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RESEARCH ARTICLE

FERMATEN FUZZY SOFT C_5 - CONNECTED HAUSDORFFSPACE ON KU-ALGEBRA

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ABSTRACT

In this paper,we study fermaten fuzzy soft topological structure on KU-algebra based on Senapati and yager,2019.A characterization theorem of the fermaten fuzzy soft strongly conneceted and c_5 conneceted spaces is given. Also,we future study preimage,image induced of fermaten fuzzy topo- logical structure and it is homomorphism.

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INTRODUCTION

Imai and Iski (5) defined a kind of type (2,0) algebras called BCK-algebras which generalizes the notion of algebra of sets with set subtraction as its only fundamental non-nullary operation and on the other hand, such BCK- algebras also generalizes the notion of implication algebras (see Iski and Tanaka (6)). It has been proved that the class of all BCK-algebras forms a quasiva- riety,however, Wronski (12)) shown that the class of BCK-algebras does not always form a variety. In this connection, Komori (7) introduced the notion of BCC-algebras, and Dudek (2) redefined the BCC-algebras by using a dual form of the ordinary definition in the sense of Komori. Later on, Dudek and Zhang (4) introduced a new notion of ideals in BCC-algebras and described the connections between such ideals and congruences. The fuzzification of BCC-ideals in BCC-algebras was then considered by Dudek and Jun (3). They shown that every fuzzy BCC-ideal of a BCC-algebra is a fuzzy BCK-ideal, and also pointed out that the converse is not true by giving a counter example. It was also proved by them that in a BCC-algebra, every fuzzy BCK-ideal is a fuzzy BCC-subalgebra and in a BCK-algebra, the notion of a fuzzy BCK-ideal and a fuzzy BCC-ideal coincide. Thus, the studying of BCK-ideals of a BCK- algebra is a special case of studying the BCC-ideals in a BCC-algebra. Yager (10) explored a typical division of these collections known as q-rung orthopair uncertainty collection in which the aggregate of the qth power of the help for and the qth power of the help against is limited by one. He explained thatas 'q' builds the space of truth able orthopairs increments and therefore givesthe user more opportunity in communicating their conviction about value of membership. At the point when q = 3, Senapathi and Yager (8) have evoked q-rung orthopair uncertainty collection as fermatean uncertainty sets (FUSs). Pythagorean uncertainty collections have studied the concentration of many researchers within a short period of time.

For example, Yager (9) has derived up a helpful decision technique in view of Pythagorean uncertainty aggregation operators to deal with Pythagorean uncertainty MCDM issues. Yager and Abbasov (11) studied the Pythagorean membership grades (PMGs) and the considerations related to Pythagorean uncertainty collections and presented the association between the PMGs and the imaginary numbers. Reformat and Yager (11) applied the PFNs in dealing with the communitarian with respect to recommender system. Gou et al. (1) originated a few Pythagorean uncertainty mappings and investigated their preliminary properties like derivability, con- tinuity, and differentiability in details. Senapathi and Yager (9) specified basic activities over the FUSs and concentrated new score mappings and accuracy mappings of FUSs.After Zadeh (13), various notions of higher-order fuzzy setshave been proposed.we study fermaten fuzzy soft topological structure on KU- algebra based on Senapati and yager,2019(a). A characterization theorem of the fermaten fuzzy soft strongly conneceted and c_5 conneceted spaces is given. Also,we future study preimage,image induced of fermaten fuzzy topological structure and it is homomorphism.

Definition

By a KU-algebra X we mean an algebra $(x, \square, 0)$ of type (2,0) with binary operation.satisfying the following conditions:

- (KU_1) $(x * y).((y * z).(x * z)) = 0$
- (KU_2) $0 * x = x$
- (KU_3) $x * 0 = 0$
- (KU_4) $x * y = 0 = y * x$ implies x=y, $\forall\ x, y, z \in X$.

Example

$*$	0	1	2	3
0	0	1	2	3
1	0	0	3	0
2	0	0	0	0
3	0	3	3	0

Then clearly $(x, *, 0)$ is a KU-algebra.

In a KU-algebra the following equavlity holds $(x * y) * x = 0$.... any BCK- algebra is a KU-algebra but there exist KU-algebra which are not necessarly BCK-algebra if and only ifit satisfies the equavlity $(x*y)*z = (x*z)*y$. A nonempty subset S of a KU-algebra X is called a subalgebra of X.if it is closed under the KU-operation such subalgebra contains the constant 0 and it is clearly a KU-algebra but some subalgebras may also be BCK-algebra.Moreover there exists of Ku-algebras is called a homomorphism if $f(x + y) = f(x) + f(y)$ holds, for all $x, y \in X_1$

Definition

For the sake of simplicity,we just write $F = \langle m_F, n_F\rangle$ inside $F = \{\langle x, mF(x), nF(x)\rangle /x \in G\}$ the FFSSs $0\sim$ and $1\sim$ in X are defined by $0 \sim= \{\langle x, 0, 1\rangle /x \in X\}$ and$1 \sim= \{\langle x, 0, 1\rangle /x \in X\}$ respectively.

If f is a mapping which maps a set X_1 into another set X_2 ,then the followingstatements hold:

- If $B = \{\langle y, mB(y), nB(y)\rangle /y \in X_2\}$ is a FFss in X_2 then the preimageof B under if,denoted by $f^{-1}(B)$, is still an FFs in X_1, we now write by$f^{-1}(B) = \{ x, f^{-1}(m_B)(x), f^{-1}(n_B)(x)\ /x \in X_1\}$.
- If $A = \{\langle y, mA(x), nA(x)\rangle /y \in X_1\}$ is a FFss in X_1 then the preimageof B under if,denoted by $f(A)$, is still an FFs in X_2, which is defined by$f(A) = \{\langle y, f_{\sup}(m_B)(y), f_{\inf}(n_B)(y)\rangle /y \in X_2\}$.

$$\text{where}\quad f_{sup}(m_A)(y) = \begin{cases} \sup\limits_{x\in f^{-1}(y)} m_A(x) \text{ if } f^{-1}(y) \neq \phi \\ 0 \qquad\qquad\qquad\qquad\qquad otherwise \end{cases}$$

$$\text{where}\quad f_{inf}(n_A)(y) = \begin{cases} \inf\limits_{x\in f^{-1}(y)} n_A(x) \text{ if } f^{-1}(y) \neq \phi \\ 1 \qquad\qquad\qquad\qquad\qquad otherwise \end{cases}$$

for each $y \in X_2$

Proposition

Let A, $A_i (i \in I)$ be FFss in X_1 and B an FFss in X_2.If $f : X_1 \longrightarrow X_2$ is a function then the following condition as hold:

- If f is onto then $f(f^{-1}(B)) = B$
- $f^{-1}(\bigcup_{i=1}^{n} A_i)=\bigcup_{i=1}^{n}(f^{-1}A_i)$
- $f^{-1}(A_i)=(f^{-1}A_i)$
- $f^{-1}(1\sim) = 1\sim$
- $f^{-1}(0\sim) = 0\sim$
- $f^{-1}(1\sim) = 1\sim$ if is onto
- $f^{-1}(0\sim) = 0\sim$

Definition (Coker.D.1997): A fermaten fuzzy soft topology (In short FFST)on a non-empty set X is a family of Z of FFSS in X which satisfies the following conditions

- $0\sim, 1\sim \in Z$
- If $X_1, X_2 \in Z$, then $X_1 \cap X_2 \in Z$.
- If $X_j \in Z\ \forall j \in J$, then $\cup\ i \in I\ X_i \in Z$.

The pair (X, τ) is called fermaten fuzzy soft topologcal spaces (Briefly FFSTS) and any FFSS in Z is called fermaten fuzzy soft open sets (FFSOS)in X. The topology Z on a FFSt is said to be an indiscrite fermation fuzzy soft topologyif its only elements 0x(0) and (1). On the other hand, the FFST τ on a space X is said to be adiscrite fermation fuzzy soft topology if the topology FFST τ contains all fermaten fuzzy soft subsets of X. If A is FFSS in a FFSTS (X, τ),then the induced fermaten fuzzy soft topology IFFST on A is the family of FFSS in A which are the intersection with A of FFSOSS in X. the induced fermaten fuzzy soft topology is denoted by τ_A andthe pair (A, τ_A) is called fermaten fuzzy soft subspace of (X, τ). Let $(X_1, \tau_1)$and (X_2, τ_2) be two IFFSTS and $f : (X_1, \tau_1) \longrightarrow (X_2, \tau_2)$ be a function then fis said to be fermaten fuzzy soft continuous function if and only if the preimage of each FFSS in τ_2 is a FFSS in τ_1. Let $(X - 1, \tau_1)$ and (X_2, τ_2) be two IFFSTS and let $f : (X - 1, \tau_1) \longrightarrow (X_2, \tau_2)$ be a function. Then f is said to be fermaten fuzzy FFSS in τ_1 is on FFSS in τ_2.

Fermaten fuzzy soft topological sub algebrs

Definition

A fermaten fuzzy soft set $A =< m_A, n_A >$ in X is called fermaten fuzzy softsubalgebra of X if it satiesfies the following conditions

- $(FFSS_1)\quad m_A(x * y) \geq T\{m_A(x), m_A(y)\}$
- $(FFSS_2)\quad n_A(x * y) \leq T\{n_A(x), n_A(y)\}\ \forall\ \ x, y$ □ $X.$

Example

$*$	0	l	m	n	p
0	0	0	0	0	0
l	l	0	l	0	0
m	m	m	0	0	0
n	n	n	l	0	0
p	p	n	p	n	0

Let $X = \{0, l, m, n, p\}$ be a KU-algebra with the following cayley table.
Let $A =< m_A, n_A >$ be FFSS in X defined by $m_A(p) = 0.04$, $m_A(x) = 0.6, n_A(x) = 0.4$ and $n_A(x) = 0.04\ \forall\ x /= P$. Then A is fermaten fuzzy soft sub algebra of G.

Definition

Let τ_1 and τ_2 be the fermaten fuzzy soft topologeis on KU-algebras X_1 and X_2respectively. A function $f : (X_1, \tau_1) \longrightarrow (X_2, \tau_2)$ is called fermaten continuous function which maps (X_1, τ_1) and (X_2, τ_2) if f satisfies the following conditions

- For every $A \in \tau_2, f^{-1}(A) = \tau_1$
- For every fermaten fuzzy soft sub algebras $A(of X_2)$ in τ_2, $f^{-1}(A)$ isfermaten fuzzy soft sub algebras $A(of X_1)$ in τ_1.

Proposition

If τ_1 is fermetan fuzzy soft topology on a KU-algebra X_1 and τ_2 is indiscrete fermaten fuzzy soft topology on a KU-algebras X_2,then every function $f : (X_1, \tau_1) \longrightarrow (X_2, \tau_2)$ is fermaten fuzzy soft continuous function.

proof:

Since τ_2 is fermaten fuzzy soft topology, τ_2 is an indiscrete fermaten fuzzy softtopology,$\tau_2 = \{0_\sim, 1_\sim\}$. Let $f : X_1 \longrightarrow X_2$ be a mapping of KU-algebras. Then ,every member of τ_2 is fermaten fuzzy soft sub algebra of KU-algebra Y. We now show that f is fermetan fuzzy soft continuous function,we only need to prove that for every $A \in \tau_2, f^{-1}(A) \in \tau_1$. For this purpose, we let $0_\sim \in \tau_2$.Then for any $x \in G$.We have $f^{-1}(0_\sim)(x) = 0_\sim(f(x)) = 0 = 0_\sim(x)$. This shows that $(f^{-1}(0_\sim)) = 0_\sim \in \tau_1$ on the otherhand if $1_\sim \in \tau_2$ and $x \in G$ then $(f^{-1}(1_\sim))(x) = 1 \sim (f(x)) = 1 = 1_\sim(x)$.thus $(f^{-1})(1_\sim) = 1_\sim \in \tau_1$. This shows that f is indiscrete fermaten fuzzy soft continuous function of X_1 to X_2.

Theorem

Let τ_1 and τ_2 be any two discreate fermaten fuzzy soft topologies defined on the KU-algebras X_1 and X_2 respectively. Then every homomorphism f: $X_1 \longrightarrow X_2$ is fermaten fuzzy soft continuous function. proof:
Since τ_1 and τ_2 on discreate FFSTS on the KU-algebras X_1 and X_2 respecively,we have $f^{-1}(A) \in \tau_1$, for every $A \in \tau_2$.(we note that f is not the useual inverse homomorphism from X_2 to X_1). Let A be fermaten fuzzy soft sub algebra($of X_2$) in τ_2. Then for $x, y \in X_1$, we have

$$\begin{aligned}
(f^{-1}(m_A))(x*y) &= m_A(f(x*y)) \\
&= m_A(f(x)) * m_A(f(y))(\text{ If f is a homomorphism}) \\
&\geq T\{m_A(f(x)), m_A(f(x))\} \\
&= T\{f^{-1}(m_A)(x), f^{-1}(m_A)(x)\} and \\
(f^{-1}(n_A))(x*y) &= n_A(f(x*y)) \\
&= n_A(f(x)) * n_A(f(y))(\text{ If f is a homomorphism}) \\
&\geq S\{n_A(f(x)), n_A(f(x))\} \\
&= S\{f^{-1}(n_A)(x), f^{-1}(n_A)(x)\}.
\end{aligned}$$

Hence $f^{-1}(A)$ is fermaten fuzzy soft sub algebra $(of\ G_1)$ in τ_1 and consequenly, f in fermaten fuzzy soft continuous function which maps (X_1, τ_1) to (X_2, τ_2).

Definition

Let (X_1, τ_1) to (X_2, τ_2). be FFSTS. A function $f : X_1 \longrightarrow X_2$ is said to be fermaten fuzzy soft homomorphism if satiesfies the following conditions:

- f is 1-1 and onto map;
- f is fuzzy soft continuous function which maps X_1 to X_2;
- f^{-1} is a fuzzy soft continuous function which maps X_2 to X_1;

Definition

Let τ be FFST on KU-algebra X. A IFFSTS (X_1, τ) is a fermaten fuzzy soft Hausdorff space if and only if for any discreate fermaten fuzzy soft points$x_1, x_2 \in X$, then exist FFSOS $\delta_1 =< m\delta_1, n\delta_1 >$ and $\delta_2 =< m\delta_2, n\delta_2 >$ such that $m\delta_1(x_1) = 1$, $m\delta_2(x_2) = 1$, $n\delta_1(x_1) = 0$, $n\delta_2(x_2) = 0$, and $\delta_1 \cap \delta_2 = 0_\sim$

Theorem

Let τ_1 and τ_2 be FFSTS on KU-algebras X_1 and X_2 respectively and $f : X_1 \longrightarrow X_2$ be fermaten fuzzy soft homomorphism.Then X_1 is fermaten fuzzy soft Hausdorff space if and only if X_2 is fermaten fuzzy soft Hausdorff space. proof:
Suppose that X_1 is fermaten fuzzy soft Hausdorff fuzzy soft Hausdorff space.Letx_1 and x_2 be the fermaten fuzzy soft points in τ_2 with $x \neq y$ $(x, y \in X_1)$. then$f^{-1}(x) \neq f^{-1}(y)$ becase f is 1-1 function for $z \in X_1$,

$$\text{we consider } (f_x^{-1})(z) = x_1(f(z)) = \begin{cases} \omega \in (0,1], \text{if } f(z) = x; \\ 0 \quad \text{if} \quad f(z) \neq x; \\ \omega \in (0,1] \text{ if } z = f^{-1}(x); \\ 0 \text{ if } \quad z^{-1} \neq f^{-1}(x); \end{cases}$$

that is $(f^{-1}(x))(z) = (f^{-1}(x)), (z), \forall\ z \in X_1$
Hence $f^{-1}(x_1) = (f^{-1}(x))_1$,
similarly we can also prove that $f^{-1}(x_2) = (f^{-1}(x))_2$

Now by definition of fermaten fuzzy soft Hausdorff space , there exists fermaten fuzzy soft open sets F_1 and F_2 of $f^{-1}(x_1)$ and $f^{-1}(x_2)$ respectively such that $F_1 \cap F_2 = 0_\sim$. Since f is a fermaten fuzzy soft continuous map from X_1 to X_2 and f^{-1} is fermaten fuzzy soft continuous map from X_2 to X_1, there exists fermaten fuzzysoft open sets $f(F_1)$ and $f(F_2)$ of x_1 and x_2 respectively such that $f(F_1) \cap f(F_2) = f(F_1 \cap F_2) = f(0_\sim) = 0_\sim$.This shows that X_2 is fermaten fuzzy soft Hausdorff space. Conversely,if (X_2, τ_2) is fermaten fuzzy soft Hausdorff space, then by using a similar argument as above and by the fact that both f and $f^{-1}$are fermaten fuzzy soft continuous functions, we can easly prove that $(x_1, \tau_1)$is fermaten fuzzy soft Hausdorff space.

Definition

Let τ be fermaten fuzzy soft topology on a Ku-algebra X. Then (X, τ) is called fermaten fuzzy soft C_5 disconnected space if there exists fermaten fuzzy soft open and closed set F such that $F /= 1_\sim$ and $F /= 0_\sim$.

Theorem: Let τ_1 and τ_2 be the fermaten fuzzy soft topological sets on KU-algebras $X_1$and X_2 respectively and $f : X_1$ *longrightarrow*X_2 be fermaten fuzzy soft continuous onto function. If (X_1, τ_1) is fermaten fuzzy soft C_5-connected space then (X_2, τ_2) is fermaten fuzzy soft C_5- conneceted space.

proof:

Assume that (X_2, τ_2) is fermaten fuzzy soft C_5-disconnected. Then there exist fermaten fuzzy soft open and closed set F such that $F /= 1_\sim$ and $F \neq 0_\sim$. Since f is fermaten fuzzy soft continuous function,$f^{-1}(F)$ is both fermaten fuzzy soft open sets and fermaten fuzzy soft closed sets. In this case,$f^{-1}(F) = 1_\sim$ or $f^{-1}(F) = 0_\sim$.Since $F = f(f^{-1}(F)) = f(1_\sim) = 1_\sim$ and $F = f(f^{-1}(F)) = f(0_\sim) = 0_\sim$.We see that these result contradict to over assumption . Hencethe space (X_2, τ_2) must be fermaten soft C_5-connected.

Definition

Let τ be a function fuzzy soft topology on a KU-algebra X. A FFSTS $(X, \tau)$is called fermaten fuzzy soft disconnected space if there exist fermaten fuzzy soft open sets $A /= 0_\sim$ and $B /= 0_\sim$ such that $A \cup B = 1_\sim$ and $A \cap B = 0$Actually, we call the set (X, τ) is fermaten fuzzy softconnected if (X, τ) is not fermaten fuzzy soft disconnected.

Theorem

Let τ_1 and τ_2 be FFSTS on KU-algebras X_1 and X_2 respectively and let$f : X_1 \longrightarrow X_2$ be fermaten fuzzy soft continuous and onto function .If X_1 is fermaten fuzzy soft connected space,then so is X_2.

proof:

Suppose that X_2 is fermaten fuzzy soft disconnected then exists fermaten fuzzy soft open set $C /= 0_\sim, D0_\sim$ in X_2 such that $C \cup D = 1_\sim$ and $C \cap D = 0_\sim$.Since f is fermaten fuzzy soft continuous function , $A = f^{-1}(c)$ and $B = f^{-1}(D)$ and $D /= 0_\sim$ implies that $B = f^{-1}(D) /= 0_\sim$. Now,we have

$C \cup D = 1_\sim$
$\Rightarrow f^{-1}(C \cup D) = f^{-1}(1)$
$\Rightarrow f^{-1} \cup f^{-1}(D) = 1_\sim$
$\Rightarrow A \cup B = 1_\sim$ and $C \cap D = 0_\sim$
$\Rightarrow f^{-1}(C \cap D) = f^{-1}(0)$
$\Rightarrow f^{-1}(C) \cap f^{-1}(D) = 0_\sim$
$\Rightarrow A \cap B = 0_\sim$

which is a controdiction our hypothesis.
Hence X_2 is fermaten fuzzy softconnected space.

Definition

A FFSTS (X_1, τ) is said to be fermaten fuzzy soft strongly connected , if there exists no non-zero fermaten fuzzy soft closed sets A and B in G such that $m_A + m_B \leq 1$ and $n_A + n_B \geq 1$. the following immediately from our definition.

Proposition: If X is fermaten fuzzy soft strongly connceted if and only if there exist no fermaten fuzzy open sets A and B such that $A1$ and $B /= 1$ and $m_A + m_B \geq 1$, $n_A + n_B \leq 1$. we now formulate the following theorem.

Theorem

Let τ_1 and τ_2 be FFSTS on KU-algebras X_1 and X_2 respectively and $f : X_1 \longrightarrow X_2$ be fermaten fuzzy soft continuous and onto mapping. If X_1 is fermaten fuzzy soft strongly connected, then so is X_2.

proof:

Suppose that $X_2$is not fermaten fuzzy soft strongly connected. Then there

exists fermaten fuzzy soft sets C and D in X_2 with C
$0_\sim$ D so that

$m_C + m_D \leq 1$ and $n_C + n_D \geq 1$. Since f is fermaten fuzzy soft continuous function $f^{-1}(C)$ and $f^{-1}(D)$ are fermaten fuzzy soft closed sets in X_1. Nowwe can deduce the following eqvalities:
$mf^{-1}(C) + mf^{-1}(D)=f^{-1}(m_C) + f^{-1}(m_D)$
$=m_C 0 f + m_D 0 f$

≤ 1 $(Since\ m_C + m_D)$,

$f^{-1}(C)$ 0 and $f^{-1}(0)$

$0_\sim$. This is a controdiction of over assumption.

Hence X_2 is fermaten fuzzy soft strongly connected space.

Definition

Let τ be FFST on a KU-algebra X and A be fermaten fuzzy soft KU-algebra with fermaten fuzzy soft topology τ_A. Then A is called fermaten fuzzy soft topological KU-algebra 1's the self mapping δ_a: $A \longrightarrow A$ defined by $\delta_a(x)=x * a$ $\forall$ $a \in X_1$ is a relatively fermaten fuzzy soft continuous function.

Theorem

Let $f : X_1 \longrightarrow X_2$ be a homomorphism of KU-algebras and let τ and τ * be fermaten fuzzy soft toplogy on X_1 and X_2 respectively suh that $\tau = f^{-1}(\tau *)$.If B is fermaten fuzzy soft topological KU-algebra in X_2 then $f^{-1}(B)$ in X_1 is fermaten fuzzy soft topological KU-algebra in X_1.

Theorem

Let f: $X_1 \longrightarrow X_2$ be a is the respectivly FFSTS on the spaces X_1 and X_2 such that $f(\tau) = \tau *$. If A is on fermaten fuzzy soft topological KU-algebra in X_1, then f(A) is also fermaten fuzzy soft topological KU-algebra in X_2.

CONCLUSION

This paper presented a new concept on spherical fuzzy sets and its algebric structures together with ideal theory in BCK/BCI algebra. Consider for a DEL-spherical fuzzy set to be a n-fold positive implicative BDEL-spherical fuzzy ideal are provided. Characterization of n-fold positive implicative BDEL- spherical fuzzy ideals are displyed.A characterization theorem of the fermatean fuzzy soft strongly connected and C5 connected space is given. Also, we study pre image, image induced of fermatean fuzzy topological structure and its homomorphism.

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