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A COMMON FIXED POINT THEOREM IN INTUITIONISTIC MENGER (PQM) SPACE WITH USING PROPERTY (E.A.)

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ABSTRACT

In this paper, we prove a common fixed point theorem in intuitionisic menger space with using property E.A. also it a generalization of a result.

Mathematics subject classification: *47A62, 47A63.*

Keywords*: fixed point, common fixed point, fuzzy set, fuzzy metric space instutionistic menger space.*

1. INTRODUCTION

There have been various speculations of metric space. One such speculation is Menger space presented in 1942 by Menger [102] who utilized dispersion capacities rather than nonnegative genuine numbers as estimations of the metric. Indeed, he supplanted the separation capacity d: X×X→R+ with a conveyance capacity F_(p, q): R→ [0,1] wherein for any number x, the quality F_(p,q) (x) portrays the likelihood that the separation amongst p and q is not exactly. Aamri and Moutawakil [4] and Liu *et al.* [99] individually characterized the property (E.A) and basic property (E.A) and demonstrated some normal settled point hypotheses in metric spaces. Imdad *et al.* [72] developed the aftereffects of Aamri and Moutawakil [4] to semi-metric spaces. Most as of late, Kubiaczyk and Sharma [90] characterized the property (E.A) in PM spaces and utilized the same to demonstrate a few results on basic altered focuses wherein creators guarantee their outcomes for strict withdrawals which are in truth demonstrated for compressions.

Kutukcu *et. al* characterized the thought of intuitionistic Menger spaces with the assistance of t-standards and t−conorms as a speculation of Menger spaces due to Menger .On the other hand Rezaiyan *et al.* demonstrate altered point hypothesis for Menger (PQM) space which is changed by Mihet

The point of this section is to demonstrate an altered point hypothesis in Intuitionistic Menger (PQM) space utilizing property E.A. for this first we give a few definitions and known results which are utilized as a part of this section.

Definition 1.1: "A binary operation T: [0,1] × [0,1] → [0,1], is a t-norm if T satisfies the following conditions:
1.1 (i) T is commutative and associative.
1.1 (ii) $T(a, 1) = a$ for all $a \in [0,1]$.
1.1 (iii) $T(a, b) \leq T(c, d)$ whenever $a \leq c$ and $b \leq d$
For $a, b, c, d \in [0,1]$. "

Definition 1.2: "A binary operation $S : [0, 1] \times [0, 1] \to [0, 1]$ is a t−conorm if S satisfies the following conditions:
1.2 (i) S is commutative and associative.
1.2 (ii) $S(a, 0) = a$ for all $a \in [0, 1]$
1.2 (iii) $S(a, b) \leq S(c, d)$ whenever $a \leq c$ and $b \leq d$
For $a, b, c, d \in [0,1]$."

Remark 1.3: The ideas of t−norm T and t−conorm S are known as the proverbial skeletons that we use for portraying fuzzy crossing points and unions individually. All through this paper, we will mean R= (- ∞, ∞) and R^+ = [0, ∞).

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Definition 1.4: A separation circulation capacity is a capacity F: R→R^+, which is left constant on R, non-diminishing and inf_(t∈R) F(t) = 0, sup_(t ∈ R) F(t) = 1. We will mean by D, the group of all separation dispersion capacities and by H an extraordinary component of D characterized by

$$\text{“H(t)} = \begin{cases} 0, & \text{if } t \le 0 \\ 1, & \text{if } t > 0 \end{cases}$$

In the event that X is a nonempty set, F: X×X→D is known as a probabilistic separation on X.”

Definition 1.5: A non-separation appropriation capacity is a capacity L: R→R^+, which is correct consistent on R, non-expanding and 〖inf〗(t∈R) L(t) =1, sup_(t∈R) L(t) = 0.

We will indicate by E, the group of all non-separation appropriation capacities and by G a unique component of E characterized by

$$\text{"G(t)} = \begin{cases} 1, & \text{if } t \le 0 \\ 0, & \text{if } t > 0 \end{cases}$$

In the event that X is a nonempty set, L: X×X→D is known as a probabilistic non-separation on X. “

Definition 1.6: A triple (X, F, L, T, S) is said to be an intuitionistic Menger (PQM) space if X is a nonempty set, F is a probabilistic separation and L is probabilistic non-separation on X fulfilling the accompanying conditions:

For all a, b, c ∈ X and x, y > 0

- F_(a, b) (x) + L_(a, b) (x)≤1
- F_(a, b) (x) = 0
- F_(a, b) (x)=H(x)for all x>0 if and just if a = b
- F_(a, b) (x) = F_(b,a) (x)
- L_(a, b) (0) = 1
- L_(a, b) (x) = G(x) for all x > 0 if and just if a = b
- L_(a, b) (x) = L_(b, a) (x)

On the off chance that moreover, we have the triangle imbalances:

- F_(a, b) (x+y) ≥ T(F_(a, c) (x),F_(c, b) (y)).
- L_(a, b) (x+y) ≤ S(L_(a, c) (x),L_(c, a) (x)).

Here T is a t-norm and S is a t−conorm. At that point (X , F, L, T, S) is said to be an intuitionistic Menger (PQM) space. The capacities F_(a, b) (x) and L_(a, b) (x) signify the level of proximity and level of non-closeness amongst a and b as for x separately.

Remark 1.7: Every Menger (PQM) space (X, F, T) is an intuitionistic Menger (PQM) space of the structure (X, F, 1-F, T, S) with the end goal that t−norm T and t−conorm S are related i.e.

S(a, b)= 1 - T(1 - a,1 - b) for any a, b∈ X.

Illustration 1.8: (Induced intuitionistic Menger (PQM) space) Let (X, d) be a metric space. At that point the metric d actuates a separation appropriation capacity F characterized by

F_(a, b) (x)= H(x - d(a,b))

what's more, a non-separation circulation capacity L characterized by

L_(a, b) (x) = G(x - d(a, b)) for all a, b, ∈ X and x ≥ 0.

At that point (X, F, L) is an intuitionistic Menger (PQM) space.

We call this intuitionistic Menger (PQM) space actuated by a metric d the incited intuitionistic Menger (PQM) space. On the off chance that t-norm T is T(x ,y)=min{x,y} and t−conorm S is S(x,y)=min{1,x+y} for each of the x, y belogs [0 ,1], then (X,F,L,T_M ,S_M) is an intuitionistic Menger (PQM)space.

Definition1.10: “Let (X, F, L, T, S) be an Intuitionistic Menger (PQM) space.

(i) An arrangement 〖{x〗_n} in X is said to be joined to x in X, if for each ε> 0, λ> 0, there exists positive whole number N with the end goal that

F_(x_n,x) (ε)> 1-λ and L_(x_n,x) (ε)< λ at whatever point n≥N.

We compose x_(n)→ x as n→∞ or lim┬(n→∞) x_n=x."

Lemma 1.11: "Let (X, F, L, T, S) be an intuitionistic Menger space. If there is a constant $k \in (0,1)$ such that for $x, y \in X$, $t > 0$,

1. $F_{x,y}(kt) \geq F_{x,y}(t)$ and $L_{x,y}(kt) \leq L_{x,y}(t)$, then $x = y$."
2. Then $F_{x,y}(t)$ and $L_{x,y}(t)$ are continuous functions on $X \times X \to (0, \infty)$."
3. such that the t-norm T and t−conorm S is continuous and P, Q be mappings from X into itself. Then, P and Q are said to be compatible if

$$\lim_{n\to\infty} F_{PQx_n,QPx_n}(x) = 1 \text{ and } \lim_{n\to\infty} L_{PQx_n,QPx_n}(x) = 0 \text{ for all } x > 0,$$

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

$$\lim_{n\to\infty} Px_n = \lim_{n\to\infty} Qx_n = z \text{ for some } z \in X."$$

Definition 1.13: **"**Two self mappings P and Q are said to be weakly compatible if they commute at their coincidence points that is $Px = Qx$.

For some $x \in X$ implies

$$PQx = QPx."$$

Definition 1.14: **"**Let P and Q be two self mappings of a Menger space (X, F, L, T, S). We say that P and Q satisfy the property (E.A) if there exists a sequence $\{x_n\}$ in X such that

$$\lim_{n\to\infty} Px_n = \lim_{n\to\infty} Qx_n = z \quad \text{for some } z \in X."$$

Example 1.16: Let A= $[0, +\infty)$. Define X,Y: A → A by

$$Aa = \frac{5a}{6} \text{ and } a = \frac{3a}{4}, \forall a \in A$$

Consider the sequence $a_n = \frac{1}{n}$.Clearly

$$\lim_{n\to\infty} a_n = Xa_n = \lim_{n\to\infty} a_n = Ya_n = 0$$

Then A and B satisfy (F, X).

Example 1.17: Let $A = [2, +\infty)$. Define $X, Y : A \to A$ by

$$Aa = a + 1 \text{ and } a = 2a + 1 \ \forall a \in A.$$

Suppose that the property (E.A.) satisfies. Then there is a sequence $\{a_n\}$ in A satisfying $\lim_{n\to\infty} Aa_n = \lim_{n\to\infty} Bb_n = w$ for some $w \in A$,Therefore$\lim_{n\to\infty} a_n = w - 1$ and $\lim_{n\to\infty} a_n = \frac{w-1}{2}$.Thus, $w = 1$, which is a contradiction since $1 \notin A$.

Hence U and V do not satisfy (E.A.).

2. MAIN RESULTS

Theorem 2.1: Assume that "(A, F, L, T, S) be an Intuitionistic Menger (PQM) space with T(a, b) = min {a, b} and S(a,b)= max {a, b} for all a, b ∈ [0 ,1]."

Let X, Y, U, V be capacities from An into itself to such an extent that:

X(A)) ⊂ Y(A) and X(B) ⊂ Y(B)).

(X, V) or (Y, U) fulfills the property (E.A).

There exists a number s ∈ (0, 1) with the end goal that
F_(xa,yb) (sa) ≥ min{(F_(Qu,Pv) (x),F_(Qu,Bv) (x),F_(Pv,Bv) (x),@F_(Au,Qu) (x),F_(Au,Pv) (x))}

L_(Au,Bv) (kx) ≤ min{(L_(Qu,Pv) (x),L_(Qu,Bv) (x),L_(Pv,Bv) (x),@L_(Au,Qu) (x),L_(Au,Pv) (x))} for all u, v ∈ X.
2.1 (IV) (X, V) and (Y, U) are feebly good,
2.1 (V) One of X(X), Y(X), V(X) or U(X) is a shut subset of X.

At that point A, B, P and Q have a remarkable regular altered point in X.

Proof: Assume that (B, P) fulfills the property (E.A). At that point there exists a succession {x_n} in X with the end goal that

$$\lim_{n\to\infty} Bx_n = \lim_{n\to\infty} Px_n = z$$

limBx_n〗┬(n→∞) = lim┬(n→∞) Px_n=z for some z ∈ X.

Since B(X) ⊂ Q(X), there exists in X a succession 〖{y〗_n} with the end goal that Bx_n= Qy_n. Subsequently lim┬(n→∞) Qy_n=z.

Give us a chance to demonstrate that lim┬(n→∞) Ay_n=z.

$$"F_{Ay_n,Bx_n}(kx) \geq \min\left\{\begin{matrix} F_{Qy_n,Px_n}(x), F_{Qy_n,Bx_n}(x), F_{Px_n,Bx_n}(x), \\ F_{Ay_n,Qy_n}(x), F_{Ay_n,Px_n}(x) \end{matrix}\right\}$$
$$\geq \min\left\{\begin{matrix} F_{Bx_n,Px_n}(x), F_{Px_n,Bx_n}(x), \\ F_{Ay_n,Bx_n}(x), F_{Ay_n,Px_n}(x) \end{matrix}\right\}$$
$$\geq F_{Ay_n,Bx_n}(x)$$

$$L_{Ay_n,Bx_n}(kx) \leq \min\left\{\begin{matrix} L_{Qy_n,Px_n}(x), L_{Qy_n,Bx_n}(x), L_{Px_n,Bx_n}(x), \\ L_{Ay_n,Qy_n}(x), L_{Ay_n,Px_n}(x) \end{matrix}\right\}$$
$$\leq \min\left\{\begin{matrix} L_{Bx_n,Px_n}(x), L_{Px_n,Bx_n}(x), \\ L_{Ay_n,Bx_n}(x), L_{Ay_n,Px_n}(x) \end{matrix}\right\}$$
$$\leq L_{Ay_n,Bx_n}(x)$$

Therefore with the Lemma (1.11) $Ay_n = Bx_n$.

Letting $n \to \infty$, we obtain

$$\lim_{n\to\infty} Bx_n = \lim_{n\to\infty} Ay_n = z.$$

Suppose Q(X) is a closed subset of X. Then z = Qu for some u ∈ X.

Subsequently, we have

$$\lim_{n\to\infty} Ay_n = \lim_{n\to\infty} Bx_n = \lim_{n\to\infty} Px_n = \lim_{n\to\infty} Qy_n = Qu$$

We have

$$F_{Au,Bx_n}(kx) \geq \min\left\{\begin{matrix} F_{Qu,Px_n}(x), F_{Qu,Bx_n}(x), F_{Px_n,Bx_n}(x), \\ F_{Au,Qu}(x), F_{Au,Px_n}(x) \end{matrix}\right\}$$
$$L_{Au,Bx_n}(kx) \leq \min\left\{\begin{matrix} L_{Qu,Px_n}(x), L_{Qu,Bx_n}(x), L_{Px_n,Bx_n}(x), \\ L_{Au,Qu}(x), L_{Au,Px_n}(x) \end{matrix}\right\}$$

Letting $n \to \infty$, we obtain

$$F_{Au,Su}(kx) \geq F_{Au,Su}(x)$$
$$L_{Au,Su}(kx) \leq L_{Au,Su}(x)$$

Therefore with the Lemma 1.11) we have

$$Au = Qu.$$

The weak compatibility of A and Q implies that

$$AQu = QAu \text{ and then } AAu = AQu = QAu = QQu.$$

On the other hand, since A(X) ⊂ P(X), there exists a point v ∈ X, such that Au = Pv.

We claim that Pv = Bv .
We have

$$F_{Au,Bv}(kx) \geq \min\left\{\begin{matrix} F_{Qu,Pv}(x), F_{Qu,Bv}(x), F_{Pv,Bv}(x), \\ F_{Au,Qu}(x), F_{Au,Pv}(x) \end{matrix}\right\} \geq F_{Au,Bv}(x)$$

$$L_{Au,Bv}(kx) \leq \min\left\{\begin{matrix} L_{Qu,Pv}(x), L_{Qu,Bv}(x), L_{Pv,Bv}(x), \\ L_{Au,Qu}(x), L_{Au,Pv}(x) \end{matrix}\right\}$$
$$\leq L_{Au,Bv}(x).$$

Therefore, with the Lemma (1.11), we have $Au = Bv$.

Thus $Au = Qu = Pv = Bv$.

The weak compatibility of B and P implies that

$$BPv = PBv \text{ and } PPv = PBv = BPv = BBv.$$

Let us show that Au is a common fixed point of A, B, P and Q.

We have

$$\begin{aligned} F_{Au,AAu}(kx) &= F_{AAu,Bv}(kx) \\ &\geq \min\left\{\begin{matrix} F_{QAu,Pv}(x), F_{QAu,Bv}(x), F_{Pv,Bv}(x), \\ F_{AAu,QAu}(x), F_{AAu,Pv}(x) \end{matrix}\right\} \end{aligned}$$

$$F_{Au,AAu}(kx) \geq F_{AAu,Av}(x)$$

$$\begin{aligned} L_{Au,AAu}(kx) &= L_{AAu,Bv}(kx) \\ &\leq \min\left\{\begin{matrix} L_{QAu,Pv}(x), L_{QAu,Bv}(x), L_{Pv,Bv}(x), \\ L_{AAu,QAu}(x), L_{AAu,Pv}(x) \end{matrix}\right\} \end{aligned}$$

$$L_{Au,AAu}(kx) \leq L_{AAu,Av}(x)\text{”}$$

“Therefore, we have

$$Au = AAu = QAu$$

That is Au is a common fixed point of A and Q.

Similarly, we can prove that Bv is a common fixed point of B and P.

Since $Au = Bv$, we conclude that Au is a common fixed point of A, B, P and Q.

The proof is similar when $P(X)$ is assumed to be a closed subset of X.

The cases in which $A(x)$ or $B(x)$ is closed subset of X are similar to the cases in which $P(X)$ or $Q(X)$, respectively, is closed

Since $\qquad A(X) \subset P(X)$ and $B(X) \subset Q(X)$.

If $Au = Bu = Su = Lu = u$ and $Av = Bv = Sv = Lv = v$.

We have

$$\begin{aligned} F_{u,v}(kx) = F_{Au,Bv}(kx) &\geq \min\left\{\begin{matrix} F_{Qu,Pv}(x), F_{Qu,Bv}(x), F_{Pv,Bv}(x), \\ F_{Au,Qu}(x), F_{Au,Pv}(x) \end{matrix}\right\} \\ &\geq F_{u,v}(x). \end{aligned}$$

$$\begin{aligned} L_{u,v}(kx) = L_{Au,Bv}(kx) &\leq \min\left\{\begin{matrix} L_{Qu,Pv}(x), L_{Qu,Bv}(x), L_{Pv,Bv}(x), \\ L_{Au,Qu}(x), L_{Au,Pv}(x) \end{matrix}\right\} \\ &\leq L_{u,v}(x).\text{”} \end{aligned}$$

Hence we have $u = v$ and the common fixed point is unique.

Hence the proof.

For three functions, we have the following result:

Corollary 2.2: “Let (X, F, L, T, S) be an Intuitionistic Menger (PQM) space with $T(x, y) = \min\{x, y\}$ and $S(x, y) = \max\{x, y\}$ for all $x, y \in [0, 1]$.

Let A, B and P be mappings from X into itself such that:
2.2 (I) $A(X) \subset P(X)$ and $B(X) \subset P(X)$
2.2 (II) (A, P) or (B, P) satisfies the property (E.A.),

2.2 (III) There exists a number $k \in (0,1)$ such that

$$F_{Au,Bv}(kx) \geq \min\left\{\begin{matrix} F_{Pu,Pv}(x), F_{Pu,Bv}(x), \\ F_{Pv,Bv}(x), F_{Au,Pu}(x), F_{Au,Pv}(x) \end{matrix}\right\}$$

$$L_{Au,Bv}(kx) \leq \min\left\{\begin{matrix} L_{Pu,Pv}(x), L_{Pu,Bv}(x), \\ L_{Pv,Bv}(x), L_{Au,Pu}(x), L_{Au,Pv}(x) \end{matrix}\right\} \text{ for all } u, v \in X .$$

2.2 (IV) (A, P) and (B, P) are weakly compatible,
2.2 (V) One of $A(X), B(X)$ or $P(X)$ is a closed subset of X.
Then A, B and P have a unique common fixed point in X."

Corollary 2.3: **"**Let (X, F, L, T, S) be a Intuitionistic Menger (PQM) space with $T(x, y) = \min\{x, y\}$ and $S(x, y) = \max\{x, y\}$ for all $x, y \in [0,1]$.

Let Aand P be mappings from X into itself such that:
2.3 (I) $A(X) \subset P(X)$.
2.3 (II) (A, P) satisfies the property (E.A),
2.3 (III) There exists a number $k \in (0,1)$ such that

$$F_{Au,Av}(kx) \geq \min\left\{\begin{matrix} F_{Pu,Pv}(x), F_{Pu,Av}(x), \\ F_{Pv,Av}(x), F_{Au,Pu}(x), F_{Au,Pv}(x) \end{matrix}\right\}$$

$$L_{Au,Av}(kx) \leq \min\left\{\begin{matrix} L_{Pu,Pv}(x), L_{Pu,Av}(x), \\ L_{Pv,Av}(x), L_{Au,Pu}(x), L_{Au,Pv}(x) \end{matrix}\right\} \text{ for all } u, v \in X .$$

2.3 (IV) (A, P) be weakly compatible,
2.3 (V) One of $A(X)$ or $P(X)$ is a closed subset of X.
Then A and P have a unique common fixed point in X."

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