forall a,b,c\in F$,

i) $0\leq H(a,b,\lambda)\leq 1$, $0\leq M(a,b,\lambda)\leq 1$, $0\leq S(a,b,\lambda)\leq 1 \forall\lambda\in\mathbb{R}^+$,

ii)$H(a,b,\lambda)+M(a,b,\lambda)+S(a,b,\lambda)\leq 3$, $(for \lambda\in\mathbb{R}_+)$,

iii)$H(a,b,\lambda)=1$ $(for \lambda>0)$ $if and only if a=b$,

iv)$H(a,b,\lambda)=H(b,a,\lambda)$ $(for \lambda>0)$,

v)$H(a,b,\lambda)\odot H(b,c,\mu)\leq H(a,c,\lambda+\mu)$ $(for \lambda,\mu>0)$,

vi)$H(a,b,.):[0,\infty)\to[0,1]$ is continuous,

vii) $\lim_{\lambda\to\infty}(a,b,\lambda)=1$ $(\forall\lambda>0)$,

viii)$(a,b,\lambda)=0$ $(for \lambda>0)$ $if and only if a=b$,

ix)$(a,b,\lambda)=M(b,a,\lambda)$ $(for \lambda>0)$,

x)$M(a,b,\lambda)\boxdot M(b,c,\mu)\geq M(a,c,\lambda+\mu)$ $(for \lambda,\mu>0)$

xi)$M(a,b,.):[0,\infty)\to[0,1]$ is continuous,

xii)$\lim_{\lambda\to\infty}M(a,b,\lambda)=0$ $(\forall\lambda>0)$,

xiii)$(a,b,\lambda)=0$ $(for \lambda>0)$ $if and only if a=b$

xiv)$(a,b,\lambda)=S(b,a,\lambda)$ $(for \lambda>0)$,

xv)$S(a,b,\lambda)\boxdot S(b,c,\mu)\geq S(a,c,\lambda+\mu)$ $(for \lambda,\mu>0)$,

xvi)$S(a,b,.)$:$[0,\infty)\to[0,1]$ is continuous,

xvii)$\lim_{\lambda\to\infty}S(a,b,\lambda)=0$ $(\forall\lambda>0)$

xviii) If $\lambda\leq 0$, then $H(a,b,\lambda)=0,M(a,b,\lambda)=1$, $S(a,b,\lambda)=1$.

Then $\Omega=(H,M,S)$ is called Neutrosophic Metric (NM) on F.

The functions $H(a,b,\lambda),M(a,b,\lambda)$, $S(a,b,\lambda)$ denote the degree of nearness, the degree of neutralness and the degree of non-nearness between a and b with respect to λ, respectively.

Definition 2.5. [28] Give V be a NMS, $0<\varepsilon<1$, $\lambda>0$ and $a\in F$. The set $D(a,\varepsilon,\lambda)=\{b\in F$: $H(a,b,\lambda)>1-\varepsilon$, $M(a,b,\lambda)<\varepsilon$, $S(a,b,\lambda)<\varepsilon\}$ is said to be the open ball (OB) (center a and radius ε with respect to λ).

Lemma 2.6. [28] Every OB$D(a,\varepsilon,\lambda)$ is an open set (OS).

Definition 2.7. Let $\{a_n\}$be a sequence in $V=(F,\Omega,\odot,\boxdot)$. Then the sequence converges to a point $a\in F$ if and only if for given $\varepsilon\in(0,1)$, $\lambda>0$, there exists $n_0\in\mathbb{N}$ such that for all $n\geq n_0$
$H(a_n,a,\lambda)>1-\varepsilon$,$M(a_n,a,\lambda)<\varepsilon$, $S(a_n,a,\lambda)<\varepsilon$,
or
$\lim_{n\to\infty}H(a_n,a,\lambda)=1$, $\lim_{n\to\infty}M(a_n,a,\lambda)=0$, $\lim_{n\to\infty}S(a_n,a,\lambda)=0$. (2)

Definition 2.8. [28] Take V to be a NMS. A sequence $\{a_n\}$ in F is called Cauchy if for each $\varepsilon>0$ and each >0, there exist $n_0\in\mathbb{N}$ such that
$H(a_n,a_m,\lambda)>1-\varepsilon$, $M(a_n,a_m,\lambda)<\varepsilon$, $S(a_n,a_m,\lambda)<\varepsilon$,
or
$\lim_{n,m\to\infty}H(a_n,a_m,\lambda)=1$,$\lim_{n,m\to\infty}M(a_n,a_m,\lambda)=0$, $\lim_{n,m\to\infty}S(a_n,a_m,\lambda)=0$
for all $n,m\geq n_0$.
V is called complete if every Cauchy sequence is convergent.

3. NEUTROSOPHIC CONTRACTIVE MAPPING

The following definitions and results are given in [21]:

Definition 3.1. Let V be a NMS. The mapping $f:F\to F$ is called neutrosophic contraction (NC) if there exists $k\in(0,1)$ such that

$$\frac{1}{H(f(a),f(b),\gamma)}-1\leq k\left(\frac{1}{H(a,b,\gamma)}-1\right)$$

$M(f(a),f(b),\lambda)\leq kM(a,b,\lambda)$,
$S(f(a),f(b),\lambda)\leq kS(a,b,\lambda)$,
for each $a,b\in F$ and $\lambda>0$.

Definition 3.2. Let V be a NMS and let $f:F\to F$be a NC mapping. If there exists $c\in F$ such that (c) = c . Then$c$ is called neutrosophic fixed point (NFP) of f.

Proposition 3.3. Suppose that f is a NC. Then, $f^n$is also a NC. Furthermore, if k is the constant for f, then $k^n$is the constant for f^n.

Proposition 3.4. Let f be a NC and $a\in F$.fD$[(a,\varepsilon,\lambda)]\subset$ D(fa,ε,λ) for large enough values of ε.

Proposition 3.5. The inclusion[D(a,ε,λ)]$\subset D(f^n(a),\varepsilon_*,\lambda)$ is hold for all n, where $\varepsilon_*=k^n\times\varepsilon$.

Also the following result is given in [31]:

Definition 3.6. Let V be a NMS. A mapping $f:F\to F$ is a generalized neutrosophic contraction, if there exists k_1, k_2, $k_3\in(0,1)$ and $k_1+k_2+k_3\leq 1$ such that

$$\frac{1}{H(f(a),f(b),\gamma)}-1\leq k_1\left(\frac{1}{H(a,b,\gamma)}-1\right)+k_2\left(\frac{1}{H(a,f(a),\gamma)}-1\right)+k_3\left(\frac{1}{H(b,f(b),\gamma)}-1\right)$$

$$(f(a),f(b),\gamma)\leq k_1(a,b,\gamma)+k_2\,M(a,f(a)),\gamma)+k_3\,M(b,f(b),\gamma)$$

$$S(f(a),f(b),\gamma) \leq k_1 S(a,b,\gamma) + k_2 S(a, f(a)),\gamma) + k_3 S(b, f(b),\gamma),$$
for each $a,b \in F$ and $\gamma > 0$.

Theorem: Let V be a complete NMS with (2) in which a NC sequence is a Cauchy sequence. Let f:$F \rightarrow F$ is a generalized neutrosophic contraction satisfying conditions of Definition 3.9. Then f has a unique fixe point in V.

Main Result

Now, we shall give new definitions and results:

Definition 3.6. Let V be a NMS. A mapping f,g :$F \rightarrow F$ is a generalized neutrosophic contraction, if there exists k_1, k_2, $k_3 \in (0,1)$ and $k_1 + k_2 + k_3 \leq 1$ such that

$$\frac{1}{H(f(a), g(b), \gamma)} - 1 \leq k_1 \left(\frac{1}{H(a, b, \gamma)} - 1\right) + k_2 \left(\frac{1}{H(a, f(a), \gamma)} - 1\right) + k_3 \left(\frac{1}{H(b, g(b), \gamma)} - 1\right)$$
$$M(f(a),g(b),\gamma) \leq k_1 M(a,b,\gamma) + k_2 M(a, f(a)),\gamma) + k_3 M(b, g(b),\gamma)$$
$$S(f(a),g(b),\gamma) \leq k_1 S(a,b,\gamma) + k_2 S(a, f(a)),\gamma) + k_3 S(b, g(b),\gamma),$$
for each $a,b \in F$ and $\gamma > 0$.

Remark: If $k_2 = k_3 = 0$**,** the above NC reduced to NC defined by Kirisci et al [21].

Theorem: Let V be a complete NMS with (2) in which a NC sequence is a Cauchysequence. Let f:$F \rightarrow F$ is a generalized neutrosophic contraction satisfying conditions of Definition 3.9. Then f has a unique fixe point in V.

Proof: Let
$a_0 \in V$ *and* $a_1 = f(a_0)$, $a_2 = g(a_1)$; $a_{2n+1} = f(a_{2n})$, $a_{2n+2} = g(a_{2n+1})$ *for all* $n \in \mathbb{N}$.
For each $\gamma > 0$,

$$\frac{1}{H(a_{2n+1}, a_{2n+2}, \gamma)} - 1 = \frac{1}{H(f(a_{2n}), g(a_{2n+1}), \gamma)} - 1$$

$$\leq k_1 \left(\frac{1}{H(a_{2n}, a_{2n+1}, \gamma)} - 1\right) + k_2 \left(\frac{1}{H(a_{2n}, f(a_{2n}), \gamma)} - 1\right) + k_3 \left(\frac{1}{H(a_{2n+1}, g(a_{2n+1}), \gamma)} - 1\right)$$

$$= k_1 \left(\frac{1}{H(a_{2n}, \ a_{2n+1}, \gamma)} - 1\right) + k_2 \left(\frac{1}{H(a_{2n}, \ a_{2n+1}, \gamma)} - 1\right) + k_3 \left(\frac{1}{H(a_{2n+1}, a_{2n+2}), \gamma)} - 1\right)$$

which implies that

$$\frac{1}{H(a_{2n+1}, a_{2n+2}, \gamma)} - 1 \leq \left(\frac{k_1 + k_2}{1 - k_3}\right)\left(\frac{1}{H(a_{2n}, a_{2n+1}, \gamma)} - 1\right). \quad (3.1)$$

Also

$$\frac{1}{H(a_{2n+2}, a_{2n+3}, \gamma)} - 1 = \frac{1}{H(a_{2n+3}, a_{2n+2}, \gamma)} - 1 = \frac{1}{H(f(a_{2n+2}), g(a_{2n+1}), \gamma)} - 1$$

$$\leq k_1\left(\frac{1}{H(a_{2n+2},a_{2n+1},\gamma)}-1\right)+k_2\left(\frac{1}{H(a_{2n+2},f(a_{2n+2}),\gamma)}-1\right)$$
$$+k_3\left(\frac{1}{H(a_{2n+1},g(a_{2n+1}),\gamma)}-1\right)$$

$$=k_1\left(\frac{1}{H(a_{2n+2},a_{2n+1},\gamma)}-1\right)+k_2\left(\frac{1}{H(a_{2n+2},\ a_{2n+3},\gamma)}-1\right)+k_3\left(\frac{1}{H(a_{2n+1},a_{2n+2}),\gamma)}-1\right)$$

which implies that

$$\frac{1}{H(a_{2n+2},a_{2n+3},\gamma)}-1\ \leq\left(\frac{k_1+k_3}{1-k_2}\right)\left(\frac{1}{H(a_{2n+1},a_{2n+2},\gamma)}-1\right). \quad (3.2)$$

Taking $k=Max\left(\frac{k_1+k_2}{1-k_3},\frac{k_1+k_3}{1-k_2}\right)$, $0<k<1$.

(3.1) and (3.2) yields

$$\frac{1}{H(a_{n+1},a_{n+2},\gamma)}-1\ \leq k\left(\frac{1}{H(a_n,a_{n+1},\gamma)}-1\right).$$

In the same way

$$M(a_{n+1},a_{n+2},\gamma)\leq k\,M(a_n,a_{n+1},\gamma),$$
$$S(a_{n+1},a_{n+2},\gamma)\leq k\,S(a_n,a_{n+1},\gamma).$$

Thus $\{a_n\}$ is a NC sequence. Therefore it is a Cauchy sequence in complete NMS V.Hence $\{a_n\}$, so its subsequences $\{a_{2n}\}$ and $\{a_{2n+1}\}$ are convergent and converges to some $c\ \in V$. Now we show that this point c is a neutrosophic fixed point of $f\ and\ g$. For

$$\frac{1}{H(a_{2n+2},f(c),\gamma)}-1=\frac{1}{H(f(c),g(a_{2n+1}),\gamma)}-1$$

$$\leq k_1\left(\frac{1}{H(\ c,a_{2n+1},\gamma)}-1\right)+k_2\left(\frac{1}{H(c,f(c),\gamma)}-1\right)+k_3\left(\frac{1}{H(a_{2n+1},g(a_{2n+1}),\gamma)}-1\right)$$

letting $n\to\infty$, we get

$$\frac{1}{H(c,f(c),\gamma)}-1\leq k_2\left(\frac{1}{H(c,f(c),\gamma)}-1\right)$$

yielding thereby

$$\frac{1}{H(c,f(c),\gamma)}-1\leq k_2^n\left(\frac{1}{H(c,f(c),\gamma)}-1\right)\to 0\ \ as\ \ n\to\infty.$$

So that $\frac{1}{H(c,f(c),\gamma)}-1=0\ and\ thus\ H(c,f(c),\gamma)=1$.

In the same way, we can have

$$M(c,f(c),\gamma)=0\qquad and\qquad S(c,f(c),\gamma)=0$$

and so $f(c)=c$. .

Again

$$\frac{1}{H(a_{2n+1},g(c),\gamma)}-1=\frac{1}{H(f(a_{2n}),g(c),\gamma)}-1$$

$$\leq k_1\left(\frac{1}{H(\,a_{2n},c,\gamma)}-1\right)+k_2\left(\frac{1}{H(a_{2n},f(a_{2n}),\gamma)}-1\right)+k_3\left(\frac{1}{H(c,g(c),\gamma)}-1\right)$$

letting $n\to\infty$, we get

$$\frac{1}{H(c,g(c),\gamma)}-1\leq k_3\left(\frac{1}{H(c,g(c),\gamma)}-1\right)$$

yielding thereby

$$\frac{1}{H(c,g(c),\gamma)}-1\leq k_3^n\left(\frac{1}{H(c,g(c),\gamma)}-1\right)\to 0 \;\; as \;\; n\to\infty.$$

So that $\frac{1}{H(c,g(c),\gamma)}-1=0$ *and thus* $H(c,g(c),\gamma)=1$.

In the same way, we can have

$$M(c,g(c),\gamma)=0 \qquad and \qquad S(c,g(c),\gamma)=0.$$

Therefore $g(c)=c.$ *consequenly* $f(c)=c=g(c)$ *i.e.* f *and* g *have a common fixed point* c.
To show the uniqueness, let $f(b)=g(b)=b$ for some $b\in V$. Then for all $\gamma>0$, we have

$$\frac{1}{H(c,b,\gamma)}-1=\frac{1}{H(f(c),g(b),\gamma)}-1$$
$$\leq k_1\left(\frac{1}{H(c,b,\gamma)}-1\right)+k_2\left(\frac{1}{H(c,f(c),\gamma)}-1\right)+k_3\left(\frac{1}{H(b,g(b),\gamma)}-1\right)$$
$$=k_1\left(\frac{1}{H(c,b,\gamma)}-1\right).$$

Which on repeating yields

$$\frac{1}{H(c,b,\gamma)}-1\leq {k_1}^n\left(\frac{1}{H(c,b,\gamma)}-1\right)\to 0 \qquad as \;\; n\to\infty.$$

Also

$M(c,b,\gamma)=\mathrm{M}(f(c),g(b),\gamma)\leq k_1M(c,b,\gamma)+k_2M(c,f(c),\gamma)+k_3M(b,g(b),\gamma)$
$\mathrm{S}(c,b,\gamma)=\mathrm{S}(f(c),g(b),\gamma)\leq k_1\,\mathrm{S}(c,b,\gamma)+k_2\,\mathrm{S}(c,f(c),\gamma)+k_3\,\mathrm{S}(b,g(b),\gamma)$

which are yielding thereby
$M(c,b,\gamma)\leq {k_1}^nM(c,b,\gamma)\to 0$ *and* $\mathrm{S}(c,b,\gamma)\leq {k_1}^n\,\mathrm{S}(c,b,\gamma)\to 0$ *as* $n\to\infty$.

Thus $H(c,b,\gamma)=1$ *and* $M(c,b,\gamma)=S(c,b,\gamma)=0$ *and hence* $c=b$.

Conclusion: If $k_2=k_3=0$ and $g=f$ the above theorem is reduced to the one Kirisci et al [21]. Also this theorem is the generalization of the theorem due to Lj. B. Ciric [29] on Neutrosophic Metric Space. Taking $g=f$, we get the result due to M. Kumar [31]

References

[1] Zadeh, LA. (1965) Fuzzy sets, Inf Comp, 8, 338–353.
[2] Atanassov K. (1986) Intuitionistic fuzzy sets, Fuzzy Sets and Systems, 20, 87–96.
[3] Smarandache, F. (2005) Neutrosophic set, a generalisation of the intuitionistic fuzzy sets, Inter J Pure Appl Math, 24, 287–297.
[4] Turksen, I. (1996) Interval valued fuzzy sets based on normal forms, Fuzzy Sets and Systems, 20, 191–210.
[5] Atanassov K., Gargov G. (1989) Interval valued intuitionistic fuzzy sets, Inf Comp, 31, 343–349.
[6] Smarandache, F. (2003) A unifying field in logics: Neutrosophic logic. Neutrosophy, neutrosophic set, neutrosophic probability and statistics. Phoenix, Xiquan.
[7] Yager, R.R. (2013) Pythagorean fuzzy subsets. Proc Joint IFSA World Congress and NAFIPS Annual Meeting, Edmonton, Canada, 2013.
[8] Kramosil I., Michalek J. (1975) Fuzzy metric and statistical metric spaces, Kybernetika, 11, 336–344.
[9] Kaleva O., Seikkala S. (1984) On fuzzy metric spaces, Fuzzy Sets and Systems 12, 215–229.
[10] George A., Veeramani P. (1994) On some results in fuzzy metric spaces, Fuzzy Sets and Systems, 64, 395–399.
[11] George A., Veeramani P. (1997) On some results of analysis for fuzzy metric spaces, Fuzzy Sets and Systems, 90, 365–368.
[12] Park, J.H. (2004) Intuitionistic fuzzy metric spaces, Chaos Solitons and Fractals, 22, 1039–1046.
[13] Heilpern, S. (1981) Fuzzy mappings and fixed point theorems, J Math Anal Appl, 83, 566–569.
[14] Bose R.K., Sahani D. (1987) Fuzzy mappings and fixed point theorems, Fuzzy Sets and Systems, 231, 53–58.
[15] Alaca, C., Turkoglu D., Yildiz C. (2006) Fixed points in intuitionistic fuzzy metric spaces, Chaos Solitons and Fractals 29, 1073–1078.
[16] Gregori V., Sapane A. (2002) On fixed-point theorems in fuzzy metric spaces, Fuzzy Sets and Systems, 125, 245–252.
[17] Imdad M., Ali J. (2006) Some common fixed point theorems in fuzzy metric spaces, Mathematical Communications, 11, 153–163.
[18] Mihet, D. (2004) A Banach contraction theorem in fuzzy metric spaces, Fuzzy Sets and Systems, 44, 431–439.
[19] Turkoglu D., Alaca C., Cho Y.J., Yildiz C. (2006) Common fixed point theorems in intuitionistic fuzzy metric spaces, J Appl Math Comput, 22, 411–424.
[20] Hussain N., Khaleghizadeh S., Salimi P., Abdou A.A.N. (2014) A New Approach to fixed point results in triangular intuitionistic fuzzy metric spaces, Abstract and Applied Analysis, 2014, 1–16.
[21] Kirişci M., Simsek N., Akyigit M. Fixed point results for a new metric space. mathematical Methods in the Applied Sciences(to appear).
[22] Mohamad, A. (2007) Fixed-point theorems in intuitionistic fuzzy metric spaces, Chaos Solitons and Fractals, 34, 1689–1695.
[23] Kirişci, M. (2017) Integrated and differentiated spaces of triangular fuzzy numbers, Fas Math, 59, 75–89.
[24] Wang H., Smarandache F., Zhang Y.Q., Sunderraman R. (1996) Single valued neutrosophic sets, Fuzzy Sets and Systems, 4, 410–413.
[25] Ye, J. (2014) A multicriteria decision-making method using aggregation operators for simplified neutrosophic sets, J Intell Fuzzy Syst, 26, 2459–2466.
[26] Peng J.J., Wang J.Q., Wang J., Zhang H.Y., Chen, X.H. (2016) Simplified neutrosophic sets and their applications in multi-criteria group decision-making problems, International Journal of Systems Science, 47, 2342–2358.
[27] Menger, K.M. (1942) Statistical metrics, Proc Nat Acad Sci, 28, 535–537.

[28] Kirişci M, Simsek N. (2019) Neutrosophic metric spaces, arXiv:1907.00798.
[29] Ciric, Lj. B. (1976) A generalization of Banach contraction principle, Proceeding of American Mathematical Society, 45(2) 267-273.
[30]Kumar M, Acommon best proximity theorem for two special generalized β-quasi contractive mappings, Journal of Information and Computational Science 10(1),(2020)165-173.
[31] Kumar M, Fixed Point for A Generalized Neutrosophic Contraction On Neutrosophic Metric Space, Journal of Information and Computational Science 11(6), (2021)828-835.

Address of correspondence

Manish Kumar
Department of Mathematics
Government Degree College Nanauta,
Saharanpur