Pure and Applied Mathematics Journal
2024, Vol. 13, No. 5, pp. 66-71
https://doi.org/10.11648/j.pamj.20241305.11

Research Article

Common Tripled Fixed Point Theorem on M- Fuzzy Metric Space for Occasionally Weakly Compatible Mappings

Raghavendra Singh Rathore[1, *], Rekha Agrawal[2]

[1]Department of Mathematics, Govt Madhav Science College, Vikram University, Ujjain, India
[2]Department of Mathematics, Govt Girls' Geetanjali College, Barkatullah University, Bhopal, India

Abstract

The fixed point theorems, which are primarily existential in nature, serve as a fundamental topological toolkit for the qualitative analysis of solutions to both linear and nonlinear equations in various branches of mathematics. Many authors have extended and generalized these results in different ways, particularly in the context of fuzzy metric spaces and fuzzy mappings. Numerous researchers have also proved common fixed point theorems under the condition of compatible mappings for fizzy metric spaces. Coupled common fixed point theorems for fuzzy metric spaces with the condition of weakly compatible mappings were attempted to be proved by many authors. Tripled fixed points have emerged as a significant area of research within fixed point theory. Berinde and Borcut introduced the concept of a tripled fixed point for nonlinear mappings in partially ordered metric spaces. They also established a common fixed point theorem for contractive type mappings in M-fuzzy metric spaces. Later, other authors extended these results for common tripled fixed point theorems in fuzzy metric spaces. In this paper we introduce a new technique for proving some new common tripled fixed point theorems for Occasionally Weakly Compatible Mappings in M-fuzzy metric spaces, a method which is not previously utilized by authors in this field. Additionally, we provide illustrative example to support our findings, which represent an improvement over recent results found in the literature.

Keywords

Occasionally Weakly Compatible Maps, M-Fuzzy Metric Space, Tripled Fixed Point

1. Introduction

The Classical Theory of Fixed Points typically lies at the intersection of topology and nonlinear functional analysis. It develops and formulates general principles that form the foundation for many modern results across various areas of mathematics. A central focus of vigorous research has been the study of common fixed points for mappings that satisfy certain contractive-type conditions, resulting in numerous significant findings by various authors. The Fixed point theorems are extremely useful in many different areas of mathematics, especially in best approximation and optimization problems.

Several efforts have been made to extend fixed point theorems into the realm of fuzzy mathematics. In 1965, Zadeh [22] introduced Fuzzy Set Theory, which was followed by the introduction of fuzzy metric spaces by Kramosil and Michalek [9]. Since then, numerous contributions have

*Corresponding author: raghavendrasingh.rathore@gmail.com (Raghavendra Singh Rathore)

Received: 28 August 2024; **Accepted:** 14 September 2024; **Published:** 29 September 2024

emerged from this concept. After fuzzy metric spaces, the notion of fuzzy mappings was developed, and many authors [1, 6-8, 10, 16, 20, 21] proved fixed point theorems for fuzzy mappings in various spaces, including fuzzy metric spaces.

After established a common fixed point theorem for commuting maps, Jungck and Rhoades B. E [7] introduced a further generalization, known as compatibility. Jungck and Rhoades B. E [8] then introduced the concept of weakly compatible maps, proving that compatible maps are weakly compatible, although the converse is not true. Subsequently, additional common fixed point theorems were established for mappings that satisfy different types of commutativity conditions [19].

In 2006, Sedghi and Shobe [18] defined M-fuzzy metric spaces and proved a common fixed point theorem for four weakly compatible mappings in this space. Since then, many more fixed point theorems have been proven in M-fuzzy metric spaces, with further research conducted by other authors [12, 14].

In 2008, Al-Thagafi and Shahzad [11] introduced the concept of occasionally weakly compatible mappings, which represents the most general form of commutativity.

In 2011, The concept of tripled fixed points was introduced by Berinde and Borcut [3], along with certain tripled fixed point results for contractive-type mappings with mixed monotone properties in partially ordered metric spaces. In 2012, Borcut and Berinde [4] presented the notion of a tripled coincidence point for pairs of nonlinear contractive mappings and proved related theorems. In 2013, Roldan and Martinez et al. [15] modified the concept of a tripled fixed point, as introduced by Berinde and Borcut [3], for nonlinear mappings and established a common tripled fixed point theorem for contractive-type mappings in M-fuzzy metric spaces. Many more authors [2, 13, 14] later extended these results for common tripled fixed point theorems.

Here, we utilize the concept of occasional weak compatibility to prove our results in M-fuzzy metric spaces and present some Tripled common fixed point theorems.

2. Notation and Preliminaries

Definition 2.1 [17]. A binary operation $*$: $[0, 1] \times [0, 1] \to [0, 1]$ is a continuous t-norm if it satisfies the following conditions:

(1) $*$ is associative and commutative,
(2) $*$ is continuous,
(3) $a * 1 = a$ for all $a \in [0, 1]$,
(4) $a * b \leq c * d$ whenever $a \leq c$ and $b \leq d$, for each $a, b, c, d \in [0, 1]$.

Definition 2.2 [18]. A 3-tuple $(X, M, *)$ is called a M-fuzzy metric space if X is an arbitrary (non-empty) set, $*$ is a continuous t- norm, and M is fuzzy sets on $X^3 \times (0, \infty)$, satisfying the following conditions: for each $x, y, z, a \in X$ and $t, s > 0$

(1) $M(x, y, z, t) > 0$;
(2) $M(x, y, z, t) = 1$ if and only if $x = y = z$;
(3) $M(x, y, z, t) = M(p\{x, y, z\}, t)$, (symmetry) where p is a permutation function;
(4) $M(x, y, a, t) * M(a, z, z, s) \leq M(x, y, z, t + s)$;
(5) $M(x, y, z): (0,\infty) \to [0, 1]$ is continuous;

Example 2.3 [18]. Let X is a nonempty set and D is the D-metric on X. Denote $a * b = a.\, b$ for all $a, b \in [0, 1]$. For each $t \in (0, \infty)$, define

$$M(x, y, z, t) = \frac{t}{t + D(x,y,z)}$$

for all $x, y, z \in X$. It is easy to see that $(X, M, *)$ is a M-fuzzy metric space.

Remark 2.4 [18]. Let $(X, M,*)$ be a M-fuzzy metric space. Then for every $t > 0$ and for every $x, y \in X$, we have $M(x, x, y, t) = M(x, y, y, t)$

Because for each $\varepsilon > 0$ by triangular inequality we have

(1) $M(x, x, y, \varepsilon + t) \geq M(x, x, x, \varepsilon) * M(x, y, y, t) = M(x, y, y, t)$
(2) $M(y, y, x, \varepsilon + t) \geq M(y, y, y, \varepsilon) * M(y, x, x, t) = M(y, x, x, t)$

By taking limits of (i) and (ii) when $\varepsilon \to 0$, we obtain $M(x, x, y, t) = M(x, y, y, t)$.

Lemma 2.5 [18]. Let $(X, M, *)$ be a M-fuzzy metric space. Then $M(x, y, z, t)$ is non-decreasing with respect to t, for all x, y, z in X

Lemma 2.6 [18]. Let $(X, M, *)$ be a M-fuzzy metric space and for all $x, y \in X$, $t > 0$ and if for a number $k \in (0, 1)$ such that $M(x, y, kt) \geq M(x, y, t)$ then $x = y$.

Lemma 2.7 [18]. Let $(X, M, *)$ is a fuzzy metric space. If we define $M: X^3 \times (0, \infty) \to [0, 1]$ by $M(x, y, z, t) = M(x, y, t) * M(y, z, t) * M(z, x, t)$

for every x, y, z in X, then $(X, M, *)$ is a M-fuzzy metric space.

Definition 2.8 [3]. An element $(x, y, z) \in X \times X \times X$ or (X^3) is called a tripled fixed point of $F: X^3 \to X$ if

$$F(x, y, z) = x;\ F(y, z, x) = y \text{ and } F(z, x, y) = z$$

Definition 2.9 [4].

(1) An element $(x, y, z) \in X \times X \times X$ is called a tripled coincidence point of the mappings $F: X^3 \to X$ and $g: X \to X$ if

$$F(x, y, z) = g(x);\ F(y, z, x) = g(y);\ F(z, x, y) = g(z)$$

(2) An element $(x, y, z) \in X \times X \times X$ is called a common tripled coincidence point of the mappings $F: X^3 \to X$ and $g: X \to X$ if

$$x = F(x, y, z) = g(x);\ y = F(y, z, x) = g(y);\ z = F(z, x, y) = g(z)$$

(3) An element $(x, y, z) \in X \times X \times X$ [5] is called a common tripled fixed point of mappings $F: X^3 \to X$ and g:

$X \to X$ if

$$x = F(x, x, x) = g(x)$$

Definition 2.10 [15] Let (X, M, *) be a M - fuzzy metric space and F: $X^3 \to X$ and g: $X \to X$ be two mappings.

(1) F is said to be commutative with g, if

$$gF(x, y, z) = F(g(x), g(y), g(z)) \text{ for all } x, y, z \in X$$

(2) F and g are said to be weakly compatible (W-compatible) if they commute at their coupled coincidence points, i.e. if (x, y, z) is a tripled coincidence point of g and F, then gF (x, y, z) = F (g (x), g (y), g (z)).

Definition 2.11. [11] Let (X, M, *) be a M - fuzzy metric space then mappings F: $X^3 \to X$ and g: $X \to X$ are called occasionally weakly compatible (OWC) iff there is a point (x, y, z) in X^3 which is a coincidence point of F and g at which F and g commute. In other words F and g are OWC if F (x, y, z) = g (x), F (y, z, x) = g (y), F (z, x, y) = g (z) implies

$$gF(x, y, z) = F(gx, gy, gz)$$

$$gF(y, z, x) = F(gy, gz, gx)$$

$$gF(z, x, y) = F(gz, gx, gy) \text{ for all } x, y, z \in X$$

Example 2.12 Let (X, M, *) be a M - fuzzy metric space where X= [0, 1] here a ∗b = a. b for all a, b ∈ [0, 1]. Now for each t ∈ (0, ∞), define

$$M(x, y, z, t) = \frac{t}{t + D(x, y, z)}$$

For all x, y, z ∈ X. Now we define maps F: $X^3 \to X$ and g: $X \to X$ such that

$$F(x, y, z) = \frac{x+y+z}{3} \text{ and } g(x) = \begin{cases} \frac{x}{2}, & if\ 0 \le x < 1 \\ 1, & if\ x = 1 \end{cases}$$

Here x=1, y=1, z=1 will be common tripled fixed point for mapping F and g because F (1, 1, 1) = 1 while g (1) = 1

Now gF (1, 1, 1)= g (1) =1 and F (g1, g1, g1) = F (1, 1, 1) =1 so that

$$gF(1, 1, 1) = F(g1, g1, g1) = 1$$

Example 2.13. For X= [0, 2] let (X, M, *) be a M - fuzzy metric space with metric given in the above example. Suppose F: $X^3 \to X$ and g: $X \to X$ be maps defined as below

$$F(x, y, z) = \frac{xyz+2}{xy+yz+zx}$$

$$g(x) = \begin{cases} 1, & if\ 0 \le x < 1 \\ x, & if\ 1 \le x < 2 \\ \frac{x}{2}, & if\ x = 2 \end{cases}$$

Here F and g will be occasionally weakly compatible (OWC) mapping and x=1, y=0, z=2 will be tripled coincidence point for F & g because

$$F(1, 0, 2) = 1 \text{ while } g(1) = 1,$$

$$F(0, 2, 1) = 1 \text{ while } g(0) = 1,$$

$$F(2, 1, 0) = 1 \text{ while } g(2) = 1$$

Now gF (1, 0, 2)= g (1) =1 and F (g1, g0, g2) = F (1, 1, 1) =1 so that gF (1, 0, 2)= F (g1, g0, g2)

Similarly

gF (0, 2, 1)= g (1) =1 and F (g0, g2, g1) = F (1, 1, 1) =1 so that gF (0, 2, 1)= F (g0, g2, g1) and gF (2, 1, 0)= g (1) =1 and F (g2, g1, g0) = F (1, 1, 1) =1 so that gF (2, 1, 0)= F (g2, g1, g0)

3. Main Result

If X will be denoted by a non-empty set and $X^3 = X \times X \times X$ then for convenience we can write g (x) as gx, similarly F (x, y, z) will be denoted by Fxyz again A (x, y, z) will be denoted by Axyz while B (u, v, w) will be denoted by Buvw and so on.

Theorem3.1 Let A, B: $X^3 \to X$ be two mappings while S, T: $X \to X$ be two self-mappings of a M-fuzzy metric space (X, M, ∗) satisfying:

(1) M (Axyz, Buvw, Buvw, qt) ≥ min {M (Sx, Tu, Tu t), M (Axyz Sx, Sx, t), M (Buvw, Tu, Tu, t), for all x, y, z, u, v, w in X and t > 0 where 0 < q< 1/2

(2) A (X × X × X) ⊆ S (X) and B (X × X × X) ⊆ T (X)

(3) The pair (A, S) and (B, T) are occasionally weakly compatible

Then ∃ a unique fixed point x in X such that Axxx = Tx= Bxxx = Sx =x

Proof. Let a, b, c ∈ X, since A (X × X × X) ⊆ S (X) and B (X × X × X) ⊆ T (X) therefore we can choose x′, y′, z′ ∈ X such that

$$Aabc = Sa,\ Abca = Sb,\ Acab = Sc$$

$$\text{and } Bx'y'z' = Tx',\ By'z'x' = Ty',\ Bz'x'y' = Tz'$$

Now we shall give the proof in the following steps

Step I: We claim that Sa= Tx′. On contrary, let Sa ≠ Tx′. Now by inequality (1) given in the statement of theorem 3.1 we can write

(4) M (Aabc, Bx′y′z′, Bx′y′z′, qt) ≥ min {M (Sa, Tx′, Tx′, t), M (Aabc, Sa, Sa, t), M (Bx′y′z′, Tx′, Tx′, t)} or M

(Sa, Tx′, Tx′, qt) ≥ min {M (Sa, Tx′, Tx′, t), M (Sa, Sa, Sa, t), M (Tx′, Tx′, Tx′, t)} = min {M (Sa, Tx′, Tx′ t), 1, 1} = M (Sa, Tx′, Tx′, t)

Thus M (Sa, Tx′, Tx′, qt) ≥ M (Sa, Tx′, Tx′, t) ⇒ Sa= Tx′

Therefore we can write Aabc = Tx′ = Sa = Bx′y′z′,

Similarly Abca = Ty′ = Sb = By′z′x′,

Acab = Tz′ = Sc = Bz′x′y′

Thus (A, S) and (B, T) have common coincidence point, let

$$Aabc = Tx' = Sa = Bx'y'z' = x$$

$$Abca = Ty' = Sb = By'z'x' = y$$

$$Acab = Tz' = Sc = Bz'x'y' = z$$

Step 2: Since (A, S) and (B, T) are OWC therefore

$$Sx = SAabc = A(Sa, Sb, Sc) = Axyz$$

$$Sy = SAbca = A(Sb, Sc, Sa) = Ayzx$$

$$Sz = SAcab = A(Sc, Sa, Sb) = Azxy$$

$$\text{Also } Tx = TBx'y'z' = B(Tx', Ty', Tz') = B(x, y, z)$$

$$Ty = TBy'z'x' = B(Ty', Tz', Tx') = B(y, z, x)$$

$$Tz = TBz'x'y' = B(Tz', Tx', Ty') = B(z, x, y)$$

Next we will show that x = y = z for it we will take help of inequality (4)

$$\begin{aligned} M(x, y, z, qt) &= M(Aabc, By'z'x', Bz'x'y', qt) \\ &\geq \min\{M(Sa, Ty', Tz' t), M(Aabc, Sa, Sa, t), M(By'z'x', Ty', Ty', t)\} \\ &= \min\{M(Sa, Ty', Tz' t), M(Sa, Sa, Sa, t), M(Ty', Ty', Ty', t)\} \\ &= \min\{M(Sa, Ty', Tz' t)\} \\ &= M(x, y, z, t) \end{aligned}$$

Thus M (x, y, z, qt) ≥ M (x, y, z, t) ⇒ x = y = z

Step 3: now we shall prove that Sx=Tx

$$\begin{aligned} M(Sx, Tx, Tx, qt) &= M(Axyz, Bxyz, Bxyz, qt) \\ &\geq \min\{M(Sx, Tx, Tx, t), M(Axyz, Sx, Sx, t), M(Bxyz, Tx, Tx, t)\} \\ &= \min\{M(Sx, Tx, Tx, t), M(Sx, Sx, Sx, t)\ M(Tx, Tx, Tx, t)\} \\ &= M(Sx, Tx, Tx, t) \end{aligned}$$

Thus M (Sx, Tx, Tx, qt) ≥ M (Sx, Tx, Tx, t) ⇒ Sx = Tx

Similarly we can show that Sy = Ty and Sz = Tz

Step 4: now we shall prove that x= Sx

$$\begin{aligned} M(x, Tx, Tx, qt) &= M(Aabc, Bxyz, Bxyz, qt) \\ &\geq \min\{M(Sx, Tx, Tx, t), M(Aabc, Sa, Sa, t), M(Bxyz, Tx, Tx, t)\} \\ &= \min\{M(Sx, Tx, Tx, t), M(Sa, Sa, Sa, t)\ M(Tx, Tx, Tx, t)\} \\ &= M(Sx, Tx, Tx, t) \end{aligned}$$

Thus M (x, Tx, Tx, qt) ≥ M (Sx, Tx, Tx, t) ⇒ Sx = x

So we can show that Axxx = Tx = B (x, x, x) = Sx = x

Example 3.2. Let X= [0, 1] and D (x, y, z) = | x-y | +| y-z | + | z-x | Denote a ∗b = min {a, b} for all a, b ∈ [0, 1] and for each t ∈ (0, ∞), define

$$M(x, y, z, t) = \frac{t}{t + D(x, y, z)}$$

For all x, y, z ∈ X. It is easy to see that (X, M, ∗) is a M-fuzzy metric space. Let us define maps A, B: X^3 → X and S, T: X → X on this M-fuzzy metric such that

$$A(x, y, z) = \frac{x+y+z}{3}$$

$$S(x) = \begin{cases} 2x, if\ 0 \leq x < 1 \\ 1, if\ x = 1 \end{cases}$$

$$B(u, v, w) = uvw$$

$$\text{and } T(u) = \begin{cases} u, if\ 0 \leq u < 1 \\ \frac{\pi}{2}, if\ u = 1 \end{cases}$$

We can easily say that all condition of theorem 3.1 are satisfied by the above maps A, B, S, T for any 0 < q< ½ again

SA (0, 0, 0) = S (0) =0, so that A (S0, S0, S0) = A (0, 0, 0) = 0 thus SA (0, 0, 0)= A (S0, S0, S0)

Similarly

TB (0, 0, 0) = T (0)= 0 so that B (T0, T0, T0) =B (0, 0, 0) =0 thus TB (0, 0, 0) = B (T0, T0, T0)

Now we can say that pairs (A, S) and (B, T) are OWC and (0, 0, 0) is common tripled fixed point of maps A, B, S, T.

Theorem 3.3 Let A, B: $X^3 \to X$ and S, T: $X \to X$ be self-mappings of a M-fuzzy metric space (X, M, ∗) satisfying:

M (Axyz, Buvw, Buvw, qt) ≥ min {M (Sx, Tu, Tu t)} for all x, y, z, u, v, w in X and t >0 where 0 < q< ½

$$A (X \times X \times X) \subseteq S (X) \text{ and } B (X \times X \times X) \subseteq T (X)$$

The pair (A, S) and (B, T) are occasionally weakly compatible

Then ∃ a unique fixed point x in X such that Axxx = Tx= Bxxx = Sx =x

Theorem 3.4 Let A, B: $X^3 \to X$ and S, T: $X \to X$ be self-mappings of a M-fuzzy metric space (X, M, ∗) satisfying:

M (Axyz, Buvw, Bvwu, qt) ≥ min {M (Sx, Tu, Tv, t), M (Axyz, Sx, Sx, t), M (Axyz, Tu, Tv, t), M (Sx, Buvw, Tv, t), M (Sx, Tu, Bvwu, t)} for all x, y, z, u, v, w in X and t >0 where 0 < q< ½

$$A (X \times X \times X) \subseteq S (X) \text{ and } B (X \times X \times X) \subseteq T (X)$$

The pair (A, S) and (B, T) are occasionally weakly compatible

Then there exist a unique fixed point x in X such that

$$Axxx = Tx= Bxxx = Sx = x$$

Theorem 3.5 Let A: $X^3 \to X$ and S: $X \to X$ be self-mapping of a M-fuzzy metric space (X, M, ∗) satisfying:

M (Axyz, Auvw, Auvw, qt) ≥ min {M (Sx, Su, Su t), M (Axyz, Sx, Sx, t), M (Auvw, Su, Su, t)} for all x, y, z, u, v, w in X and t >0 where 0 < q< ½

$$A (X \times X \times X) \subseteq S (X)$$

If A and S are occasionally weakly compatible mappings

Then there exist a unique fixed point x in X such that Axxx = Sx = x

Proof. If we take B=I and T=I here I is identity mapping then with the help of proof given in theorem 3.1 we can obtain the result.

4. Conclusion

The primary scientific findings of this study indicate that this paper provided a technique through which, utilizing the occasionally weak compatibility condition, we can establish tripled common fixed point theorems in M-fuzzy metric spaces.

Abbreviations

OWC Occasionally Weakly Compatible

Author Contributions

Raghavendra Singh Rathore: Writing – original draft
Rekha Agrawal: Writing – original draft

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Alaca C., Turkoglu D., and Yildiz C., Fixed point in fuzzy metric spaces, *Chaos, Solitons and Fractals* 29(2006), 1073-1078.

[2] Aydi H, Abbas M, Sintunavarat W. and. Kumam P, Tripled fixed point of W-compatible mappings in abstract metric spaces, *Fixed Point Theory and its Applications*, 134(2012) 20 pages.

[3] Berinde V. and Borcut M., Tripled fixed point theorems for contractive type mappings in partially ordered metric spaces, *Nonlinear Analysis,* 74(2011) 4889 - 4897.

[4] Borcut M. and Berinde V, Tripled coincidence theorems for contractive type mappings in partially ordered metric spaces, *Appl. Math. Comput.,* 218(2012) 5929-5936.

[5] Feng Gu, Liya Liu, Common tripled fixed point theorem in two rectangular b-metric spaces and applications, *J. Nonlinear Sci. Appl.,* 10(2017), 3201–3216.

[6] George A. and Veeramani P., on some results in fuzzy metric spaces, *Fuzzy sets and Systems* 64(1994), 395-399.

[7] Jungck G. and Rhoades B. E., Fixed point for set valued functions without continuity, *Ind. J. Pure & Appl. Math.* 29(1998), no. 3, 227-238.

[8] Jungck G. and Rhoades B. E., "Fixed Point Theorem for Occasionally Weakly compatible mappings", Erratum*, Fixed point theory*, vol. No. 1(2008), 383-384.

[9] Kramosil I. and Michalek J., Fuzzy metric and statistical metric spaces, *Kybernetika,* 11(1975), 336-344.

[10] Kutukcu S., A common fixed point theorem for a sequence of self-maps in fuzzy metric spaces, *Commun. Korean Math. Soc*. 21(2006), no. 4, 679-687.

[11] M. A. Al-Thagafi, N. Shahzad, Generalized I-nonexpansive selfmaps and invariant approximations, *Acta. Math. Sin.,* 24(2008), pp. 867-876.

[12] Park J. H., Park J. S. and Kwun Y. C., Fixed points in M-fuzzy metric spaces, *Fuzzy Optim. Decis. Making,* vol. 7, 305-315, (2008).

[13] Radenovic S., A note on tripled coincidence and tripled common fixed point theorems in partially ordered metric spaces, *Appl. Math. Comput.,* 236(2014) 367-372.

[14] Rao K. P. R. and Ravi Babu G. and Raju V. C. C., A Common Fixed Point Theorem for Three Pairs of Maps in M-Fuzzy Metric Spaces, *Int. J. Contemp. Math. Sciences,* Vol. 3, 15(2008), 713 –720.

[15] Roldan A, Martinez J.-Moreno and Roldan C., Tripled fixed point theorem in fuzzy metric spaces and applications, *Fixed Point Theory Appl.,* (2013) 13 pages.

[16] R. S. Rathore, Rekha Agrawal and R S Chandel, Common Fixed Point Theorem in M-Fuzzy Metric Space for Occasionally Weakly Compatible Mapping Satisfying Integral type Inequality, *Advances in Fixed Point Theory*, 2021, 11: 3, 1 -11 https://doi.org/10.28919/afpt/5222 ISSN: 1927-6303.

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

[18] Sedghi S. and Shobe, Fixed point theorem in M-fuzzy metric spaces with property (E), *Advances in Fuzzy Mathematics,* Vol. 1, No. 1(2006), 55-65.

[19] Sessa S., "On Weak Commutativity Condition of Mapping in Fixed Point Consideration", *Publ. Inst. Math (Beograd) N. S.* 32(46) (1982), 149-153.

[20] Sharma S., On fuzzy metric space, Southeast *Asian Bull. Math*. 6(2002), no. 1, 145-157.

[21] Sushil Sharma, Servet Kutukcu and R. S. Rathore, Common fixed point for multivalued mappings in intuitionistic fuzzy metric space, *Comm. Korean Math. Soc.*, Vol. 22, No. 3(2007), 391-399 https://doi.org/10.4134/CKMS.2007.22.3.391

[22] Zadeh L. A., Fuzzy sets, *Inform. and Control* 8(1965), 338-353.

Research Fields

Raghavendra Singh Rathore: fuzzy mappings, mathematical modeling, fixed point theory, Metric spaces, topological spaces

Rekha Agrawal: fuzzy mappings, mathematical modeling, fixed point theory, Metric spaces, topological spaces