South East Asian J. of Mathematics and Mathematical Sciences
Vol. 17, No. 3 (2021), pp. 215-224

ISSN (Online): 2582-0850

ISSN (Print): 0972-7752

FIXED POINT THEOREM IN M COMPLETE NON-ARCHIMEDEAN FUZZY-METRIC-LIKE SPACES

Sarika Saxena and Abha Tenguria*

Department of Mathematics,
Barkatullah University Institute of Technology,
Bhopal - 462026, Madhya Pradesh, INDIA

E-mail : sarika.s2011@rediffmail.com

*Department of Mathematics
Govt. M. L. B. Girls P. G. College,
Bhopal - 462001, Madhya Pradesh, INDIA

E-mail : abha.tenguria@gmail.com

(**Received:** *May 26, 2021* **Accepted:** *Aug. 17, 2021* **Published:** *Dec. 30, 2021)*

Abstract: The purpose of this paper is to establish a unique fixed point theorem for a self mapping, satisfying, $\beta - \psi -$contractive conditions and β admissibility in M complete non-archimedean fuzzy metric like space. The established result generalizes, extends some existing results in the literature.

Keywords and Phrases: Fuzzy metric like, non-archimedean, fixed point, $\beta - \psi -$contraction.

2020 Mathematics Subject Classification: 47H10, 54H25.

1. Introduction

The theory of fuzzy sets was first introduced by Zadeh [12], after that a lot of research papers have been published on fuzzy sets. The fuzzy sets concept places an important role in scientific and engineering application. Kramosil and michalek [7] introduced the concept of fuzzy metric space by generalizing the concept of probabilistic metric space to fuzzy situation. George and Veeramani [2] modified this concept of fuzzy metric space and obtained a Hausdorff topology for this kind of fuzzy metric spaces. Grabiec [4] initiated the study of fixed point theory on fuzzy metric space. For more results on the development of fixed point theory in fuzzy metric spaces, see [1, 5, 10].

On the other hand Harandi [6] introduced a new extension of the concept of partial metric space called a metric like space. The concept of a fuzzy metric like space which generalizes the notion of fuzzy metric spaces and metric like spaces was introduced by Shukla and Abbas [9].

2. Preliminaries

To clarify the issue we first recall some basic definitions.

Definition 2.1. [8] *A binary operation* $* : [0,1] \times [0,1] \to [0,1]$ *is a continuous t-norm if* $\{[0,1], *\}$ *is an abelian topological monoid with unit 1 such that* $a * b \leq c * d$ *whenever* $a \leq c$ *and* $b \leq d, a, b, c, d, \in [0,1]$. *Three typical examples of t-norms are* $a * b = \min\{a, b\}$ *(minimum t-norm),* $a * b = ab$ *(product t-norm), and* $a * b = \max\{a + b - 1, 0\}$ *(Lukasiewicz t-norm).*

Definition 2.2. [2] *The triplet* $(X, M, *)$ *is a fuzzy metric space if* X *is an arbitrary set,* $*$ *is a continuous* $t-$*norm,* M *is a fuzzy set in* $X^2 \times (0, \infty)$ *satisfying the following conditions:*
(FM1) $M(x, y, t) > 0$;
(FM2) $M(x, y, t) = 1$ *if and only if* $x = y$;
(FM3) $M(x, y, t) = M(y, x, t)$;
(FM4) $M(x, y, t) * M(y, z, s) \leq M(x, z, t + s)$;
(FM5) $M(x, y, \cdot) : (0, \infty) \to [0, 1]$ *is a continuous mapping;*
for all $x, y, z \in X$ *and* $s, t > 0$.
Here M *with* $*$ *is called a fuzzy metric on* X. *Note that,* $M(x, y, t)$ *can be thought of as the definition of nearness between* x *and* y *with respect to* t. *It is known that* $M(x, y, \cdot)$ *is nondecreasing for all* $x, y \in X$.

Definition 2.3. [9] *The triplet* $(X, F, *)$ *is a fuzzy metric-like space if* X *is an arbitrary set,* $*$ *is a continuous* $t-$*norm,* F *is a fuzzy set in* $X^2 \times (0, \infty)$ *satisfying the following conditions:*
(FML1) $F(x, y, t) > 0$;
(FML2) If $F(x, y, t) = 1$ *then* $x = y$;
(FML3) $F(x, y, t) = F(y, x, t)$;
(FML4) $F(x, y, t) * F(y, z, s) \leq F(x, z, t + s)$;
(FML5) $F(x, y, \cdot) : (0, \infty) \to [0, 1]$ *is a continuous mapping;*
for all $x, y, z \in X$ *and* $s, t > 0$.
Here M *with* $*$ *is called a fuzzy metric-like on* X. *A fuzzy metric-like space satisfies*

all of the conditions of a fuzzy metric space except that $F(x,x,t)$ may be less than 1 for all $t > 0$ and for some (or may be for all) $x \in X$. Also, every fuzzy metric space is fuzzy metric-like space with unit self fuzzy distance, that is, with $F(x,x,t) = 1$ for all $t > 0$ and for all $x \in X$.

Note that, the axiom $(FM2)$ in Definition 3 gives the idea that when $x = y$ the degree of nearness of x and y is perfect, or simply 1, and then $M(x,x,t) = 1$ for each $x \in X$ and for each $t > 0$. While in fuzzy metric-like space, $M(x,x,t)$ may be less than 1, that is, the concept of fuzzy metric-like is applicable when the degree of nearness of x and y is not perfect for the case $x = y$.

Example 2.4. [9] Let $X = \mathbb{R}^+, k \in \mathbb{R}^+$ and $m > 0$. Define $*$ by $a * b = ab$ and the fuzzy set F in $X^2 \times (0,\infty)$ by $F(x,y,t) = \frac{kt}{kt+m(\max\{x,y\})}$ for all $x, y \in X,\ t > 0$. Then, since $\sigma(x,y) = \max\{x,y\}$ for all $x, y \in X$, is a metric-like on X (see [6]) therefore, $(X, F, *)$ is a fuzzy metric-like space, but it is not a fuzzy metric space, as $F(x,x,t) = \frac{kt}{kt+mx} \neq 1$ for all $x > 0$ and $t > 0$.

Definition 2.5. [9] *A sequence $\{x_n\}$ in a fuzzy metric-like space $(X, F, *)$ is said to be convergent to $x \in X$. If $\lim_{n\to\infty} F(x_n, x, t) = F(x,x,t)$ for all $t > 0$.*

Definition 2.6. [9] *A sequence $\{x_n\}$ in a fuzzy metric-like space $(X, F, *)$ is said to be Cauchy if $\lim_{n\to\infty} F(x_{n+p}, x_n, t)$ for all $t > 0$, $p \geq 1$ exists and is finite.*

Definition 2.7. [9] *A fuzzy metric like spaces $(X, F, *)$ is said to be complete if every Cauchy sequence $\{x_n\}$ in X converges to some $x \in X$ such that*
$\lim_{n\to\infty} F(x_n, x, t) = F(x,x,t) = \lim_{n\to\infty} F(x_{n+p}, x_n, t)$ for all $t > 0$, $p \geq 1$.
Let ψ be the class of all functions $\psi : [0,1] \to [0,1]$ such that
(i) ψ is non-decreasing and left continuous,
(ii) $\psi(r) > r$ for all $r \in (0,1)$.
It can easily be shown that if $\psi \in \Psi$, then $\psi(1) = 1$ and $\lim_{n\to+\infty} \psi^n(r) = 1$ for all $r \in (0,1)$.

Definition 2.8. [3] *Let $(X, M, *)$ be a fuzzy metric space. We say that $T : X \to X$ is a $\beta - \psi-$fuzzy contractive mapping if there exist two functions $\beta : X \times X \times (0,+\infty) \to (0,+\infty)$ and $\psi \in \Psi$ such that $M(x,y,t) > 0 \Rightarrow \beta(x,y,t)M(Tx,Ty,t) \geq \psi(M(x,y,t))$ for all $t > 0$ and for all $x, y \in X$ with $x \neq y$.*

Definition 2.9. [3] *Let $(X, M, *)$ be a fuzzy metric space. We say that $T : X \to X$ is $\beta-$ admissible if there exists a function $\beta : X \times X \times (0,+\infty) \to (0,+\infty)$ such that, for all $t > 0$, $x, y \in X$, $\beta(x,y,t) \leq 1 \Longrightarrow \beta(Tx,Ty,t) \leq 1$.*

Definition 2.10. [11] *Let $(X, F, *)$ be a fuzzy metric-like space and let $\{x_n\}$ be a sequence in X. The sequence $\{x_n\}$ is called a 1-G-Cauchy sequence if $\lim\limits_{n\to\infty} F(x_{n+p},$*

$x_n, t) = 1$ for all $t > 0$ and each $p \geq 1$. The space $(X, F, *)$ is called 1-G-complete if every 1-G-Cauchy sequence in X converges to some $x \in X$ such that $F(x, x, t) = 1$ for all $t > 0$.

Definition 2.11. [11] *Let $(X, F, *)$ be a fuzzy metric-like space and let $\{x_n\}$ be a sequence in X. The sequence $\{x_n\}$ is called a 1-M-Cauchy sequence if $\lim_{n,m\to\infty} F(x_n, x_m, t) = 1$ for all $t > 0$. The space $(X, F, *)$ is called 1-M-complete if every 1-M-Cauchy sequence in X converges to some $x \in X$ such that $F(x, x, t) = 1$ for all $t > 0$.*

Remark. *Every complete fuzzy metric space in the sense of Grabiec (1988) is 1-G-complete as a fuzzy metric-like space, and every complete fuzzy metric space in the sense of George and Veeramani (1994) is 1-M-complete as a fuzzy metric-like space.*

Non-Archimedean fuzzy metric-like space. If in Definition 2.3, the triangular inequality FML 4 is replaced by condition (NA), then we call $(X, F, *)$ a non-Archimedean fuzzy metric-like space. If $(X, F, *)$ is a non-Archimedean fuzzy metric-like space, then the following holds
$F(x, z, \max\{t, s\}) \geq F(x, y, t) * F(y, z, s)$ for all $x, y, z \in X$ and $t, s > 0$.
Or equivalently,
$F(x, z, t) \geq F(x, y, t) * F(y, z, t)$ for all $x, y, z \in X$ and $t > 0$.
Now, we give one example which is a non-Archimedean fuzzy metric-like space, but not a fuzzy metric-like space since as follows:

Example 2.11. Let $X = N$. Define a fuzzy set F on $x^2 \times [0, \infty)$ by $F(x, y, 0) = 0$ for all $x, y, \in X$, $F(1, 1, t) = 1$ for all $t > 0$ and

$$F(x, y, t) = \begin{cases} \frac{1}{5} & \text{if } 0 < t \leq \frac{1}{2} \\ \frac{3}{10} & \text{if } \frac{1}{2} < t \leq 1 \\ \frac{1}{10} & \text{if } t \geq 1 \end{cases}$$

It is easy to check that $(X, F, *_F)$ is a non- Archimedean fuzzy metric-like space.

3. Main Results

Definition 3.1. *Let $(Z, F, *)$ be a fuzzy metric like space. We say that $K : Z \to Z$ is a $\beta - \psi-$fuzzy contractive mapping if there exist two functions $\beta : Z \times Z \times (0, +\infty) \to (0, +\infty)$ and $\psi \in \Psi$ such that $F(z, y, t) > 0 \Rightarrow \psi(F(z, y, t)) \leq \beta(z, y, t)F(Kz, Ky, t)$ for all $t > 0$ and for all $z, y \in Z$ with $z \neq y$.*

Definition 3.2. *Let $(Z, F, *)$ be a fuzzy metric like space. We say that $K : Z \to Z$*

is $\beta-$admissible if there exists a function $\beta : Z \times Z \times (0,+\infty) \to (0,+\infty)$ such that, for all $t > 0$, $z, y \in Z$ $\beta(z,y,t) \leq 1 \Longrightarrow \beta(Kz,Ky,t) \leq 1$.

Theorem 3.3. *Let $(Z,F,*)$ be a M-complete non-Archimedean fuzzy metric like space and $K : Z \to Z$ be a self fuzzy $\beta-\psi-$contractive mapping. It is also $\beta-$admissible, satisfying the following assertions:*
(i) there exists $z_0 \in Z$ such that $\beta(z_0, Kz_0, t) \leq 1$ for all $t > 0$;
(ii) if $\{z_n\}$ is a sequence in Z such that $\beta(z_n, z_{n+1}, t) \leq 1$, and $z_n \to u$ as $n \to +\infty$, then $\beta(z_n, u, t) \leq 1$. Also there exists $l_0 \in N$ with $m > n \geq l_0$ for all $m, n \in N$ and for all $t > 0$ such that $\beta(z_{m+1}, z_{n+1}, t) \leq 1$; Then, K has a fixed point.
Proof. We choose $z_0 \in Z$ such that $\beta(z_0, Kz_0, t) \leq 1$ for all $t > 0$, and define a sequence $\{z_n\}$ in Z by $z_{n+1} = Kz_n$, for all $n \in N$. If $z_{n_0} = z_{n_0+1}$ for some $n_0 \in N$, then $z = z_n$ is a fixed point of K. So we assume that $z_n \neq z_{n+1}$, for all $n \in N$. Since K is $\beta-$admissible, we have

$$\beta(z_0, z_1, t) = \beta(z_0, Kz_0, t) \leq 1.$$
$$\beta(z_1, z_2, t) = \beta(Kz_0, Kz_1, t) \leq 1$$

Continuing in this way, by induction, we get

$$\beta(z_n, z_{n+1}, t) \leq 1 \quad \text{for all } n \in N \text{ and for all } t > 0. \tag{3.1}$$

Now, since K is $\beta-\psi-$fuzzy contractive mapping, we have

$$F(z,y,t) > 0 \Rightarrow \beta(z,y,t)F(Kz,Ky,t) \geq \psi(F(z,y,t)) \ \forall\ t > 0 \text{ and } \forall z, y \in Z. \tag{3.2}$$

Put $z = z_1$ and $y = z_2$ and in equation (3.2), we get

$$\begin{aligned} F(z_1, z_2, t) &= F(Kz_0, Kz_1, t) \\ &\geq \beta(z_0, z_1, t)F(Kz_0, Kz_1, t) \\ &\geq \psi(F(z_0, z_1, t)). \end{aligned}$$

Put $z = z_2$ and $y = z_3$ in equation (3.2), we get

$$\begin{aligned} F(z_2, z_3, t) &= F(Kz_1, Kz_2, t) \\ &\geq \beta(z_1, z_2, t)F(Kz_1, Kz_2, t) \\ &\geq \psi(F(z_1, z_2, t)) \geq \psi(\psi F(z_0, z_1, t)) \geq \psi^2(F(z_0, z_1, t)). \end{aligned}$$

Continuing in this way, by induction, we get

$$\begin{aligned} F(z_n, z_{n+1}, t) &= F(Kz_{n-1}, Kz_n, t) \\ &\geq \beta(z_{n-1}, z_n, t)F(Kz_{n-1}, Kz_n, t) \\ &\geq \psi^n(F(z_0, z_1, t)), \quad \text{for all } n \in N. \end{aligned}$$

Thus it is an increasing sequence, and since $\lim_{n\to+\infty}\psi^n(p)=1$ for all $p\in(0,1)$, then we deduce from the above expression that

$$\lim_{n\to+\infty} F(z_n, z_{n+1}, t) = 1 \text{ for all } t > 0.$$

Now we prove that $\{z_n\}$ is a M-Cauchy sequence, for this, on the contrary suppose that the sequence $\{z_n\}$ is not M-Cauchy, then there exist $\epsilon\in(0,1)$, $t>0$ and $l_0\in N$, such that, for each $l\in N$ with $l\geq l_0$, there exist $m(l), n(l)\in N$ with $m(l)>n(l)\geq l$ and

$$F(z_{m(i)}, z_{n(i)}, t) \leq 1-\epsilon \text{ and } \beta(z_{m(l)}, z_{n(l)}, t) \leq 1.$$

Assume that for each l, $m(l)$ be the least positive integer exceeding $n(l)$ satisfying the above inequality, that is $F(z_{m(l)-1}, z_{n(l)}, t) > 1-\epsilon$ and $F(z_{m(l)}, z_{n(l)}, t)\leq 1-\epsilon$. So for all $l\in N$, such that $l\geq l_0$, we have

$$\begin{aligned} 1-\epsilon &\geq F(z_{m(l)}, z_{n(l)}, t) \\ &\geq F(z_{m(l)-1}, z_{n(l)}, t) * F(z_{m(l)-1}, z_{m(l)}, t) \quad \text{by(NA)} \\ &\geq (1-\epsilon) * F(z_{m(l)-1}, z_{m(l)}, t). \end{aligned}$$

Taking limit as $n\to\infty$ in above inequality, we have

$$\lim_{n\to+\infty}(1-\epsilon) * F(z_{m(l)-1}, z_{m(l)}, t) = (1-\epsilon) * 1 = 1-\epsilon$$

We deduce that

$$\lim_{n\to+\infty} F(z_{m(l)}, z_{n(l)}, t) = (1-\epsilon)$$

Now from FML (IV) we have

$$\begin{aligned} F(z_{m(l)}, z_{n(l)}, t) &\geq F(z_{m(l)}, z_{m(l)+1}, t) * F(z_{m(l)+1}, z_{n(l)}, t) \quad \text{by (NA)} \\ &\geq F(z_{m(l)}, z_{m(l)+1}, t) * F(z_{m(l)+1}, z_{n(l)+1}, t) * F(z_{n(l)+1}, z_{n(l)}, t) \\ &= F(z_{m(l)}, z_{m(l)+1}, t) * F(Kz_{m(l)}, Kz_{n(l)}, t) * F(z_{n(l)+1}, z_{n(l)}, t) \\ &\geq F(z_{m(l)}, z_{m(l)+1}, t) * \beta(z_{m(l)}, z_{n(l)}, t) F(Kz_{m(l)}, z_{n(l)}, t) \\ &\quad * F(z_{n(l)+1}, z_{n(l)}, t) \quad \text{by (iii)} \\ &\geq F(z_{m(l)}, z_{m(l)+1}, t) * \psi(F(z_{m(l)}, z_{n(l)}, t)) * F(z_{n(l)}, z_{n(l)+1}, t). \end{aligned}$$

Taking limit as $l\to+\infty$, we obtain

$$1-\epsilon \geq 1 * \psi(1-\epsilon) * 1 = \psi(1-\epsilon) > (1-\epsilon).$$

Which is a contradiction and so $\{z_n\}$ is a Cauchy sequence in $(Z, F, *)$. Since $(Z, F, *)$ is M-complete non Archimedean fuzzy metric like space, by the completeness of FML ,there is $u \in Z$, such that $\lim_{n\to\infty} F(z_n, u, t) = \lim_{n\to+\infty} F(z_n, z_{n+p}, t)$ $= F(u, u, t) = 1$, for all $t > 0$, $p \geq 1$. Now we prove that u is a fixed point of K, for this we obtain from equation (3.1) and hypothesis $\beta(z_n, u, t) \leq 1$ for all $t > 0$ by (NA) and using (3.2), we obtain

$$\begin{aligned} F(Ku, u, t) &\geq F(Ku, Kz_n, t) * F(Kz_n, u, t) \quad \text{Using (NA)} \\ &\geq F(Ku, Kz_n, t) * F(z_{n+1}, u, t) \\ &\geq \beta(z_n, u, t) F(Kz_n, Ku, t) * F(z_{n+1}, u, t) \quad \text{Using (3.2)} \\ &\geq \psi(F(z_n, u, t)) * F(z_{n+1}, u, t). \end{aligned}$$

Since $\psi(1) = 1$, taking the limit as $n \to +\infty$ in the above inequality, we get that $F(Ku, u, t) = 1$ that is, $Ku = u$. Therefore u is a fixed point of K and $F(u, u, t) = 1$, for all $t > 0$. Hence the result.

Example 3.4. Let $Z = (0, +\infty)$, $a * b = ab$ for all $a, b \in [0, 1]$ and $F(z, y, t) = \frac{\min\{z,y\}}{\max\{z,y\}}$ for all $z, y \in Z$ and for all $t > 0$. Clearly, $(Z, F, *)$ is a M-complete non-Archimedean fuzzy metric space. Since every fuzzy metric space is a fuzzy metric like space with unit self fuzzy distance that is $F(z, z, t) = 1$ for all $t > 0$, z in Z so $(Z, F, *)$ is a M-complete non-Archimedean fuzzy metric like space.

Define the mapping $K : Z \to Z$ by $Kz = \begin{cases} \sqrt{z} & \text{if } z \in (0, 1] \\ 2 & \text{Otherwise,} \end{cases}$

and the function $\beta : Z \times Z \times (0, +\infty) \to (0, +\infty)$ by $\beta(z, y, t) = \begin{cases} 1 & \text{if } z \in (0, 1] \\ 2 & \text{Otherwise,} \end{cases}$

for all $t > 0$. It is easy to show that K is a $\beta - \psi-$contractive mapping with $\psi(v) = \sqrt{v}$, for all $v \in [0, 1]$. Clearly, K is $\beta-$admissible. Further, there exists $z_0 \in Z$ such that $\beta(z_0, Kz_0, t) \leq 1$ for all $t > 0$, indeed for $z_0 = 1$ we have $\beta(1, K(1), t) = 1$.

Let $\{z_n\}$ $n \in N$ be a sequence in Z such that $\beta(z_n, z_{n+1}, t) \leq 1$ for all $n \in N$, $z_n \to u \in Z$ as $n \to +\infty$ and let $l_0 = 1$ such that for all $m, n \in N$ we have $m > n \geq l_0$. By the definition of the function β, it follows that $z_n \in (0, 1]$ for all $n \in N$.

Now, if $u > 1$, we get $F(z_n, u, t) = \frac{\min\{zn,u\}}{\max\{zn,u\}} = \frac{z_n}{u} \leq \frac{1}{u} < 1$, that contradicts to the definition of convergence, since $\lim_{n\to\infty} F(z_n, u, t) = 1$ for all $t > 0$. Consequently, we obtain that $u \in (0, 1]$. Therefore $\beta(z_n, u, t) = 1$ and $\beta(z_{m+1}, z_{n+1}, t) = 1$ for all $m, n \in N$. Thus, all the hypotheses of Theorem 3.3 are satisfied. Here 1 and 2 are two fixed points of K.

Theorem 3.5. *Adding the following condition, to the hypothesis of Theorem 3.3* *we obtain the uniqueness of the fixed point of K for all $z, y \in Z$ and for all $t > 0$, there exists a point $u \in Z$ such that $\beta(z, u, t) \leq 1$ and $\beta(y, u, t) \leq 1$.*

Proof. Suppose that u and v are two fixed point of K. Then there exists $z \in Z$ such that $\beta(u, z, t) \leq 1$ and $\beta(v, z, t) \leq 1$ Since K is $\beta-$admissible, therefore we get

$$\begin{aligned}\beta(u, K^n z, t) &\leq 1 \text{ and } \beta(v, K^n z, t) \leq 1 \text{ for all } n \in N \text{ for all } t > 0.\\ F(u, K^n z, t) &= F(Ku, K(K^{n-1}z), t)\\ &\geq \beta(u, K^{n-1}z, t)F(Ku, K(K^{n-1}z), t)\\ &\geq \psi(F(u, K^{n-1}z, t))\end{aligned}$$

This implies that $F(u, K^n z, t) \geq \psi^n(F(u, z, t))$ for all $n \in N$. Then, letting $n \to \infty$, we have $K^n z \to u$. Similarly, for using v and letting $n \to \infty$, we get $K^n z \to v$ as $n \to \infty$ the uniqueness of the limit gives us $u = v$.

4. Conclusion

In this paper we have used the idea of β admissible mapping to prove some fixed point theorems for $\beta - \psi-$fuzzy-contractive mapping in M complete non Archimedean fuzzy metric like space. Our result generalizes and extends some known results in the literature.

Acknowledgement

The authors are thankful to the referees for their valuable suggestions to improve this paper.

References

[1] Beg, I., Gopal D., Dose Novic, T. and Rakic D., α-Type Fuzzy $H-$Contractive mappings in fuzzy metric spaces, Fixed point theory, 19(2) (2018), 463-474.

[2] George, A. and Veeramani P., On some results in fuzzy metric spaces, Fuzzy Sets and Systems, 64 (1994), 395-399.

[3] Gopal, D. and Vetro, C., Some new fixed point theorem in fuzzy metric spaces, Iranian Journal of Fuzzy Systems, 11(3) (2014), 95-107.

[4] Grabiec, M., Fixed points in fuzzy metric spaces, Fuzzy Sets and Systems, 27(3) (1988), 385-389.

[5] Gregori, V. and Sapena, A., On fixed-point theorems in fuzzy metric spaces, Fuzzy Sets and Systems, 125 (2002), 245-252.

[6] Harandi, A. A., Metric-like spaces, partial metric spaces and fixed points, Fixed Point Theory Appl., 2012(1) (2012), 1-10.

[7] Kramosil, I. and Michalek, J., Fuzzy metric and statistical metric spaces, Kybernetica, 15 (1975), 326-334.

[8] Schweizer, B. and Sklar, A., Statistical metric spaces, Pacific J. Math., 10 (1960), 313-334.

[9] Shukla, S. and Abbas, M. Fixed point results in fuzzy metric-like spaces, Iranian Journal of Fuzzy Systems, 11(5) (2014), 81-92.

[10] Shukla S., Gopal D. and Sintunavarat W., A new class of fuzzy contractive mapping and fixed point theorems, Fuzzy sets and system, 350 (2018), 85-94.

[11] Shukla, S., Gopal, D. And Roldan-Lopez-de- Hierro, A. F., Some fixed point theorems in 1-M-complete fuzzy metric –like spaces, International Journal of General Systems, (2016).

[12] Zadeh, L. A., Fuzzy sets, Information and Control, 8 (1965), 338-353.