Mathematical Sciences Letters
An International Journal

http://dx.doi.org/10.18576/msl/100201

Common Fixed Point Theorems Satisfying Common Limit Range Property in the Frame of G_S Metric Spaces

Sahil Arora

Department of Mathematics, K.R.M.D.A.V. College, Nakodar District Jalandhar, Punjab, 144040, India

Received: 21 Dec. 2020, Revised: 5 Feb. 2021, Accepted: 25 Feb. 2021
Published online: 1 May 2021

Abstract: In this manuscript, we explore the presence and uniqueness of common fixed point for four self maps in the context of G_s-metric space via $CLR_{S_3S_4}$ property. Also, several existing results within the frame of b-metric space can easily be deduced from our main results.

Keywords: $CLR_{S_3S_4}$ property, common fixed point, G_s-metric space, weakly compatible maps.

1 Introduction

The approach of fixed point is a powerful tool in the field of analysis. Sims and Mustafa [15] suggested an enhanced version of the generalized metric structure and called it G-metric space. Ding et al. [6] investigated the concept of b-metric space and proved some useful fixed point results for a pair of maps. By combining the perception of G-metric space and b-metric space, [2] gave a new category of metric space known as G_s-metric space which is mathematically equivalent to b-metric space. In 2011, Gopal et al.[7] established common fixed point theorems for weakly compatible generalized fuzzy contractive pair of functions with the aid of E.A property. Subsequently, Tanveer et al.[18] established the uniqueness of common fixed point via E.A. property in the context of modified intuitionistic fuzzy metric spaces. In 2012, Binayak et al.[5] introduced E.A property in the edge of G-metric space and hence developed some results for common fixed point of two functions. Several researchers proved fixed point results on G_s metric space with the assistance of different contractions (see[10],[16],[17],[13]). In 2018, Meitei et al.[14] established fixed point results for weakly compatible map of type (A) in G_s-metric space. In 2019, Kumar et al.[12] established common fixed point theorems in symmetrical G-metric space. In 2020, Arora et al.[3] conferred common fixed point results for modified β-admissible contraction in the edge of metric space. Recently, Arora et al. [4] explore the presence and uniqueness of common fixed point for two pair of functions by utilizing the perception of CLR property in the framework of b-metric spaces.

2 Preliminaries

Definition 1.[2] *Let X be a nonempty set and $s \geq 1$ be a real number. Suppose the function $G : X \times X \times X \to \mathbb{R}^+$ satisfies the following properties:*
(i)$G(x,y,z) = 0$ if and only if $x = y = z$;
(ii)$0 < G(x, x, y)$ whenever $x \neq y$;
(iii)$G(x, x, y) \leq G(x, y, z)$, $y \neq z$;
(iv)$G(x,y,z) \leq s[G(x,\ell,\ell) + G(\ell,y,z)]$, for all $x, y, z, a \in X$;
(v)$G(x, y, z) = G(\rho(x, y, z))$, where ρ is the permutation of x, y and z.
Then, G is known as G_s-metric and the pair (X,G) is called a G_s-metric space.

In 1996, Jungck [9] suggest the perception of weakly compatible maps as follows.

Definition 2.[9] *Two functions $S_1, S_2 : Y \to Y$ are known as weakly compatible if there exists $p \in X$ such that $S_1p = S_2p$ implies that $S_1S_2p = S_2S_1p$.*

In 2002, Moutawakil et al. gave the idea of E.A. property and in 2011, Sintunavarat and Kumam observed that there is no need of closedness in common limit range property. They guarantee the existence of fixed point Theorem with the help of (CLR_Q) property.

* Corresponding author e-mail: drprofsahilarora@gmail.com

Definition 3.[1] *Let (X,G) be G_s-metric space and P,Q be self maps on X. The pair (P,Q) are said to satisfy the E.A. property if there exists a sequence $\{y_n\}$ in X such that* $\lim_{n\to\infty} Py_n = \lim_{n\to\infty} Qy_n = v$ *for some $v \in X$.*

Definition 4.[11] *Let (X,G) be G_s-metric space and P,Q be self maps on X. The pair (P,Q) are said to satisfy the common limit in the range of mappings (CLR_Q) property if there exists a sequence $\{y_n\}$ in X such that* $\lim_{n\to\infty} Py_n = \lim_{n\to\infty} Qy_n = Qv$ *for some $v \in X$.*

*Example 1.*Let (X,G) be G_s-metric space. We define self mappings P and Q on X as $Py = y+5$ and $Qy = 6y$ for each $y \in X$. Let sequence $\{y_n\}$ be defined as $\{y_n\} = \{1+\frac{1}{m}\}$ for each $m \in \mathbb{N}$. Now,

$$\lim_{m\to\infty} Py_n = \lim_{m\to\infty} Qy_n = 6 = Q(1).$$

Therefore, P and Q fulfils (CLR_Q) property.

Definition 5.[8] *Let (X,G) be G_s-metric space and $\{P_\ell\}$, $\{Q_m\}$ be self maps on X. Then, they are pairwise commuting if the following conditions hold:*
(i) $P_\ell P_m = P_m P_\ell$;
(ii) $Q_\ell Q_m = Q_m Q_\ell$;
(iii)$P_\ell Q_m = Q_m P_\ell$.
for each $\ell \in \{1,2,3,\ldots,p\}, m \in \{1,2,3,\ldots,q\}$.

Throughout this paper, we use following notations.
$\sum = \{\sigma/\sigma : \mathbb{R} \to \mathbb{R}$ is upper semi continuous, $\sigma(0) = 0$ and $\sigma(s) < s$ for each $s > 0\}$,
$\Phi = \{\varphi/\varphi : \mathbb{R} \to \mathbb{R}$ is comparison function which is left continuous non decreasing$\}$.

3 Main result

In this section firstly we prove point of coincidence for two pair of functions by utilizing common limit range property. Afterwards we establish uniqueness of common fixed point with the aid of weakly compatibility of two pair of functions. Before starting our main sequel, we need lemma which have a significant role in the proof of our result.

Lemma 1.*Let (X,G) be a G_s-metric space and S_1, S_2, S_3, S_4 be four self maps such that*
(i)$S_1X \subseteq S_4X$ and $S_2X \subseteq S_3X$;
(ii)(S_1,S_3) and (S_2,S_4) share CLR_{S_3} and CLR_{S_4} properties;
(iii)If $\{S_4w_n\}$ converges, then $\{S_2w_n\}$ converges for every sequence $\{w_n\}$ in X;
(iv)S_3X and S_4X are closed in X;
(v)for all $x,y \in X$ and $s \geq 1$, there exists $\varphi \in \Phi$ and $\sigma \in \sum$ such that
$\sigma(s^2G(S_1x,S_2y,S_2y) \leq \sigma(\delta(x,y,y)) - \varphi(\delta(x,y,y))$,
where
$\delta(x,y,y) = max\{G(S_3x,S_4y,S_4y), G(S_3x,S_2y,S_2y), G(S_4y,S_2y,S_2y), G(S_1x,S_3x,S_3x)\}$.
Then, the pairs (S_1,S_3) and (S_2,S_4) satisfies the property $CLR_{S_3S_4}$.

*Proof.*Since (S_1,S_3) satisfy CLR_{S_3} property, we can find a sequence $\{z_n\}$ in X such that

$$\lim_{n\to\infty} S_1z_n = \lim_{n\to\infty} S_3z_n = r,$$

where $r \in S_3X$.
Due to given assumption $S_1X \subset S_3X$, therefore we can find a sequence $\{w_n\}$ in X such that $S_1z_n = S_4w_n$. But S_4 is closed. Therefore,

$$\lim_{n\to\infty} S_4w_n = \lim_{n\to\infty} S_1z_n = r.$$

Now, $S_1z_n \to r$, $S_3z_n \to r$, $S_2z_n \to r$, when $n \to \infty$.
We claim that $\lim_{n\to\infty} S_2w_n = r$.
Substituting $x = z_n$ and $y = w_n$ in the given assumption, we obtain

$$\begin{aligned}\sigma(G(S_1z_n,S_2w_n,S_2w_n) &\leq \sigma(s^2G(S_1z_n,S_2w_n,S_2w_n)\\ &\leq \sigma(\delta(z_n,w_n,w_n)) - \varphi(\delta(z_n,w_n,w_n))\\ &\leq \sigma(\delta(z_n,w_n,w_n)).\end{aligned}$$

where

$$\begin{aligned}\delta(z_n,w_n,w_n) = max\{&G(S_3z_n,S_4w_n,S_4w_n), G(S_3z_n,S_2w_n,S_2w_n),\\ &G(S_4w_n,S_2w_n,S_2w_n), G(S_1z_n,S_3z_n,S_3z_n)\}.\end{aligned}$$

Making $n \to \infty$, we get

$$\begin{aligned}\lim_{n\to\infty} \delta(z_n,w_n,w_n) &= max\{G(r,r,r), G(r,s,s), G(r,s,s), G(r,r,r)\}\\ &= max\{0, G(r,s,s), 0\}\\ &= G(r,s,s).\end{aligned}$$

$\sigma(s^2G(r,s,s)) \leq \sigma(G(r,s,s)$.
Using definition of σ, we obtain
$s^2G(r,s,s) \leq (G(r,s,s)$.
Therefore, $G(r,s,s) = 0$.
So, $r = s$, a contradiction,
which proves that $\lim_{n\to\infty} S_3w_n = r$.
Hence, the pairs (S_1,S_3) and (S_2,S_4) satisfies the property $CLR_{S_3S_4}$.

Theorem 1.*Let (X,G) be a G_s-metric space and S_1, S_2, S_3, S_4 be four self maps such that*
(i)$S_1X \subseteq S_4X$ and $S_2X \subseteq S_3X$;
(ii)(S_1,S_3) and (S_2,S_4) share CLR_{S_3} and CLR_{S_4} properties;
(iii)If $\{S_4w_n\}$ converges, then $\{S_2w_n\}$ converges for every sequence $\{w_n\}$ in X;
(iv)S_3X and S_4X are closed in X;
(v)for all $x,y \in X$ and $s \geq 1$, there exists $\varphi \in \Phi$ and $\sigma \in \sum$ such that
$\sigma(s^2G(S_1x,S_2y,S_2y) \leq \sigma(\delta(x,y,y)) - \varphi(\delta(x,y,y))$,
where
$\delta(x,y,y) = max\{G(S_3x,S_4y,S_4y), G(S_3x,S_2y,S_2y)$,

$G(S_4y,S_2y,S_2y),G(S_1x,S_3x,S_3x)\}$. *If the pairs* (S_1,S_3) *and* (S_2,S_4) *have a point of coincidence. Further, if* (S_1,S_3) *and* (S_2,S_4) *are weakly compatible, then* S_1,S_2,S_3 *and* S_4 *have a unique common fixed point.*

*Proof.*Using the Lemma 1, the pairs (S_1,S_3) and (S_2,S_4) satisfies the property $CLR_{S_3S_4}$. Then, there exists $\{z_n\}$ and $\{w_n\}$ in X and $r\in S_3X\cap S_4X$ such that

$$\lim_{n\to\infty} S_1z_n=\lim_{n\to\infty} S_3z_n=r=\lim_{n\to\infty} S_2w_n=\lim_{n\to\infty} S_4w_n.$$

Now, $S_3X\subset S_4X$. So there exists $s\in X$ such that $S_3s=r$.
We assert that $S_1s=S_3s$.
Substituting $x=s$ and $y=w_n$ in the given assumption, we obtain

$$\begin{aligned}\sigma(G(S_1s,S_2w_n,S_2w_n)&\leq \sigma(s^2G(S_1s,S_2w_n,S_2w_n)\\&\leq \sigma(\delta(s,w_n,w_n))-\varphi(\delta(s,w_n,w_n))\\&\leq \sigma(\delta(s,w_n,w_n)).\end{aligned}$$

where

$$\begin{aligned}\delta(s,w_n,w_n)=max\{&G(S_3s,S_4w_n,S_4w_n),G(S_3s,S_2w_n,S_2w_n),\\&G(S_4w_n,S_2w_n,S_2w_n),G(S_1s,S_3s,S_3s)\end{aligned}$$

Making $n\to\infty$, we get

$$\begin{aligned}\lim_{n\to\infty}\delta(s,w_n,w_n)=max\{&G(r,r,r),G(r,r,r),\\&G(r,r,r),G(S_1s,r,r)\}\\&=max\{0,0,0,G(S_1s,r,r)\}\\&=G(S_1s,s,s).\end{aligned}$$

$\sigma s^2G(S_1s,r,r)\leq\sigma(G(S_1s,r,r))-\varphi(G(S_1s,r,r))$, which shows that $\varphi(G(S_1s,r,r))=0$.
Therefore, $S_1s=r=S_3s$,
which implies that s is coincident point of the pair(S_1,S_3).
Now, we claim that $S_2m=S_4m$.
Since, $r\in S_4X$, therefore there exists $m\in X$ such that $S_4m=r$.
Substituting $x=s$ and $y=m$ in the given assumption, we get

$$\sigma(s^2G(S_1s,S_2m,S_2m)\leq\sigma(\delta(s,m,m))-\varphi(\delta(s,m,m)). \quad (1)$$

where

$$\begin{aligned}\delta(s,m,m)=max\{&G(S_3s,S_4m,S_4m),G(S_3s,S_2m,S_2m),\\&G(S_4m,S_2m,S_2m),G(S_1s,S_3s,S_3s)\}\\&=max\{G(r,r,r),G(r,S_2m,S_2m),\\&G(r,S_2m,S_2m),G(r,r,r)\}\\&=G(r,S_2m,S_2m).\end{aligned}$$

(1) implies that

$$\sigma(s^2G(r,S_2m,S_2m)\leq\sigma(G(r,S_2m,S_2m))-\varphi(G(r,S_2m,S_2m)). \quad (2)$$

Therefore, $\varphi(G(r,S_2m,S_2m))=0$, which implies that $S_2m=r=S_4m$.
Hence, m is coincident point of the pair (S_2,S_4). Since $S_1s=S_3s$ and the pair(S_1,S_3) is weakly compatible. Therefore, $S_1r=S_1S_3s=S_3S_1s=S_3r$.
Now, we claim that r is common fixed point of (S_2,S_3).
Substituting $x=s$ and $y=m$ in the given assumption, we obtain

$$\begin{aligned}\sigma(G(S_1s,S_2m,S_2m)&\leq\sigma(s^2G(S_1s,S_2m,S_2m)\\&\leq\sigma(\delta(s,m,m))-\varphi(\delta(s,m,m)),\end{aligned} \quad (3)$$

where

$$\begin{aligned}\delta(s,m,m)=max\{&G(S_3s,S_4m,S_4m),G(S_3s,S_2m,S_2m),\\&G(S_4m,S_2m,S_2m),G(S_1s,S_3s,S_3s)\}\\&=max\{G(S_1r,r,r),G(S_1r,r,r),\\&G(r,r,r),G(S_1r,r,r)\}\\&=G(S_1r,r,r).\end{aligned}$$

(3) implies that $\varphi(G(S_1r,r,r))=0$. Therefore, $S_1r=r=S_3r$.
So, r is common fixed point of the pair (S_1,S_3).
Analogously, we can prove that
$S_2r=r=S_4r$. So, r is common fixed point of S_1,S_2,S_3 *and* S_4.
Now, we prove the uniqueness of fixed point of S_1. Let us assume that r and n be two common fixed points of S_1,S_2,S_3 *and* S_4. Substituting $x=r$ and $y=n$ in the given assumption, we obtain

$$\begin{aligned}\sigma(G(S_1r,S_2n,S_2n)&\leq\sigma(s^2G(S_1r,S_2n,S_2n)\\&\leq\sigma(\delta(r,n,n))-\varphi(\delta(r,n,n)).\end{aligned} \quad (4)$$

where

$$\begin{aligned}\delta(r,n,n)=max\{&G(S_3r,S_4n,S_4n),G(S_3r,S_2n,S_2n),\\&G(S_4n,S_2n,S_2n),G(S_1r,S_3r,S_3r)\}\\&=max\{G(r,n,n),G(r,r,r),\\&G(n,n,n),G(r,r,r)\}\\&=G(r,n,n).\end{aligned}$$

(2.4) implies that $\varphi(G(r,n,n))=0$. Therefore, $r=n$.
So, r is unique common fixed point of S_1,S_2,S_3 *and* S_4.

Corollary 1.*Let* (X,G) *be a* G_s*-metric space and* S_1 , S_2 *be two self maps such that*
(i)$S_1X\subseteq S_4X$ *and* $S_2X\subseteq S_3X$ *;*
(ii)(S_1,S_3) *and* (S_2,S_4) *share* CLR_{S_3} *and* CLR_{S_4} *properties;*
(iii)If $\{S_4w_n\}$ *converges, then* $\{S_2w_n\}$ *converges for every sequence* $\{w_n\}$ *in* X*;*
(iv)S_3X *and* S_4X *are closed in* X*;*
(v)for all $x,y\in X$ *and* $s\geq 1$*, there exists* $\varphi\in\Phi$ *and* $\sigma\in\sum$ *such that*
$\sigma(s^2G(S_1x,S_1y,S_1y))\leq\sigma(\delta(x,y,y))-\varphi(\delta(x,y,y))$,

where
$\delta(x,y,y) = max\{G(S_2x,S_2y,S_2y), G(S_2x,S_1y,S_1y), G(S_2y,S_1y,S_1y), G(S_1x,S_2x,S_2x)\}$. *If the pair* (S_1,S_2) *satisfies the property* CLR_{S_2}*, then, the pair* (S_1,S_2) *have a point of coincidence. Further if* S_1 *and* S_2 *are weakly compatible, then* S_1 *and* S_2 *have a unique common fixed point.*

Corollary 2. *Let* (X,G) *be a* G_s*-metric space and* S_1*,* S_2*,* S_3*,* S_4 *be four self maps such that*
(i)$S_1X \subseteq S_4X$ *and* $S_2X \subseteq S_3X$ *;*
(ii)(S_1,S_3) *and* (S_2,S_4) *share* CLR_{S_3} *and* CLR_{S_4} *properties;*
(iii)If $\{S_4w_n\}$ *converges, then* $\{S_2w_n\}$ *converges for every sequence* $\{w_n\}$ *in* X*;*
(iv)S_3X *and* S_4X *are closed in* X*;*
(v)for all $x,y \in X$ *and* $s \geq 1$*, there exists* $\varphi \in \Phi$ *and* $\sigma \in \sum$ *such that*
$s^2G(S_1x,S_2y,S_2y) \leq \delta(x,y,y) - \varphi(\delta(x,y,y))$,
where
$\delta(x,y,y) = max\{G(S_3x,S_4y,S_4y), G(S_3x,S_2y,S_2y), G(S_4y,S_2y,S_2y), G(S_1x,S_3x,S_3x)\}$.
If the pairs (S_1,S_3) *and* (S_2,S_4) *have a point of coincidence. Further, if* (S_1,S_3) *and* (S_2,S_4) *are weakly compatible, then* S_1,S_2,S_3 *and* S_4 *have a unique common fixed point.*

Corollary 3. *Let* (X,G) *be a* G_s*-metric space and* S_1 *,* S_2 *be two self maps such that*
(i)$S_1X \subseteq S_4X$ *and* $S_2X \subseteq S_3X$ *;*
(ii)(S_1,S_3) *and* (S_2,S_4) *share (E.A) property;*
(iii)If $\{S_4w_n\}$ *converges, then* $\{S_2w_n\}$ *converges for every sequence* $\{w_n\}$ *in* X*;*
(iv)S_3X *and* S_4X *are closed in* X*;*
(v)for all $x,y \in X$ *and* $s \geq 1$*, there exists* $\varphi \in \Phi$ *and* $\sigma \in \sum$ *such that*
$\sigma(s^2G(S_1x,S_1y,S_1y)) \leq \sigma(\delta(x,y,y)) - \varphi(\delta(x,y,y))$,
where
$\delta(x,y,y) = max\{G(S_2x,S_2y,S_2y), G(S_2x,S_1y,S_1y), G(S_2y,S_1y,S_1y), G(S_1x,S_2x,S_2x)\}$.
If the pair (S_1,S_2) *satisfies the property* CLR_{S_2}*, then, the pair* (S_1,S_2) *have a point of coincidence. Further if* S_1 *and* S_2 *are weakly compatible, then* S_1 *and* S_2 *have a unique common fixed point.*

Corollary 4. *Let* (X,G) *be a* G_s*-metric space and* S_1*,* S_2*,* S_3*,* S_4 *be four self maps such that*
(i)$S_1X \subseteq S_4X$ *and* $S_2X \subseteq S_3X$ *;*
(ii)(S_1,S_3) *and* (S_2,S_4) *share (E.A) property;*
(iii)If $\{S_4w_n\}$ *converges, then* $\{S_2w_n\}$ *converges for every sequence* $\{w_n\}$ *in* X*;*
(iv)S_3X *and* S_4X *are closed in* X*;*
(v)for all $x,y \in X$ *and* $s \geq 1$*, there exists* $\varphi \in \Phi$ *and* $\sigma \in \sum$ *such that*
$s^2G(S_1x,S_2y,S_2y) \leq \delta(x,y,y) - \varphi(\delta(x,y,y))$,
where
$\delta(x,y,y) = max\{G(S_3x,S_4y,S_4y), G(S_3x,S_2y,S_2y), G(S_4y,S_2y,S_2y), G(S_1x,S_3x,S_3x)\}$.
If the pairs (S_1,S_3) *and* (S_2,S_4) *have a point of coincidence. Further, if* (S_1,S_3) *and* (S_2,S_4) *are weakly compatible, then* S_1,S_2,S_3 *and* S_4 *have a unique common fixed point.*

4 Conclusion

In this paper, by merging the concept of b-metric and G-metric space, we prove common fixed point theorems for weakly compatible map via common limit range property in the context of new type of metric space known as G_s-metric space. The significance of CLR property is, it guarantees that we dont need closedness of subspaces. The presented results improve and enhance several existing fixed point results in the literature.

Acknowledgement

The author is extremely thankful to the anonymous referee for a careful checking of the details and for helpful comments that improved this paper.

Conflict of interest

The authors declare no conflicts of interest.

Funding

The authors received no financial support for the research.

References

[1] M. Aamri and D.El Moutawakil, Some new common fixed point theorems under strict contractive conditions, Journal of Mathematical Analysis and Applications **270(1)**, 181–188 (2002).
[2] A. Aghajani, M. Abbas and J. R. Roshan, Common Fixed Point of Generalized Weak Contractive Mappings in Partially Ordered $G_b$metric Spaces, Filomat **28(6)**, 1087-1101 (2014).
[3] S. Arora, M. Kumar and S. Mishra, A New Type of Coincidence and Common Fixed-Point Theorems for Modified α-admissible Z-Contraction Via Simulation Function, Journal of Mathematical and Fundamental Sciences **52(1)**, 27-42 (2020) doi:10.5614/j.math.fund.sci.2020.52.1.3.
[4] S. Arora, S. Mishra, M. Kumar and Heena, Common fixed point theorems for four self-maps satisfying (CLR_{ST})-property in b-metric spaces **1531** 012083, 1-7 (2020) doi:10.1088/1742-6596/1531/1/012083.
[5] B. S. Choudhury, S. Kumar, A. Rani and K. Das, Some fixed point theorems in G-metric spaces, Mathematical Sciences Letters **1(1)**, 25-31 (2012).

[6] H. S. Dinga, M. Imdad, S. Radenovic and J. Vujakovic, On some fixed point results in b-metric, rectangular and b-rectangular metric spaces, Arab Journal of Mathematical Sciences **22(2)**, 151-164 (2016).
[7] D. Gopal, M. Imdad and C. Vetro, Impact of common property (E.A.) on fixed point theorems in fuzzy metric spaces. Fixed Point Theory Appl **297360**, 297-360 (2011).
[8] M. Imdad, J. Ali and M. Tanveer, Coincidence and common fixed point theorems for nonlinear contractions in menger pm spaces, Chaos Solitons Fractals **42**, 3121-3129 (2009).
[9] G. Jungck, Common fixed point for noncontinuous non-self mappings on non metric spaces, Far East Journal of Mathematical Sciences **4(2)**, 199-212 (1996).
[10] B. Khomdram and Y. Rohen, Quadrupled common fixed point theorems in G_b-metric spaces, IJPAM **109(2)**, 279-293 (2016).
[11] P. Kumam and W. Sintunavarat, Common fixed point theorems for a pair of weakly compatible mappings in fuzzy metric spaces, Journal of Applied Mathematics **Article ID 637958**, 1-14 (2016).
[12] M. Kumar, S. Arora, M. Imdad and W.M. Alfaqih, Coincidence and common fixed point results via simulationfunctions in G-metric spaces, Journal of Mathematics and computer science **19**, 288–300 (2019) doi: 10.22436/jmcs.019.04.08
[13] M. Kumar, S. Arora and S. Mishra, On the power of simulation map for almost Z-contraction in G-metric space with applications to the solution of the integral equation, Italian Journal of Pure and Applied Mathematics **44**, 639-648 (2020).
[14] M. K. Meitei, Y. Rohen and R. S. Verma, Some common fixed point theorems for two pairs of weak compatible mappings of type (A) in G_b-metric space, American Journal of Applied Mathematics and Statistics **6(4)**, 135-140 (2018).
[15] Z. Mustafa and B. Sims, A new approach to a generalised metric spaces, Journal of Nonlinear and Convex Analysis **7**, 289-297 (2006).
[16] Z. Mustafa, J. R. Roshan and V. Parvaneh, Existence of a tripled coincidence point in ordered G_b-metric spaces and applications to a system of integral equations, Journal of Inequalities and Applications **453**, 12 pages (2013).
[17] S. Sedghi, N. Shobkolaei, J. R. Roshan and W. Shatanawi, Coupled fixed point theorems in G_b-metric spaces, Matematiki Vesnik **66(2)**, 190-201 (2014).
[18] M. Tanveer, M. Imdad, D. Gopal and D.K. Patel, Common fixed point theorems in modified intuitionistic fuzzy metric spaces with common property (E.A.), Fixed Point Theory and Applications **36** (2012).