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A Common Fixed Point Theorem For Generalized (ψ, ϕ) Contraction In Complete B-Metric Spaces

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Abstract: In this paper, we obtain a common fixed point result for weakly compatible mapping in b-metric like spaces. We generalize and extend various fixed point theorems of the literature. In addition, we attempt to make some important conclusions for the established result.
Mathematics Subject Classification: 47H10, 54H25.

Keywords: coincidence point • weakly compatible • common fixed point • b-metric like space

Introduction and Preliminaries

Mathews (1994) introduced a generalization of the metric space, popularly known as partial metric space, in which self-distance may be non-zero. Harandi (2012) further generalized this notion by introducing a new space named the metric-like-space.in which the self-distance of a point may be greater than the distance of that point to any other point. Meanwhile, Alghamdi et al. (2013) introduced the concept of b-metric-like spaces that generalized the notions of partial b-metric space and metric-like space. Afterwards, Shukla (2014), also introduced an idea of the partial b-metric which generalizes of the partial metric and b-metric, altogether.

Zoto et. al. (2017) established some fixed point theorems in generalized $(\alpha - \psi, \phi)$ contractions in b- metric-like spaces. Also, Guan and Li (2021) proved some common fixed point results for generalized (ψ, ϕ) weakly contractive mappings in b-metric like spaces. Besides, many authors developed various fixed point results in metric-like spaces and generalized metric-like spaces (Aydi et al. 2017, Chen et al. 2015, Guan et al.2021 , Hammad et al. 2019, Harandi 2012, Hussain et al. 2014, Sen et al. 2019 , Shah 2022), Sumalai et al.2019), Zoto et al. 2018,2019).

We define the following class of functions.

1. $\Psi = \{\psi: [0, +\infty) \to [0, +\infty)$ is continuous and non-decreasing with $\psi(t) = 0$ if and only if $t = 0\}$
2. $\Phi = \{\phi: [0, +\infty) \to [0, +\infty)$ is lower semi continuous with $\phi(t) > 0$ for all $t > 0$ and $\phi(0) = 0\}$.

Now we recall some important definitions and other consequences from the availed literature. The notion of metric-like space due to A. Harandi is defined as follows:

Definition 1.1 (Harandi (2012) *Let* X *be a non-empty set. Then, a mapping* $d: X \times X \to [0,\infty)$ *is said to be a metric-like if for all* $x, y, z \in X$,

1. $d(x,y) = 0 \Rightarrow x = y$;
2. $d(x,y) = d(y,x)$;
3. $d(x,z) \leq d(x,y) + d(y,z)$.

Then, the pair (X,d) is known as metric- like space.

Alghamdi et al. (2013) defined the concept of b-metric like space as follows:

Definition 1.2 (Alghamdi et al., 2013) *Let* X *be a non-empty set. Then, a mapping* $d: X \times X \to [0,\infty)$ *is said to be a* b*-metric- like if there exists a number* $s \geq 1$ *such that for all* $x, y, z \in X$,

1. $d(x,y) = 0 \Rightarrow x = y$;
2. $d(x,y) = d(y,x)$;
3. $d(x,z) \leq s[d(x,y) + d(y,z)]$.

Then, the pair (X,d) is known as b- metric- like space.

Definition 1.3 (Alghamdi et al. ,2013) *Let* (X,d) *be a b-metric like space with parameter* $s \geq 1$ *and* $\{x_n\}$ *be a sequence in* X.

1. The sequence $\{x_n\}$ is said to be convergent to x if
$$\lim_{n\to+\infty} d(x_n, x) = d(x,x).$$
2. The sequence $\{x_n\}$ is said to be Cauchy sequence if and only if
$$\lim_{n\to+\infty} d(x_n, x_m)$$
exists and is finite.
3. (X,d) is said to be complete iff for every Cauchy sequence $\{x_n\}$ in X, there exists an $x \in X$ such that
$$\lim_{n,m\to+\infty} d(x_n, x_m) = \lim_{n\to+\infty} d(x_n, x) = d(x,x).$$

Lemma 1.1 (Sen et al., 2019) *Let* $(X, d, s \geq 1)$ *be a b-metric-like spaces and* $\{x_n\}$ *be a sequence in* X *such that*
$$d(x_n, x_{n+1} \leq \lambda d(x_{n-1}, x_n),$$
for some $\lambda \in [0,1)$ and for each $n \in \mathbb{N}$. Then $\{x_n\}$ is a Cauchy sequence with
$$\lim_{n,m\to+\infty} d(x_n, x_m) = 0.$$

Lemma 1.2 (Alghamdi et al., 2013)) *let* (X,d) *be a b-metric like space with* $s \geq 1$. *We assume that* $\{x_n\}$ *and* $\{y_n\}$ *are convergent to* x *and* y, *respectively. Then , we have*

$$\frac{1}{s^2}d(x,y) - \frac{1}{s}d(x,x) - d(y,y) \leq \liminf_{n\to+\infty} d(x_n,y_n)$$
$$\leq \limsup_{n\to+\infty} d(x_n,y_n)$$
$$\leq sd(x,x) + s^2d(y,y) + s^2d(x,y).$$

In particular, if $d(x,y)=0$, then we have $\lim_{n\to+\infty} d(x_n,y_n)=0$. Moreover, for each $z \in X$, we have

$$\frac{1}{s}d(x,z) - d(x,x) \leq \liminf_{n\to+\infty} d(x_n,z) \leq \limsup_{n\to+\infty} d(x_n,z), \leq sd(x,z) + sd(x,x).$$

Also, if $d(x,x)=0$ then

$$\frac{1}{s}d(x,z) \leq \liminf_{n\to+\infty} d(x_n,z) \leq \limsup_{n\to+\infty} d(x_n,z) \leq sd(x,z).$$

Lemma 1.3 (Zoto et al., 2017) *Let* (X,d) *be a b-metric like space with* $s \geq 1$. *Then,*

1. If $d(x,y)=0$ then $d(x,x)=d(y,y)=0$.
2. If $\{x_n\}$ is a sequence such that $\lim_{n\to+\infty} d(x_n,x_{n+1})=0$, then we have $\lim_{n\to+\infty} d(x_n,x_n) = \lim_{n\to+\infty} d(x_{n+1},x_{n+1}) = 0$
3. If $x \neq y$ then $d(x,y) > 0$.

In the next section, we state and prove a common fixed point result for generalized (ψ,ϕ) weak contraction in a complete b-metric like space by using the notion of weakly compatible.

Main Results

Theorem 2.1 *Let* (X,d,s) *be a complete b-metric like space and let* $S,T: X \to X$ *be two self mappings satisfying* $T(X) \subseteq S(X)$, *where* $S(X)$ *is a closed subset of* X. *If there are functions* $\psi \in \Psi$ *and* $\phi \in \Phi$ *such that for all* $x,y \in X$,

$$\psi(s^2d(Tx,Ty)) \leq \psi(M_1(x,y)) - \phi(N_1(x,y)), \tag{2.1}$$

where

$$M_1(x,y) = \max\left\{\begin{array}{l} d(Ty,Sy)\left(\frac{1+d(Sx,Tx)}{1+d(Sx,Sy)}\right), d(Tx,Sx), d(Sx,Sy), \\ \frac{1}{2s}[d(Ty,Sy)+d(Tx,Sx)], d(Tx,Sx)\left(\frac{1+d(Sx,Sy)}{1+d(Ty,Sy)}\right) \end{array}\right\}$$

and

$$N_1(x,y) = \max\{d(Ty,Sy), d(Tx,Ty), d(Tx,Sy), d(Sx,Sy)\}.$$

Then S and T have a unique coincidence point in X. Moreover, S and T have a unique common fixed point provided that S and T are weakly compatible.

Proof. Let $x_0 \in X$ be an arbitrary. As $T(X) \subseteq S(X)$, there exists $x_1 \in X$ such that $Tx_0 = Sx_1$. Now, we define sequences $\{x_n\}$ and $\{y_n\}$ in X by $y_n = Tx_n = Sx_{n+1}$, for all $n \in \mathbb{N}$. If $y_n = y_{n+1}$ for some $n \in \mathbb{N}$, then we have $y_n = y_{n+1} = Tx_{n+1} = Sx_{n+1}$ and T and S have a coincidence point.

Without loss of generality we assume that $y_n \neq y_{n+1}$. By Lemma 1.3, we have $d(y_n, y_{n+1}) > 0$ for all $n \in \mathbb{N}$. Apply 2.1 with $x = x_n$ and $y = x_{n+1}$, we obtain

$$\psi(s^2 d(y_n, y_{n+1})) = \psi(s^2 d(Tx_n, Tx_{n+1}))$$
$$\leq \psi(M_1(x_n, x_{n+1})) - \phi(N_1(x_n, x_{n+1})).$$

Here,

$$M_1(x_n, x_{n+1}) = \max \left\{ \begin{array}{l} d(y_{n+1}, y_n)\left(\frac{(1+d(y_{n-1}, y_n))}{1+d(y_n, y_{n+1})}\right), \\ d(y_n, y_{n-1}), d(y_{n-1}, y_n), \\ \frac{1}{2s}[d(y_n, y_{n+1}) + d(y_n, y_{n-1})], \\ d(y_{n+1}, y_n)\left(\frac{(1+d(y_n, y_{n-1}))}{1+d(y_{n+1}, y_n)}\right) \end{array} \right\},$$

and

$$N_1(x_n, x_{n+1}) = \max\{d(y_{n+1}, y_n), d(y_n, y_{n+1}), d(y_n, y_n), d(y_{n-1}, y_n)\}.$$

If $d(y_n, y_{n+1}) \geq d(y_n, y_{n-1}) > 0$, then $M_1 \leq d(y_{n+1}, y_n)$ and $N_1 \geq d(y_{n+1}, y_n)$. Now,

$$\psi(d(y_n, y_{n+1})) \leq \psi(s^2 d(y_n, y_{n+1}))$$
$$\leq \psi(M_1(x_n, x_{n+1})) - \phi(N_1(x_n, x_{n+1}))$$
$$\leq \psi(d(y_n, y_{n+1})) - \phi(d(y_{n+1}, y_n)),$$

which gives that $d(y_n, y_{n+1}) = 0$, a contradiction. Thus $d(y_n, y_{n+1}) > 0$. It follows that $d(y_n, y_{n+1}) < d(y_n, y_{n-1})$. Hence $\{d(y_n, y_{n+1})\}$ is a non-increasing sequence.

Consequently, the limit of the sequence is a non-negative say $r \geq 0$. That is $\lim_{n\to\infty} d(y_n, y_{n+1}) = r$. Therefore

$$M_1(x_n, x_{n+1}) \leq d(y_n, y_{n-1})$$
$$N_1(x_n, x_{n+1}) \geq d(y_n, y_{n-1}),$$

so,

$$\psi(d(y_n, y_{n+1})) \leq \psi(s^2 d(y_n, y_{n+1}))$$
$$\leq \psi(s^2 d(Tx_n, Tx_{n+1}))$$
$$\leq \psi(M_1(x_n, x_{n+1})) - \phi(N_1(x_n, x_{n+1}))$$

$$\leq \psi(d(y_n, y_{n-1})) - \phi(d(y_n, y_{n-1})).$$

If $r > 0$, then letting $n \to \infty$ in above inequalities, we obtain that $\psi(r) \leq \psi(r) - \phi(r) \Rightarrow r = 0$. That is $\lim_{n\to\infty} d(y_n, y_{n+1}) = 0$.

Now we prove that $\lim_{n,m\to\infty} d(y_n, y_m) = 0$. If not, there exists $\epsilon > 0$ for which, we can find sequences $\{y_{mk}\}$ and $\{y_{nk}\}$ of $\{y_n\}$, so that n_k is the smallest index for which $n_k > m_k > k$, $\epsilon \leq d(y_{m_k}, y_{n_k})$ and $d(y_{m_k}, y_{n_k-1}) < \epsilon$. In view of triangle inequalities in b-metric like space the following inequalities hold:

$$\epsilon \leq \limsup_{k\to\infty} d(y_{m_k}, y_{n_k}) \leq s\epsilon,$$
$$\frac{\epsilon}{s} \leq \limsup_{k\to\infty} d(y_{m_k}, y_{n_k-1}) \leq \epsilon,$$
$$\frac{\epsilon}{s} \leq \limsup_{k\to\infty} d(y_{m_k-1}, y_{n_k}) \leq s^2\epsilon,$$
$$\frac{\epsilon}{s^2} \leq \limsup_{k\to\infty} d(y_{m_k-1}, y_{n_k-1}) \leq s\epsilon.$$

Also, we find

$$M_1(x_{m_k}, x_{n_k}) = \max \begin{Bmatrix} d(Tx_{n_k}, Sx_{n_k})\left(\frac{1+d(Sx_{m_k},Tx_{m_k})}{1+d(Sx_{m_k},Sx_{n_k})}\right), \\ d(Tx_{m_k}, Sx_{m_k}), d(Sx_{m_k}, Sx_{n_k}) \\ \frac{1}{2s}[d(Tx_{n_k}, Sx_{n_k}) + d(Tx_{m_k}, Sx_{m_k})], \\ d(Tx_{m_k}, Sx_{m_k})\left(\frac{1+d(Sx_{m_k},Sx_{n_k})}{1+d(Tx_{n_k},Sx_{n_k})}\right) \end{Bmatrix}$$

$$= \max \begin{Bmatrix} d(y_{n_k}, y_{n_k-1})\left(\frac{1+d(y_{m_k-1},y_{m_k})}{1+d(y_{m_k-1},y_{n_k-1})}\right), \\ d(y_{m_k}, y_{m_k-1}), d(y_{m_k-1}, y_{n_k-1}), \\ \frac{1}{2s}[d(y_{n_k}, y_{n_k-1}) + d(y_{m_k}, y_{m_k-1})], \\ d(y_{m_k}, y_{m_k-1})\left(\frac{1+d(y_{m_k-1},y_{n_k-1})}{1+d(y_{n_k},y_{n_k-1})}\right) \end{Bmatrix},$$

and

$$N_1(x_{m_k}, x_{n_k}) = \max \begin{Bmatrix} d(Tx_{n_k}, Sx_{n_k}), d(Tx_{m_k}, Tx_{n_k}), \\ d(Tx_{m_k}, Sx_{n_k}), d(Sx_{m_k}, Sx_{n_k}) \end{Bmatrix}$$
$$= \max \begin{Bmatrix} d(y_{n_k}, y_{n_k-1}), d(y_{m_k}, y_{n_k}), \\ d(y_{m_k}, y_{n_k-1}), d(y_{m_k-1}, y_{n_k-1}) \end{Bmatrix}.$$

Thus, using above four inequalities, we have

$$\limsup_{k\to\infty} M_1(x_{m_k}, x_{n_k}) \leq \max\{0,0,s\epsilon,0,0\} \leq s\epsilon.$$

$$\liminf_{k\to\infty} N_1(x_{m_k}, x_{n_k}) \geq \max\left\{0, \epsilon, \frac{\epsilon}{s}, \frac{\epsilon}{s^2}\right\} \geq \frac{\epsilon}{s^2}.$$

Taking $x = x_{m_k}$ and $y = x_{n_k}$ in equation 2.1, we get

$$\psi(d(y_{m_k}, y_{n_k})) \leq \psi(s^2 d(y_{m_k}, y_{n_k}))$$
$$\leq \psi(s^2 d(Tx_{m_k}, Tx_{n_k}))$$
$$\leq \psi(M_1(x_{m_k}, x_{n_k})) - \phi(N_1(x_{m_k}, x_{n_k}))$$
$$\leq \psi(d(y_n, y_{n-1})) - \phi(d(y_n, y_{n-1})).$$

So, we find

$$\psi(s\epsilon) \leq \psi(s \lim_{k\to\infty} \sup d(Tx_{m_k}, Tx_{n_k}))$$
$$\leq \psi(s^2 \lim_{k\to\infty} \sup d(Tx_{m_k}, Tx_{n_k}))$$
$$\leq \psi(\lim_{k\to\infty} \sup M_1(x_{m_k}, x_{n_k})) - \phi(\lim_{k\to\infty} \inf N_1(x_{m_k}, x_{n_k}))$$
$$\leq \psi(s\epsilon) - \phi(\lim_{k\to\infty} \inf N_1(x_{m_k}, x_{n_k})),$$

and we conclude that $\lim_{k\to\infty} \inf N_1(x_{m_k}, x_{n_k}) = 0$, otherwise it gives a contradiction to $\lim_{k\to\infty} \inf N_1(x_{m_k}, y_{n_k}) \geq \frac{\epsilon}{s^2}$. Hence $\lim_{n,m\to\infty} d(y_n, y_m) = 0$.

As X is complete so there exists $u \in X$, such that

$$\lim_{n\to\infty} d(y_n, u) = \lim_{n\to\infty} d(Tx_n, u) = \lim_{n\to\infty} d(Sx_{n+1}, u) = \lim_{n,m\to\infty} d(y_n, y_m) = d(u, u) = 0.$$

Since $S(X)$ is closed, we obtain that $u \in S(X)$. Therefore, one can choose $z \in X$ such that $u = Sz$ and above equality becomes

$$\lim_{n\to\infty} d(y_n, Sz) = \lim_{n\to\infty} d(Tx_n, Sz) = \lim_{n\to\infty} d(Sx_{n+1}, Sz) = 0.$$

If $Tz \neq Sz$, by putting $x = x_n$ and $y = z$ in equation 2.1, we get

$$\psi(s^2 d(Tx_n, Tz)) \leq \psi(M_1(x_n, z)) - \phi(N_1(x_n, z)),$$

where

$$M_1(x_n, z) = \max \begin{Bmatrix} d(Tz, Sz)\left(\frac{1+d(Sx_n, Tx_n)}{1+d(Sx_n, Sz)}\right), d(Tx_n, Sx_n), \\ d(Sx_n, Sz), \frac{1}{2s}[d(Tz, Sz) + d(Tx_n, Sx_n)], \\ d(Tx_n, Sx_n)\left(\frac{1+d(Sx_n, Sz)}{1+d(Tz, Sz)}\right) \end{Bmatrix}$$

and

$$N_1(x_n, z) = \max\{d(Tz, Sz), d(Tx_n, Tz), d(Tx_n, Sz), d(Sx_n, Sz)\}.$$

Consequently, we get

$$\lim_{k\to\infty} \sup M_1(x_n, z) = \max \begin{Bmatrix} d(Tz, Sz)\left(\frac{1+d(y_{n-1}, y_n)}{1+d(y_{n-1}, Sz)}\right), 0, \frac{1}{2s} d(Tz, Sz), \\ d(y_n, y_{n-1})\left(\frac{1+d(y_{n-1}, Sz)}{1+d(Tz, Sz)}\right) \end{Bmatrix}$$
$$\leq \max \begin{Bmatrix} d(Tz, Sz)\left(\frac{1}{1+d(y_{n-1}, Sz)}\right), 0, \\ \frac{1}{2s} d(Tz, Sz), 0 \end{Bmatrix}$$
$$\leq d(Tz, Sz),$$

and

$$\liminf_{k\to\infty} N_1(x_n, z) = \max\{d(Tz,Sz), d(y_n,Tz), 0, d(y_{n-1},Sz)\}$$
$$\geq \max\{d(Tz,Sz), d(y_n,Tz), d(y_{n-1},Sz)\}$$
$$\geq d(Tz,Sz).$$

Taking the upper limit as k tends to ∞, we have

$$\psi(d(Sz,Tz)) = \psi(s^2 \tfrac{1}{s^2} d(Sz,Tz))$$
$$\leq \psi(s^2 \limsup_{k\to\infty} d(Tx_{n_k}, Tz))$$
$$\leq \psi(\limsup_{k\to\infty} M_1(x_{n_k}, z)) - \phi(\liminf_{k\to\infty} N_1(x_{n_k}, z))$$
$$\leq \psi(d(Sz,Tz)) - \phi(d(Sz,Tz)),$$

which implies $\phi(d(Sz,Tz)) = 0.$ It follows that $d(Sz,Tz) = 0$. That is $u = Sz = Tz$ is a point of coincidence of S and T.

We also conclude that the point of coincidence is unique. Let v be another coincidence point with $z \neq v$ such that $Sv = Tv$. Put $x = z$ and $y = v$ in equation 2.1, we obtain

$$\psi(s^2 d(Tz,Tv)) \leq \psi(M_1(z,v)) - \phi(N_1(z,v)),$$

where

$$M_1(z,v) = \max\left\{\begin{matrix} d(Tv,Sv)\left(\frac{1+d(Sz,Tz)}{1+d(Sz,Sv)}\right), d(Tz,Sz), d(Sz,Sv), \\ \frac{1}{2s}[d(Tv,Sv) + d(Tz,Sz)], d(Tz,Sz)\left(\frac{1+d(Sz,Sv)}{1+d(Tv,Sv)}\right) \end{matrix}\right\}$$

and

$$N_1(z,v) = \max\{d(Tv,Sv), d(Tz,Tv), d(Tz,Sv), d(Sz,Sv)\}.$$

Consequently, we get

$$\limsup_{k\to\infty} M_1(z,v) = \max\left\{\begin{matrix} d(Tv,Sv)\left(\frac{1}{1+d(Sz,Sv)}\right), 0, \\ d(Sz,Sv), \frac{1}{2s} d(Tv,Sv), 0 \end{matrix}\right\}$$
$$\leq \max\left\{\begin{matrix} d(Tv,Sv)\left(\frac{1}{1+d(Sz,Sv)}\right), \\ d(Tz,Tv), \frac{1}{2s} d(Tv,Sv) \end{matrix}\right\}$$
$$\leq d(Tz,Tv),$$

and

$$\liminf_{k\to\infty} N_1(z,v) = \max\{d(Tv,Sv), d(Tz,Tv), d(Tz,Sv), d(Sz,Sv)\}.$$
$$\geq \max\{d(Tv,Sv), d(Tz,Tv), d(Tz,Tv), d(Tz,Tv)\}.$$
$$\geq d(Tz,Tv).$$

Taking the upper limit as k tends to ∞, we have

$$\psi(d(Tz,Tv)) = \psi(s^2 d(Tz,Tv))$$
$$\leq \psi(\limsup_{k\to\infty} M_1(z,v)) - \phi(\liminf_{k\to\infty} N_1(z,v))$$

$$\leq \psi(d(Tz, Tv)) - \phi(d(Tz, Tv)),$$

which implies $\phi(d(Tz, Tv)) = 0$. It follows that $d(Tz, Tv) = 0$.

We see easily that if S and T are weakly compatible, z is a unique common fixed point of T and S.

According to Theorem 2.1 we can get the following results.

Corollary 2.1 *Let* (X, d, s) *be a complete b-metric like space with constant* $s \geq 1$ *and let* $T, S: X \to X$ *be given self mappings with* $T(X) \subset S(X)$, *where* $S(X)$ *is closed subset of* X. *If the following condition is satisfied:*

$$s^2[d(Tx, Ty)] \leq M_1(x, y) - L\, d(Sx, Sy),$$

where $L \in (0,1)$ represents a constant. Then T and S have a unique coincidence point in X. Moreover, T and S have a unique common fixed point provided that T and S are weakly compatible.

Corollary 2.2 *Let* (X, d, s) *be a complete b-metric like space with constant* $s \geq 1$ *and suppose* $T, S: X \to X$ *be given self mappings with* $T(X) \subset S(X)$, *where* $S(X)$ *is closed subset of* X. *If the following condition is satisfied:*

$$s^2[d(Tx, Ty)] \leq M_1(x, y) - N_1(x, y),$$

then T and S have a unique coincidence point in X. Moreover, T and S have a unique common fixed point provided that T and S are weakly compatible.

References

Alghamdi MA, Hussain N and Salimi P (2013) Fixed point and coupled fixed point theorems on b-metric-like spaces. J. Inequal. Appl. 2013(1): 1- 25.

Aydi H, Felhi A and Afshari H (2017) New Geraghty type contractions on metric-like spaces. Journal of Nonlinear Sciences & Applications (JNSA). 10(2).

Aydi H, Felhi A and Sahmim S (2017) Common fixed points via implicit contractions on b-metric-like spaces. Journal of Nonlinear Sciences & Applications (JNSA). 10(4).

Chen C, Dong J and Zhu C (2015) Some fixed point theorems in b-metric-like spaces. Fixed Point Theory and Applications. 2015.

Guan H and Li J (2021) Common fixed point theorems of generalized ($\psi - \phi$)-weakly contractive mappings in b- metric-like spaces and application. Journal of Mathematics. 2021: 1-14.

Hammad HA and De la Sen M (2019) Generalized contractive mappings and related results in b-metric like spaces with an application. Symmetry. 11(5): pp. 667.

Harandi A (2012) Metric-like spaces, partial metric spaces and fixed points. Fixed Point Theory and Applications. 2012: 1- 10.

Hussain N, Roshan JR, Parvaneh V and Kadelburg Z (2014) Fixed points of contractive mappings in b- metric- like space. The Scientific World Journal. 2014.

Mathews SG (1994) Partial metric topology. Annals of the New York Academy of Sciences. 728(1): 183-197.

Sen M, Nicolic N, Dosenovic T, Pavlovic M and Radenovic S (2019) Some results on (s-q)-graphic contraction mapping in b-metric-like spaces. Mathematics. 7(12): pp. 1190.

Shah R (2022) Some new fixed point results in b- metric- like spaces. Palestine Journal of Mathematics. 11(1): 378-384.

Shukla S (2014) Partial b- metric spaces and fixed point theorems. Mediterranean Journal of Mathematics. 11: 703-711.

Sumalai P, Kumam P, Gopal D and Hasan M (2019) Common fixed point theorems in fuzzy metric-like spaces employing common property (ea). Mathematical Methods in the Applied Sciences. 42(17): 5834- 5844.

Zoto K, Radenovic S and Ansari AH (2018) On some fixed point results for (s, p, α) -contractive mappings in b-metric-like spaces and applications to integral equations. Open Mathematics. 16(1): 235- 249.

Zoto K, Rhoades BE and Radenovic S (2017) Some generalizations for ($\tilde{\psi}, \phi$) - contractions in b-metric-like spaces and an application. Fixed Point Theory and Applications. 2017(1): 1- 20.

Zoto K, Rhoades BE and Radenovic S (2019) Common fixed point theorems for a class of (s, q)-contractive mappings in b-metric-like spaces and applications to integral equations. Mathematica Slovaca. 69 (1): 233- 247.

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