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Some Fixed Point Theorems for Occasionally Weakly Compatible Mapping in Fuzzy 2-Metric Space

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Abstract:

In this paper, we prove some common fixed point theorems in fuzzy2-metric space under the condition of occasion ally weakly compatible mappings.

Keywords and phrases: Fuzzy metric space, Fuzzy 2-metric space, Occasionally weakly Compatible mappings, Common fixed point.

I. INTRODUCTION

Impact of fixed point theory in different branches of mathematics and its applications is immense. The first result on fixed points for contractive type mapping was the much celebrated Banach's contraction principle by S. Banach [20] in 1922. In the general setting of complete metric space, this theorem runs as the follows, Theorem 1.1(Banach's contraction principle) Let (X, d) be a complete metric space, c∈ (0, 1) and f: X→X be a mapping such that for each x, y∈X, d $(fx, fy) \leq$ c d(x, y) Then f has a unique fixed point a∈X, such that for each x∈X,$\lim_{n\to\infty} f^n x = a$. After the classical result, R.Kannan [18] gave a subsequently new contractive mapping to prove the fixed point theorem. Since then a number of mathematicians have been worked on fixed point theory dealing with mappings satisfying various type of contractive conditions. In 2002, A. Branciari [1] analyzed the existence of fixed point for mapping f defined on a complete metric space (X,d) satisfying a general contractive condition of integral type.

The aim of this paper is to generalize some mixed type of contractive conditions to the mapping and then a pair of mappings, satisfying a general contractive mappings such as R. Kannan type [18], S.K. Chatrterjee type [21], T. Zamfirescu type [23], etc.

It proved a turning point in the development of fuzzy mathematics when the notion of fuzzy set was introduced by Zadeh [24] in 1965. Following the concept of fuzzy sets, fuzzy metric spaces have been introduced by Kramosil and Michalek [13] and George and Veeramani [7] modified the notion of fuzzy metric spaces with the help of continuous t-norm, which shows a new way for further development of analysis in such spaces. Consequently in due course of time some metric fixed point's results were generalized to fuzzy metric spaces by various authors. Sessa [19] improved commutativity condition in fixed point theorem by introducing the notion of weakly commuting maps in metric space. Vasuki [19] proved fixed point theorems for R-weakly commuting mapping. R.P. Pant [16, 17] introduced the new concept of reciprocally continuous mappings and established some common fixed point theorems. The concept of compatible maps by [13] and weakly compatible maps by [14] in fuzzy metric space is generalized by A.Al Thagafi and Naseer Shahzad [2] by introducing the concept of occasionally 1weakly compatible mappings. Recent results on fixed point in fuzzy metric space can be viewed in [5, 6].

In this paper we prove some fixed point theorems for occasionally weakly compatible owc mappings which improve the result of Rajesh Kumar Mishra and Sanjay Choudhary [15].

II. PRELIMINARIES

Definition2.1 [22]: A binary operation *: [0, 1] × [0, 1] → [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 ∈ [0, 1],
(4) a * b ≤ c * d whenever a ≤ c and b ≤ d for all a, b, c, d ∈ [0, 1],
Two typical examples of continuous t-norm are a * b = ab and a * b = min (a, b).

Definition2.2[7]: A 3-tuple (X, M,*) is called a fuzzy metric space if X is an arbitrary (Non-empty) set, * is a continuous t-norm and M is a fuzzy set on $X^2 \times (0,\infty)$satisfying the following conditions: for all x, y, z ∈ X and t, s > 0,
(1) $M(x, y, t) > 0$.
(2) $M(x, y, t) = 1$ if and only if x = y,
(3) $M(x, y, t) = M(y, x, t)$.
(4) $M(x, y, t) * M(y, z, s) \leq M(x, z, t + s)$.
(5) $M(x, y, .) : (0, \infty) \to [0,1]$ is continuous.

Let M(x, y, t) be a fuzzy metric space. For any t > 0, the open ball B(x, r, t) with center x∈ X and radius 0 < r < 1 is defined by B(x, r, t) = {y ∈ X: M(x, y, t) $> 1 - r$}. Let (X, M,*) be a fuzzy metric space. Let s be the set of all $A \subset S$ with x ∈ A if and only if there exist t > 0 and 0 < r < 1 such that B(x, r, t) ⊂ A. Then s is a topology on X (induced by the fuzzy metric M). This topology is Hausdorff and first countable. A sequence $\{x_n\}$ in X converges to x if and only if M $(x_n, x,$ t) → 1 as n → ∞ for all t > 0. It is called a Cauchy sequence if, for any 0 < e < 1 and t > 0, there exits n_0 ∈ N such that M $(x_n, x_m,$ t) $> 1 - \varepsilon$ for any n, m ≥ n_0 The fuzzy metric space (X, M,*) is said to be complete if every Cauchy sequence is convergent. A subset A of X is said to be F-bounded if there exists t > 0 and 0 < r < 1 such that M(x, y, t) $> 1 - r$ for all x, y ∈ A.

Example2.3: Let X = R and denote a * b = ab for all a, b ∈ [0, 1]. For any t ∈ (0,∞), define M(x, y, t) $= \frac{t}{t + |x-y|}$ for all x, y ∈ X. Then M is a fuzzy metric in X.

Definition2.4 [9]: Let f and g be mappings from a fuzzy metric space (X, M,*) into itself. Then the mappings are said to be compatible if, for all t > 0,

$$\lim_{n\to\infty} \text{M}\,(fgx_n, gfx_n, \text{t}) = 1$$

Whenever $\{x_n\}$ is a sequence in X such that

$$\lim_{n\to\infty} fx_n = \lim_{n\to\infty} gx_n = x \in X.$$

Lemma2.5: Let (X, M,*) be a fuzzy metric space. If there exists q ∈ (0, 1) such that M(x, y, qt) ≥ M(x, y, t) for all x, y ∈ X and t > 0, then x = y.

Definition2.6: Let X be a set, f and g self maps of X. A point x ∈ X is called a coincidence point of f and g iff $fx = gx$. We shall call $w = fx = gx$ a point of coincidence of f and g.

Definition2.7 [11]: A pair of maps S and T is called weakly compatible pair if they commute at coincidence points. The concept of occasionally weakly compatible is introduced by A. Al-Thagafi and Naseer Shahzad [2]. It is stated as follows.

Example2.9 [2]: Let R be the usual metric space. Define S, T: R→R by $Sx = 2x$ and $Tx = x^2$ for all x ∈ R. Then $Sx = Tx$ for x =0, 2 but ST0 = TS0 and ST2 ≠ TS2. S and T are occasionally weakly compatible self maps but not weakly compatible.

Lemma2.10 [12]: Let X be a set, f and g occasionally weakly compatible self maps of X. If f and g have a unique point of coincidence,$w = fx = gx$, then w is the unique common fixed point of f and g.

Definition2.11: the 3-tuple (X, M,*) is called a fuzzy 2-metric space if X is an arbitrary set, * is a continuous t-norm and M is a fuzzy set in $X^3 \times [0, \infty)$ satisfying the following conditions: for all x, y, z, u ∈ X and t_1, t_2, t_3 > 0,
(1) M(x, y, z, 0) = 0,
(2) M(x, y, z, t) = 1 for all t > 0 (only when the three simplex x, y, z degenerate)
(3) M(x, y, z, t) = M(x, z, y, t) = M (y, z, x, t) =……………..
(4) M(x, y, z, w,$t_1 + t_2 + t_3$) ≥*(M(x, y, u, t_1)*M(x, u, z,t_2)*M (u, y, z,t_3)
(5) M(x, y, z, .): [0, 1) × [0, 1] is left continuous.

Definition 2.12: Let (X, M,*) be a fuzzy- 2 metric space.
(1) A sequence $\{x_n\}$ in fuzzy -2 metric space X is said to be convergent to a point x ∈ X (denoted by

$$\lim_{n\to\infty} x_n = x \quad or \quad x_n \to x$$

if for any $\lambda \in (0,1)$ and t > 0, there exists n_0 ∈ N such that for all n ≥ n_0 and a ∈ X, M $(x_n, x, a,$ t) $> 1 - \lambda$.
That is

$$\lim_{n\to\infty} \text{M}\,(x_n, x, a, \text{t}) = 1 \text{ for all } a \in \text{X and } \text{t} > 0.$$

(2) A sequence $\{x_n\}$ in fuzzy- 2 metric space X is called a Cauchy sequence, if for any $\lambda \in (0,1)$ and t > 0, there exists n_0 ∈ N such that for all m, n ≥ n_0 and a ∈ X, M $(x_n, x_m, a,$ t) $> 1 - \lambda$.
(3) A fuzzy- 2 metric space in which every Cauchy sequence is convergent is said to be complete.

Definition 2.13: Self A function M is continuous in fuzzy 2-metric space if $x_n \to x$, $y_n \to y$, then

$$\lim_{n\to\infty} \text{M}\,(x_n, y_n, a, \text{t}) = \text{M}(x, y, a, \text{t}) \ for\ all\ a \in X\ and\ t > 0.$$

Definition 2.14: Two mappings f and g on fuzzy 2-metric space X are weakly commuting iff M (fgu, gfu, a, t) ≥ M (f u, gu, a, t) $for\ all\ a, u \in X\ and\ t > 0.$

III. MAIN RESULT

Theorem 3.1: Let (X, M, *) be a complete fuzzy 2-metric space and let A, B, S and T be self mappings of X. Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. If there exist $q \in (0,1)$ such that

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\left\{\min\left\{\begin{matrix} M(Sx,Ty,a,t), M(Sx,Ax,a,t), \\ \frac{\alpha M(Ax,Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax,Ty,a,t), M(By,Ty,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt \quad \ldots\ldots\ldots\ldots(1)$$

For all x, y, a ∈ X, t > 0 and $a, b, c, d \geq 0$ with a & b, c & d cannot be simultaneously 0, then there exist a unique point w ∈ X such that $Aw = Sw = w$ and a unique point z ∈ X such that $Bz = Tz = z$. Moreover $w = z$, so that there is a unique common fixed point of A, B, S and T.

Proof:

Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. So there are points x, y ∈ X such that $Ax = Sx$ and $By = Ty$. we claim that $Ax = By$, if not, by inequality (1)

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\left\{\min\left\{\begin{matrix} M(Sx,Ty,a,t), M(Sx,Ax,a,t), \\ \frac{\alpha M(Ax,Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax,Ty,a,t), M(By,Ty,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt$$

$$\geq \int_0^{\left\{\min\left\{\begin{matrix} M(Ax,By,a,t), M(Ax,Ax,a,t), \\ \frac{\alpha M(Ax,By,a,t)+\beta M(By,Ax,a,t)}{\alpha+\beta}, \\ M(Ax,By,a,t), M(By,By,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt$$

$$\geq \int_0^{\{\min\{M(Ax,By,a,t),1,M(Ax,By,a,t),1,M(Ax,By,a,t),1\}\}} \zeta(t)dt$$

$$\geq \int_0^{\{M(Ax,By,a,t)\}} \zeta(t)dt$$

Therefore using lemma 2.5, we have $Ax = By$, i.e. $Ax = Sx = By = Ty$. Suppose that there is another point z such that $Az = Sz$ then by inequality (1) we have $Az = Sz = By = T$, so $Ax = Az$ and $w = Ax = Sx$ is the unique point of coincidence of A and S. Similarly there is a unique point z ∈ X such that$z = Bz = Tz$.

Assume that $w \neq z$. We have by inequality (1)

$$\int_0^{M(Aw,Bz,a,qt)} \zeta(t)dt \geq \int_0^{\left\{\min\left\{\begin{matrix} M(Sw,Tz,a,t), M(Sw,Aw,a,t), \\ \frac{\alpha M(Aw,Tz,a,t)+\beta M(Bz,Sw,a,t)}{\alpha+\beta}, \\ M(Aw,Tz,a,t), M(Bz,Tz,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt$$

$$\int_0^{M(w,z,a,qt)} \zeta(t)dt \geq \int_0^{\left\{\min\left\{\begin{matrix} M(w,z,a,t), M(w,w,a,t), \\ \frac{\alpha M(w,z,a,t)+\beta M(z,w,a,t)}{\alpha+\beta}, \\ M(w,z,a,t), M(z,z,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt$$

$$\int_0^{M(w,z,a,qt)} \zeta(t)dt \geq \int_0^{\{\min\{M(w,z,a,t),1,M(w,z,a,t),1,M(w,z,a,t),1\}\}} \zeta(t)dt$$

$$\geq \int_0^{\{M(w,z,a,t)\}} \zeta(t)dt$$

Therefore we have $w = z$, by Lemma 2.10 z is a common fixed point of A, B, S and T.

To prove uniqueness let u be another common fixed point of A, B, S and T. Then

$$\int_0^{M(Az,Bu,a,qt)} \zeta(t)dt \geq \int_0^{\left\{\min\left\{\begin{array}{l} M(Sz,Tu,a,t), M(Sz,Az,a,t), \\ \frac{\alpha M(Az,Tu,a,t)+\beta M(Bu,Sz,a,t)}{\alpha+\beta}, \\ M(Az,Tu,a,t), M(Bu,Tu,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$= \int_0^{\left\{\min\left\{\begin{array}{l} M(z,u,a,t), M(z,z,a,t), \\ \frac{\alpha M(z,u,a,t)+\beta M(u,z,a,t)}{\alpha+\beta}, \\ M(z,u,a,t), M(u,u,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

Take $\alpha=\beta=1$ and $\lambda=0$

$$\int_0^{M(Az,Bu,a,qt)} \zeta(t)dt = \int_0^{\{M(z,u,a,qt)\}} \zeta(t)dt \geq \int_0^{\{M(z,u,a,t)\}} \zeta(t)dt.$$

Therefore by lemma 2.5, we have $z = u$.

Theorem 3.2: Let (X, M, *) be a complete fuzzy 2-metric space and let A, B, S and T be self mappings of X. Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. If there exist $q \in (0,1)$ such that

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Sx,Ty,a,t), M(Sx,Ax,a,t), \\ \frac{\alpha M(Ax,Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax,Ty,a,t), M(By,Ty,a,t) \end{array}\right\}\right\}} \zeta(t)dt \qquad \ldots\ldots\ldots\ldots(2)$$

For all x, y, a ∈ X, t > 0 and $a, b, c, d \geq 0$ with $a \,\&\, b, c \,\&\, d$ cannot be simultaneously 0 and $\emptyset : [0,1] \to [0,1]$ such that $\emptyset(t) > t$ *for all* $0 < t < 1$ then there is a unique common fixed point of A, B, S and T.

Proof:

Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. So there are points x, y ∈ X such that $Ax = Sx$ and $By = Ty$. we claim that $Ax = By$, if not, by inequality (2)

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Sx,Ty,a,t), M(Sx,Ax,a,t), \\ \frac{\alpha M(Ax,Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax,Ty,a,t), M(By,Ty,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$\geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Ax,By,a,t), M(Ax,Ax,a,t), \\ \frac{\alpha M(Ax,By,a,t)+\beta M(By,Ax,a,t)}{\alpha+\beta}, \\ M(Ax,By,a,t), M(By,By,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$\geq \int_0^{\phi\{\min\{M(Ax,By,a,t),1,M(Ax,By,a,t),1,M(Ax,By,a,t),1\}\}} \zeta(t)dt$$

$$\geq \int_0^{\{M(Ax,By,a,t)\}} \zeta(t)dt$$

Therefore using lemma 2.5, we have $Ax = By$, i.e. $Ax = Sx = By = Ty$. Suppose that there is another point z such that $Az = Sz$ then by inequality (2) we have $Az = Sz = By = T$, so $Ax = Az$ and $w = Ax = Sx$ is the unique point of coincidence of A and S. Similarly there is a unique point z ∈ X such that$z = Bz = Tz$.

Assume that $w \neq z$. We have by inequality (2)

$$\int_0^{M(Aw,Bz,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Sw, Tz,a,t), M(Sw, Aw,a,t), \\ \frac{\alpha M(Aw, Tz,a,t)+\beta M(Bz,Sw,a,t)}{\alpha+\beta}, \\ , \\ M(Aw, Tz,a,t), M(Bz, Tz,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$\int_0^{M(w,z,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(w, z,a,t), M(w,w,a,t), \\ \frac{\alpha M(w, z,a,t)+\beta M(z,w,a,t)}{\alpha+\beta}, \\ M(w, z,a,t), M(z, z,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$\int_0^{M(w,z,a,qt)} \zeta(t)dt \geq \int_0^{\phi\{\min\{M(w, z,a,t),1,M(w, z,a,t),1,M(w, z,a,t),1\}\}} \zeta(t)dt$$

$$\geq \int_0^{\{M(w, z,a,t)\}} \zeta(t)dt$$

Therefore we have $w = z$, by Lemma 2.10 z is a common fixed point of A, B, S and T.

To prove uniqueness let u be another common fixed point of A, B, S and T. Then

$$\int_0^{M(Az,Bu,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Sz, Tu,a,t), M(Sz, Az,a,t), \\ \frac{\alpha M(Az, Tu,a,t)+\beta M(Bu,Sz,a,t)}{\alpha+\beta}, \\ M(Az, Tu,a,t), M(Bu, Tu,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

$$= \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(z, u,a,t), M(z,z,a,t), \\ \frac{\alpha M(z, u,a,t)+\beta M(u,z,a,t)}{\alpha+\beta}, \\ M(z, u,a,t), M(u,u,a,t) \end{array}\right\}\right\}} \zeta(t)dt$$

Take $\alpha=\beta=1$ and $\lambda=0$

$$\int_0^{M(Az,Bu,a,qt)} \zeta(t)dt = \int_0^{\{M(z,u,a,qt)\}} \zeta(t)dt \geq \int_0^{\{M(z,u,a,t)\}} \zeta(t)dt.$$

Therefore by lemma 2.5, we have $z = u$.

Theorem 3.3: Let (X, M, *) be a complete fuzzy 2-metric space and let A, B, S and T be self mappings of X. Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. If there exist $q \in (0,1)$ such that

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{array}{l} M(Sx, Ax,a,t), M(Sx, Ty,a,t), (By,Sx,a,t), \\ \frac{\alpha M(Ax, Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax, Ty,a,t), M(By, Ty,a,t) \end{array}\right\}\right\}} \zeta(t)dt \quad \ldots\ldots\ldots\ldots(3)$$

For all x, y, a ∈ X, t > 0 and $a, b, c, d \geq 0$ with a & b, c & d cannot be simultaneously 0 and $\emptyset : [0,1]^7 \to [0,1]$ such that $\emptyset(1, t, t, t, 1, t, 1) > t$ $for\ all$ $0 < t < 1$ then there is a unique common fixed point of A, B, S and T.

Proof:

Let the pairs $\{A, S\}$ and $\{B, T\}$ be occasionally weakly compatible. So there are points x, y ∈ X such that $Ax = Sx$ and $By = Ty$. we claim that $Ax = By$, if not, by inequality (3)

$$\int_0^{M(Ax,By,a,qt)} \zeta(t)dt \geq \int_0^{\phi\left\{\min\left\{\begin{matrix} M(Sx,Ax,a,t), M(Sx,Ty,a,t),(By,Sx,a,t), \\ \frac{\alpha M(Ax,Ty,a,t)+\beta M(By,Sx,a,t)}{\alpha+\beta}, \\ M(Ax,Ty,a,t), M(By,Ty,a,t) \end{matrix}\right\}\right\}} \zeta(t)dt$$

$Take\ \alpha = \beta = 1, \lambda = 0$

$$= \int_0^{\phi\left\{\min\left\{\begin{matrix} 1, M(Ax,By,a,t),(Ax,By,a,t), \\ (Ax,By,a,t),1,(Ax,By,a,t),1 \end{matrix}\right\}\right\}} \zeta(t)dt$$

$$> \int_0^{\{(Ax,By,a,t)\}} \zeta(t)dt$$

a contradiction therefore $Ax = By$, i.e. $Ax = Sx = By = Ty$. Suppose that there is another point z such that $Az = Sz$ then by inequality (3) we have $Az = Sz = By = T$, so $Ax = Az$ and $w = Ax = Sx$ is the unique point of coincidence of A and S. Similarly there is a unique point z ∈ X such that $z = Bz = Tz$.

Thus z is a common fixed point of A, B, S and T. The uniqueness of the fixed point holds from (3)

REFERENCES

[1] A.Branciari. A fixed point theorem for mappings satisfying a general contractive condition of integral type. Int.J.Math.Sci. 29(2002), no.9, 531 - 536.

[2] A.Al -Thagafi and Naseer Shahzad, "Generalized I-Nonexpansive Selfmaps and Invariant Approximation", Acta Mathematica Sinica, English Series May,2008, Vol.24, No.5, pp.867876.

[3] Brog, "M.A. metric space in Fuzzy Set Theory ", J. Math. And Appl. ,69, 205-230(1979).

[4] B.E. Rhoades, Two fixed point theorems for mappings satisfying a general contractive condition of integral type. International Journal of Mathematics and Mathematical Sciences, 63, (2003), 4007 - 4013.

[5] C.T. Aage, J.N.Salunke,"On fixed point theorem in Fuzzy Metric Spaces" Int. J. Open Problem Compt. Math.,Vol. 3, No. 2, June 2010 ,pp 123-131.

[6] C.T. Aage, J.N.Salunke, "On fixed point theorem in Fuzzy Metric Spaces Using A Control Function" , Submitted.

[7] George A, Veeramani P. On some result in fuzzy metric space. Fuzzy Set Syst 1994; 64:395–399.

[8] Grabiec M. Fixed points in fuzzy metric spaces. Fuzzy Set Syst 1988; 27:385–389.

[9] G. Jungck,"Compatible Mappings and Common Fixed Point", International Journal of Math. Sci. 9 (1986),771-779.

[10] G. Jungck and B.E. Rhoades, "Fixed Point for Set Valued functions without Continuity" , Indian J. Pure Appl. Math.,29(3) ,(1998), pp.771- 779.

[11] G. Jungck and B.E. Rhoades," Fixed Point for Occasionally Weakly Compatible Mappings", Fixed Point Theory, Volume 7, No. 2, 2006, 287-296.

[12] G. Jungck and B.E. Rhoades, " Fixed Point for Occasionally Weakly Compatible Mappings" , Erratum, Fixed Point Theory, Volume 9, No. 1,2008,383-384.

[13] Kramosil I, Michalek J. Fuzzy metric and statistical metric spaces. Kybernetica 1975; 11:326–334.

[14] P.Balasubramaniam, S. muralisankar, R.P. Pant, "Common fixed points of four mappings in a fuzzy metric space", J. Fuzzy Math. 10(2) (2002), 379-384.

[15] Rajesh Kumar Mishra and Sanjay Choudhary ,"On fixed point theorems in Fuzzy metric spaces", IMACST Vol.1,No.1,Dec 2010, 45-47.

[16] R.P. Pant ,"Common fixed point Theorems for contractive Mappings", J. Math. Anal. Appl. 226 (1998), 251-258.

[17] R.P. Pant ,"A remark on Common fixed point of Four Mappings in a fuzzy metric space",J. Fuzzy. Math. 12(2) (2004), 433-437.

[18] R. Kannan, Some results on fixed points, Bull. Calcutta Math. Soc., 60(1968), 71-76.

[19] Sessa S. On some weak commutativity condition of mappings in fixed point considerations. Publ Inst Math (Beograd) 1982; 32:149–153.

[20] S. Banach, Sur les oprations dans les ensembles abstraits et leur application aux quations intgrales, Fund. Math.3,(1922)133-181 (French).

[21] S.K.Chatterjea, Fixed point theorems, C.R.Acad.Bulgare Sci. 25(1972), 727-730.

[22] Schweizer ans A.Sklar, “Statistical metric spaces”, Pacific J. Math. 10(1960), 313-334

[23] T.Zamfrescu, Fixed point theorems in metric spaces, Arch. Math. (Basel) 23(1972), 292-298.

[24] Zadeh LA. Fuzzy sets. Inform Control 1965; 8:338–353.

