3.3.2 "Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five years

List of Research Papers Published by Faculty in the Calendar year 2023

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Calendar Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Link to website of the Journal	Link to article / paper / abstract of the article
1	Dr. Rasik Patel	**NA**	Some Fixed Point Theorems for Occasionally Weakly Compatible Mappings Related with Fuzzy-2 and Fuzzy-3 Metric spaces	International Journal of Mathematics and Computer Research	-	**International**	2023	2320-7167	**Saffrony Institute of Technology**	-	http://ijmcr.in/	http://ijmcr.in/index.php/ijmcr/issue/view/120

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1. Some Fixed Point Theorems for Occasionally Weakly Compatible Mappings Related with Fuzzy-2 and Fuzzy-3 Metric spaces-Dr. Rasik Patel

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Some Fixed Point Theorems for Occasionally Weakly Compatible Mappings Related with Fuzzy-2 and Fuzzy-3 Metric spaces

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ARTICLE INFO	ABSTRACT
Published Online: 20 February 2023	In this paper, we give some definitions of occasionally weakly compatible maps in fuzzy-2 metric and fuzzy-3 metric spaces and some common fixed point theorems for six mappings under the condition of occasionally weakly compatible mappings in complete Fuzzy-2 and Fuzzy-3 matric spaces.
Corresponding Author: **Rasik M.Patel**	2010 Mathematics Subject Classification: Primary 47H10, 54H25

KEYWORDS: Fuzzy metric space, Fuzzy-2 & 3 metric space, Fixed point theorem, Occasionally weakly Compatible mappings

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 [19] 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 [16] 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.

Theorem 1.2 (A.Branciari) Let (X, d) be a complete metric space, c∈ (0, 1) and let f: X⟶X be a mapping such that for each x, y ∈ X, $\int_0^{d(fx,fy)} \varphi(t)dt \leq c \int_0^{d(x,y)} \varphi(t)dt$. Where φ: [0,+∞) ⟶[0,+∞) is a Lebesgue integrable mapping which is summable on each compact subset of [0,+∞) , non negative, and such that for each ε >o, $\int_0^{\varepsilon} \varphi(t)dt$, 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 paper of Branciari, a lot of a research works have been carried out on generalizing contractive conditions of integral type for a different contractive mapping satisfying various known properties. A fine work has been done by Rhoades [3] extending the result of Branciari by replacing the condition by the following

$$\int_0^{d(fx,fy)} \varphi(t)dt \leq \int_0^{max\left\{d(x,y),d(x,fx),d(y,fy),\frac{d(x,fy)+d(y,fx)}{2}\right\}} \varphi(t)\,dt$$

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 mapping such as R. Kannan type [16], S.K. Chatrterjee type [20], T. Zamfirescu type [25], Schweizer and A.Sklar [21]etc.

The concept of Fuzzy sets was introduced initially by Zadeh [27]. Since then, to use this concept in topology and analysis many authors have expansively developed the theory of fuzzy sets. Both George and Veermani [4], Kramosil [8] modified the notion of fuzzy metric spaces with the help of continuous t-norms. Many researchers have obtained common fixed point theorems for mappings satisfying different types of commutativity conditions. Vasuki [17] proved fixed point theorems for R-weakly commutating mappings. R.P. Pant and Jha [13, 14, 15] introduced the new concept reciprocally continuous mappings and established

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REVIEW PAPER ON FIXED POINT THEORY IN COMPLEX VALUED METRIC SPACE

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ABSTRACT

In this paper, we review some papers related to fixed point theory in complex valued metric space using contractive conditions, rational inequality and common limit range property for two pairs of mappings deriving common fixed point results under a generalized altering distance functions, E.A and CLR property.

1. Introduction:

The idea of complex valued metric space was presented by **Azam et al. [1],** demonstrating some fixed point results for mappings fulfilling a rational inequality in complex valued metric spaces which is the generalization of cone metric space . Since then, several papers have managed fixed point hypothesis in complex valued metric spaces (**see [3– 11**] and references in that). **Rao et al. [12]** started the concentrate of fixed point results on complex valued*b*-metric spaces, which was broader than the complex valued metric spaces [**1**]. Following this paper, a number of authors have demonstrated a few fixed point results for different mapping fulfilling a rational conditions with regards to complex valued *b*-metric spaces (see**[13– 16]**) and the related references there in. As of late, **Sintunavaratet al. [9, 10], Sitthikul and Saejung [11**], and **Singhetal.[8]**obtained basic fixed point results by supplanting the consistent of contractive condition to control functions in complex valued metric spaces. In a continuation of **[8,11,15,17],**some normal fixed point results for a couple of mappings fulfilling more broad contractive conditions including rational expressions having point-subordinate control functions as coefficients in complex valued *b*-metric spaceshave been proved by many authors.

2. Preliminaries:

Banach fixed point theorem **[1]** in a complete metric space has been summed up in numerous spaces. In 2011, **Azam et al. [2]** presented the thought of complex-valued metric space and built up sufficient conditions for the presence of common fixed points of a pair of mappings fulfilling a contractive condition. The possibility of complex-valued metric spaces can be abused to define complex-valued normed spaces and complex-valued Hilbert spaces; moreover it offers various research exercises in numerical examination. The theorems demonstrated **by Azam et al. [2]** and **Bhatt et al. [18]** utilize the rational inequality in a complex-valued metric space as contractive condition. In this paper, we present the idea of property (E.A) in a complex-valued metric space, to demonstrate some normal fixed point

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Results for a fourfold of self-mappings fulfilling a contractive condition of 'max' type. Our outcomes sum up different theorems of customary metric spaces.

An ordinary metric d is a real-valued function from a set X × X into R, where X is a nonempty set. That is, d: X × X → R. A complex number z ∈ C is an ordered pair of real numbers, whose first co-ordinate is called Re (z) and second coordinate is called Im(z). Thus acomplex-valued metric d is a function from a set X ×X into C, where X is a nonempty set andC is the set of complex number. That is, d: X × X → C. Let $z_1, {}_2 \in$ C, define a partial order - on C as follows:

$z_1 \preccurlyeq z_2$ if and only if Re $(z_1) \leq$ Re (z_2), Im$(z_1) \leq$ Im(z_2).

It follows that z1 ≼z2 if one of the following conditions is satisfied:

(i) Re(z_1) = Re(z_2), Im(z_1) < Im(z_2),

(ii) Re(z_1) < Re(z_2), Im(z_1) = Im(z_2),

(iii) Re(z_1) < Re(z_2), Im(z_1) < Im(z_2),

(iv) Re(z_1) = Re(z_2), Im(z_1) = Im(z_2).

In (i), (ii) and (iii), we have $|z_1| < |z_2|$. In (iv), we have $|z_1| = |z_2|$. So $|z_1| \leq |z_2|$. In particular, z1 ⋠ z2 if z1 ≠ z2 and one of (i), (ii), (iii) is satisfy. In this case |z1| < |z2|. We will write z1 ≺ z2 if only (iii) satisfy. Further,

$0 \preccurlyeq z_1 \npreceq z_2 \Rightarrow |z_1| < |z_2|$,

z1 ≼z2 and z2 ≺ z3 ⇒ z1 ≺ z3.

Azam et al. [2] defined the complex-valued metric space (X,d) in the following way:

Lenition 1.1. Let X be a nonempty set. Suppose that the mapping d : X×X → C satisfies the following conditions:

(C1) 0 ≼ d(x,y) for all x,y ∈ X and d(x,y) = 0 if and only if x = y;

(C2) d(x,y) = d(y,x) for all x,y ∈ X;

(C3) d(x,y) ≼ d(x,z) + d(z,y) for all x,y,z ∈ X.

Then d is called a complex-valued metric on X, and (X,d) is called a complex valued metric space.

(i).Common Fixed Point Theorems Using Property (E.A) in Complex-Valued Metric Spaces.

Fixed Point Theorem Using (E.A)-Property [19]

In this paper author proved some important fixed point theorems using (E.A) property and (CLR) property in complex valued metric space in which the author also used the notion of partial order.

Theorem[a] Let (X,d) be a complex-valued metric space and A,B,S,T : X → X be four self-mappings satisfying:

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(i) $A(X) \subseteq T(X)$, $B(X) \subseteq S(X)$,

(ii) $d(Ax,By) \preccurlyeq k \max (d(Sx,Ty),d(By,Sx),d(By,Ty))$, $\forall x,y \in X$, $0 < k < 1$,

(iii) the pairs (A,S) and (B,T) are weakly compatible,

(iv) One of the pair (A,S) or (B,T) satisfy property (E.A).

If the range of one of the mappings S(X) or T(X) is a complete subspace of X, then mappings A, B, S and T have a unique common fixed point in X.

Fixed Point Theorem Using (CLR)-Property

The notion of (CLR)-property was defined by Sintunavarat and Kumam [20] in a metric space for a pair of self-mappings, which have the common limit in the range of one of the mappings.

Definition: (The (CLR)-property [20]). Suppose that (X,d) is a metric space and $f,g : X \to X$. Two mappings f and g are said to satisfy the common limit in the range of g property if $\lim_{n\to\infty} f x_n = \lim_{n\to\infty} g x_n = gx$, for some $x \in X$.

In the complex-valued metric space, the definition will be same but the space X will be a complex valued metric space.

Theorem[b]. Let (X,d) be a complex-valued metric space and $A,B,S,T : X \to X$ be four self-mappings satisfying:

(i) $A(X) \subseteq T(X)$,

(ii) $d(Ax,By) \preccurlyeq k \max(d(Sx,Ty),d(By,Sx),d(By,Ty))$, $\forall x,y \in X$, $0 < k < 1$,

(iii) the pairs (A,S) and (B,T) are weakly compatible.

If the pair (A,S) satisfy (CLR_A) property, or the pair (B,T) satisfy (CLR_B) property, then mappings A,B,S and T have a unique common fixed point in X.

(ii).Some fixed point theorems in complex valued metric spaces [11]

In this paper author proved several fixed point theorems for mappings satisfying certain point- dependent contractive conditions by deducing the results of [7] and [9] ,[21].

Theorem: let, (X,d) be a complete complex valued metric space and $S,T:X\to X$. if there exists a mapping $\Lambda, \sqsubseteq : X\to[0,1)$ such that for all $x,y \in X$:

(i) $\Lambda(Sx) \le \Lambda(x)$ and $\sqsubseteq(Sx) \le \sqsubseteq(x)$;
(ii) $\Lambda(Tx) \le \Lambda(x)$ and $\sqsubseteq(Tx) \le \sqsubseteq(x)$;
(iii) $(\Lambda+\sqsubseteq)(x) < 1$;
(iv) $d(Sx,Sy) \preccurlyeq \Lambda(x)d(x,y) + \frac{\sqsubseteq(x)d(x,Sx)d(y,Ty)}{1+(x,y)}$

then S and T have unique fixed point .

Cor: *Let* (X,d) *be a complete complex valued metric space and* $S,T:X\to X$. *If there exist mappings* $\lambda,\mu,\gamma:X\to[0,1)$ *such that for all* $x,y\in X$:

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(a) $\lambda(TSx)\leq\lambda(x)$, $\mu(TSx)\leq\mu(x)$ *and* $\gamma(TSx)\leq\gamma(x)$;

(b)$\lambda(x)+\mu(x)+\gamma(y)<1$;

(c)$d(Sx,Ty)\precsim\lambda(x)d(x,y)+\mu(x)\frac{d(x,Sx)d(y,Ty)}{1+(x,y)}+\gamma(x)\frac{d(x,Sx)d(y,Ty)}{1+d(x,y)}$

Then S and T have a unique common fixed point.

Cor:*If S and T are self-mappings defined on a complete complex valued metricspace* (X,d)*satisfying the condition*
$d(Sx,Ty)\precsim\lambda d(x,y)+\mu\frac{d(x,Sx)d(y,Ty)}{1+(x,y)}+\gamma\frac{d(y,Sx)d(y,Ty)}{1+d(x,y)}$
for all x,y∈X*, where* λ, μ, γ *are nonnegative reals with* $\lambda+\mu+\gamma<1$*, then S and Thavea unique common fixed point.*
Cor: let, (X,d) be a real valued metric space. Let T:X→X be such that

(i) $d(Tx,Ty)\leq\lambda\, d(x,y)+\frac{\mu d(y,Ty)[1+d(x,Tx)]}{1+(x,y)}$ for all x,y∈X, $\lambda>0$, $\mu>0$, $\lambda+\mu<1$, and

(ii) for some x_0∈X, the sequence of iterates $\{T^n(x_0)\}$ has a subsequence $\{T^n(x_0)\}$ with z= $\log_{k\to\infty} T^{nk}x_0$

Then z is a unique fixed point of T.

(iii). Six Maps with a Common Fixed Point in Complex Valued Metric Spaces [22]

In this paper, author attained a common fixed point theorem for six maps in complex valued metric space which is basically the generalization of [18]

Theorem: let (X,d) be a complex valued metric space and F,G,I,J,K,L be self maps of X satisfying the following conditions:

(i) KL(X) ⊆ F(X) and IJ(X) ⊆ G(X)
(ii) d(IJx,KLy) ≤ ad(Fx,Gy) + b(d(Fx,IJx) + d(Gy,KLy)) + c(d(Fx,KLy) + d(Gy,IJx)) for all x,y ∈ X , where a,b,c ≥ 0 and a+2b+2c < 1 .assume that the pairs (KL,G) and (IJ,F)are weakly compatible . pairs (K,L) ,(K,G) ,(L,G),(I,J),(I,F) and (J,F) are commuting pairs of maps . Then K, L, I, J, G and F have unique common fixed point in X.

(iv). Some Common Fixed Point Results for Rational Type Contraction Mappings in Complex Valued Metric Spaces [23]

In this paper, author demonstrates some fixed point theorems for two pairs which fulfil a rational type condition in complex valued metric space.

Fixed Point Theorem using E.A property

Theorem1: Let, (X,d) be a complex valued metric space and A,B,S,T : X →X four self-mappings satisfying the following conditions:

(i) A(X) ⊆ T(X), B(X) ⊆ S(X)
(ii) For all x,y ∈ X and 0 < a < 1.

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$$d(Ax,By) \leq a\frac{d(Sx,Ax)d(Sx,By)+d(Ty,By)d(Ty,Ax)}{1+(Sx,By)+d(Ty,Ax)}$$

(iii) The pairs (A,S) and (B,T) are weakly compatible ;

(iv) One of the pairs (A,S) or (B,T) satisfies (E.A) – property .

If the range of one of the mappings S(X) or T(X) is a closed subspace of X, thenthe mappings A,B,S and T have a unique common fixed point in X .

Theorem2: let, (X,d) be a complex valued metric space and A,B,S,T : X→ X four mappingssatisfying the following conditions:

(i) A(X) ⊆ T(X) , B(X) ⊆ S(X);

(ii) For all x,y ∈ X and 0 < a < 1 ,

$$d(Ax,By) \leq \left\{ \begin{array}{l} a\frac{d(Sx,Ax)d(Sx,By)+d(Ty,By)d(Ty,Ax)}{d(Sx,By)+d(Ty,Ax)} \\ 0, if D \neq 0 \\ if D = 0 \end{array} \right\}$$

(iii)

where D = d(Sx,By)+d(Ty,Ax);

(iv) The pairs (A,S) AND (B,T) are weakly compatible ;

(v) One of the pairs (A,S) or (B,T) satisfies (E.A)-property.

If the range S(X) or T(X) is a closed subspace of X, then the mappings A,B,S and T have unique common fixed point in X.

Fixed point theorem using (CLR)-property

Theorem3: let , (X,d) be a complex valued metric space and A,B,S and T : X→X four self-mappings satisfying the following conditions :

(i) A(X) ⊆ T(X) , B(X) ⊆ S(X)

(ii) For all x,y ∈ X and 0 < a < 1.

$$d(Ax,By) \leq a\frac{d(Sx,Ax)d(Sx,By)+d(Ty,By)d(Ty,Ax)}{1+(Sx,By)+d(Ty,Ax)}$$

(iii)

The pairs (A,S) and (B,T) are weakly compatible ;

the pair (A,S) satisfies CLR_A or (B,T) satisfies CLR_B – property .

If the range of one of the mappings S(X) or T(X) is a closed subspace of X, then themappings A,B,S and T have a unique common fixed point in X .

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Theorem4 : let (X,d) be a complex valued metric space and A,B,S T : X→ X four mappingssatisfying the following conditions:

(i) A(X) ⊆ T(X) , B(X) ⊆ S(X);

(ii) d(Ax,By)For all x,y ∊ X and 0 < a < 1 ,

$$d(Ax,By) \le \begin{cases} a\dfrac{d(Sx,Ax)d(Sx,By)+d(Ty,By)d(Ty,Ax)}{d(Sx,By)+d(Ty,Ax)} \\ 0, if D \neq 0 \\ if D = 0 \end{cases}$$

where D = d(Sx,By)+d(Ty,Ax);

(iii) The pairs (A,S) AND (B,T) are weakly compatible ;

If the pair (A,S) satisfies CLR_A or (B,T) satisfies CLR_B-property.
If the range S(X) or T(X) is a closed subspace of X, then the mappings A,B,S and T have unique common fixed point in X.

References:

1) S. Banach, operations dans les ensembles abstracts application auxiliary Equations integrals, Fund. Math. 3 (1922) 133–181.

2) Azam, B. Fisher, M. Khan, Common fixed point theorems in complex valued metricspace

3) C.Klin-eamandC.Suanoom,"Some common fixed-point theorems for generalized- contractive type mappings on complex valued metric spaces," Abstract and Applied Analysis,vol.2013, ArticleID604215,6pages,2013.

4) M. A. Kutbi, A. Azam, J. Ahmad, and C. Di Bari, "Some common coupled fixed point results for generalized contraction in complex-valued metric spaces," Journal of Applied Mathematics, vol.2013,ArticleID352927,10pages,2013.

5) H.K.Nashine, M.Imdad, andM.Hasan, "Common fixed point theorems under rational contractions in complex valued metric spaces,"JournalofNonlinearScienceandItsApplications,vol.7,

S.P.B. Patel Engineering College Linch

no.1,pp.42–50,2014.

6) H.K.NashineandB.Fisher,“Common fixed point theorems for generalized contraction involving rational expressions in complex valued metric spaces,” Analele Stiinale University Ovidius Constanta,vol.23,no.2,pp.179–185,2015.

7) F. Rouzkard and M. Imdad, “Some common fixed point theorems on complex valued metric spaces,” Computers & MathematicswithApplications,vol.64,no.6,pp.1866–1874,2012.

8) N.Singh,D.Singh,A.Badal,andV.Joshi,“Fixed point theorems in complex valued metric spaces,” Journal of the Egyptian MathematicalSociety,vol.24,no.3,pp.402–409,2016.

9) W. Sintunavarat and P. Kumam, “Generalized common fixed point theorems in complex valued metric spaces and applications,”JournalofInequalitiesandApplications,vol.2012,article 84,12pages,2012.

10) W. Sintunavarat, Y. J. Cho, and P. Kumam, “Urysohn integral equations approach by common fixed points in complex-valued metric spaces,” Advances inDifference Equations, vol. 2013, article49,14pages,2013.

11) K.SitthikulandS.Saejung,“Some fixed point theorems in complex valued metric spaces,”Fixed Point Theory and Applications, vol.2012,article189,11pages,2012

12) K. P. R. Rao, P. R. Swamy, and J. R. Prasad, “A common fixed point theorem in complex valued b-metric spaces,” Bulletin of Mathematics and Statistics Research, vol.1,no.1,pp.1–8,2013.

13) A.K.Dubey,R.Shukla,andR.P.Dubey,“Some fixed point theorems in complex valued b- metric spaces,”Journal of Complex Systems,vol.2015,ArticleID832467,7pages,2015.

14) A.K.Dubey,“Common fixed point results for contractive mappings in complex valued b- metric spaces, “Nonlinear Functional AnalysisandApplications,vol.20,no.2,pp.257–268,2015.

15) A.K.Dubey,R.Shukla,andR.P.Dubey,“Some common fixed point theorems for contractive mappings in complex valued b metric spaces,” Asian Journal of Mathematics and Applications, vol.2015,Article ID ama0266,13pages,2015.

16) Mukheimer, “Some common fixed point theorems in complex valued b-metric spaces,” The Scientific World Journal, vol.2014,ArticleID587825,6pages,2014.

17) K. Dass and S. Gupta, “An extension of Banach contraction principle through rational expression,” Indian Journal of Pure and Applied Mathematics,vol.6,no.12,pp.1455–1458,1975.

18) S. Bhatt, S, Chaukiyal, R.C. Dimri, A common fixed point theorem for weakly compatible maps in complex-valued metric spaces, Int. J. Math. Sci. Appl. 1 (3) (2011)

S.B. Patel Engineering College Linch

1385–1389.

19) R.K Verma , H.K Pathak “Common fixed point theorems using(E.A)-property incomplex valued metric space”,vol.11,347-355(2012).

20) Sintunavarat, P. Kumam, “Common fixed point theorem for a pair of weakly compatible mappings in fuzzy metric space”, J. Appl. Math., Vol. 2011 (2011), Article ID637958, 14 pages

21) Dass,Bk ,Gupta , S:An extension of Banach Contraction Principle through rational expression.Indian.J.Pure.Appl.Math6(12),1455-1458(1975)

22) Rahul Tiwari,D.P. Shukla “Six maps with common fixed point in complex valued metricspaces “,vol.02,May(2012),827-832.

23) Sumit Chandok,Deepak Kumar “some common fixed point results for rational type contraction mappings in complex valued metric spaces,vol.2013ArticleID813707,6pages.

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