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Algebraic Properties on ω – Fuzzy Translation and Multiplication in BP– Algebras

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Abstract*: *In this paper, we first define $\omega -$ Fuzzy BP-sub algebra then explain the idea of ω –Fuzzy Translation and Multiplication in BP– Algebras. More over , we generalized the $\omega -$ Fuzzy BP- ideal and we consider, new notion discussed ω –Fuzzy Translation and Multiplication in BP– Algebras and investigate some of related algebraic properties.

Keywords : BP–Algebra; BP–Ideal; Fuzzy BP–Ideal; Fuzzy BP–Sub algebra; ω –Fuzzy Translation ($\omega - FT$); $\omega -$ Fuzzy Multiplication($\omega - FM$);

I. INTRODUCTION

Zadeh L A [9] Launched the concept of fuzzy sets. Sun Shin Ahn and Jeong Soon Han [8], described the new notation on BP-Algebras .The concept of fuzzy BP-Ideal proposed by Christopher Jefferson Y et al.[3] .Priya T et al. [5], explored the new notation of Fuzzy Translation and Multiplication on PS-Algebras .The concept of Fuzzy Algebraic Structure in BP-Algebra were established by Christopher Jefferson Y et al.[2] .Prasanna A et al. [6] depicted the various concept of Fuzzy Translation and Multiplication on B-Algebras .The proposed the study of, more recent development of Fuzzy Translation and Multiplication on BG-Algebras Prasanna A et al. [7] .Abu Ayub Ansari et al. [1], developed the aspects of the Fuzzy Translation of Fuzzy $\beta -$ Ideals of $\beta -$Aalgebras .Kyoung Ja Lee, et al.[4],described the new notation of Fuzzy Translations and Fuzzy Multiplication of BCK/BCI-Algebras.In this research paper arranged as that, section 2 basic fundamental elementary definition and related the results which are through this research article. In section 3, we have define $\omega -$ Fuzzy BP-sub algebra and Fuzzy BP-Ideal with respect to the Fuzzy BP-sub algebra and Fuzzy BP-Ideal and described the algebraic properties of $\omega -$ Fuzzy Translations ($\omega -$ FT) and $\omega -$ Fuzzy Multiplications ($\omega -$ FM) and their some generalization results.

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II. PRELIMINARIES

In this section we recall the basic elementary fundamental definition of fuzzy sets and fuzzy BP-Algebra that will play a key role for our further to be used in the sequel results.

Definition: 2.1 [8]

A BP-algebra $(X,*,0)$ is a non-empty set X with a constant 0 and a binary operation $*$ satisfying the following conditions

(i) $x * x = 0$

(ii) $x * (x * y) = y$

(iii) $(x * z) * (y * z) = x * y, \forall\, x, y, z \in X.$

Definition: 2.2 [8]

A non-empty subset A of a BP-Algebra X is said to be a BP-Sub algebra if $x * y \in A, \forall\, x, y \in A.$

Definition: 2.3 [9]

Let X be a non-empty set . A fuzzy subset of the set X is a mapping $\mu : X \rightarrow [0, 1]$.

Definition: 2.4 [2]

A fuzzy subset μ of a BP-Algebra $(X,*,0)$ is called a fuzzy BP-sub algebra if $\mu(x * y) \geq min\{\mu(x), \mu(y)\}, \forall\, x, y \in A.$

Definition: 2.5 [8]

A non-empty subset I of BP-algebra $(X,*,0)$ is said to be a BP-ideal of X if it satisfies the following conditions

(i) $0 \in I$

(ii) $x * y \in I \text{ and } y \in I \Rightarrow x \in I, \forall\, x, y \in I.$

Definition: 2.6 [3]

Let X be a BP-algebra. A fuzzy set μ of X is said to be a fuzzy BP-ideal of X if it satisfies the following conditions

(i) $\mu(0) \geq \mu(x)$

(ii) $\mu(x) \geq min\{\mu(x * y), \mu(y)\}, \forall\, x, y \in X.$

Example: 2.6.1

Let $(X = \{0,1,2,3\}, *, 0)$ be a BP-algebra with the following cayley table.

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

Define $\mu : X \rightarrow [0,1]\, by$

$$\mu(x) = \begin{cases} 0.9\ if x = 0 \\ 0.6\ if x = 2 \\ 0.3\ if\ x = 1,3 \end{cases}$$

Therefore μ is a fuzzy BP-ideal of the $BP -$algebra X.

Definition: 2.7 [3]

Let $\lambda\ and\ \mu$ be the fuzzy set in a set X. The Cartesian product $\lambda \times \mu : X \times X \rightarrow [0,1]$ is defined by $(\lambda \times \mu)(x, y) = min\{\lambda(x), \mu(x)\}, \forall\, x \in X.$

Definition: 2.8 [8]

Let $(X_1,*_1,0_1)$ and $(X_2,*_2,0_2)$ be BP-algebras. A mapping $f:X_1 \to X_2$ is called a homomorphism if , $f(x *_1 y)= f(x) *_2 f(y), \forall x,y \in X$.

Definition: 2.9 [2]

Let f be any function from the BP-algebra X_1 to the BP-algebra X_2. Let μ be any fuzzy BP-sub algebra of X_1 and σ be any fuzzy BP-sub algebra of X_2. The image of μ under f, denoted by $f(\mu)$, is a fuzzy subset of X_2 defined by

$$f(\mu(x)) = \begin{cases} sup_{x\in f^{-1}(y)}\mu(x) \text{ , } if\ f^{-1}(y) \neq \emptyset \\ 0 \quad otherwise \end{cases}$$

Where $y \in X_2$. The pre image of σ under f, symbolized by $f^{-1}(\sigma)$, is a fuzzy subset of X_1 defined by $(f^{-1}(\sigma))(x) = \sigma(f(x)), \forall x \in X_1$.

III. ON ω – FUZZY TRANSLATION AND MULTIPLICATION IN BP– ALGEBRAS

In this section, we clarify the new idea of $\omega - FT$ and $\omega - FM$. We show that ϑ be a BP-Algebra, for any fuzzy set ξ of ϑ, we define the conditions $\psi = 1 - \sup\{\xi(\pi)/\pi \in \vartheta\}$ is discussed in this section.

Definition: 3.1

If ξ is a fuzzy subset of ϑ and $\omega \in [0,1]$ then $\xi_\omega^\psi:\vartheta \to [0,1]$ is said to be a $\omega - FT$ of ξ if it satisfies the following condition is $\xi_\omega^\psi = \xi(\pi) + \omega, \forall \pi \in \vartheta$.

Definition: 3.2

If ξ is a fuzzy subset of ϑ and $\omega \in [0,1]$ then $\xi_\omega^\varepsilon:\vartheta \to [0,1]$ is said to be a ω – FM of ξ if it satisfies the following condition is $\xi_\omega^\varepsilon = \omega\, \xi(\pi), \forall \pi \in \vartheta$.

Example: 3.2.1

Let ϑ = $\{0,1,2,3\}$ be the set with the following table.

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

Then $(\vartheta,*,0)$ is a BP – Algebra.

Define fuzzy set ξ is of ϑ by $\xi(\pi) = \begin{cases} 0.4 & if\ \pi \neq 1 \\ 0.3 & if\ \pi = 1 \end{cases}$

$\Rightarrow \xi$ is a fuzzy BP-sub algebra of ϑ.

$\therefore \psi = 1 - sup\{\xi(\pi)/\pi \in \vartheta\}$ = 1-0.4 = 0.6

Choose $\omega = 0.3 \in [0,1]$ and $\omega = 0.4 \in [0,1]$.

Then the mapping $\xi_{0.3^\psi} : \vartheta \to [0,1]$ is defined by

$$\xi_{0.3^\psi} = \begin{cases} 0.3 + 0.4 = 0.7 & if\ \pi \neq 1 \\ 0.3 + 0.3 = 0.6 & if\ \pi = 1 \end{cases}$$

Then satisfies the condition is

$\xi_{0.3^\psi}(\pi) = \xi(\pi) + 0.3,\ \forall \pi \in \vartheta,$

$\Rightarrow$ Fuzzy 0.3-translation .

The mapping $\xi_{0.4^\varepsilon} : \vartheta \to [0,1]$ is defined by

$$\xi_{0.4^\varepsilon} = \begin{cases} 0.4 * 0.4 = 0.16 & if\ \pi \neq 1 \\ 0.4 * 0.3 = 0.12 & if\ \pi = 1 \end{cases}$$

Then satisfies the condition is $\xi_{0.4^\varepsilon}(\pi) = \xi(\pi)(0.4)$, $\forall \pi \in \vartheta,$

$\Rightarrow$ Fuzzy 0.4-Multiplication.

Proposition: 3.3

If ξ be a fuzzy BP-ideal of ϑ and $\omega\epsilon[0,1]$,when ϑ is a BP-algebra. Then the ω –FT $\xi_\omega{}^\psi$ of ν is a fuzzy BP-sub-algebra of ϑ.

Proof:

Let $\pi, \partial \in \vartheta$.

Now ,

$\xi_\omega{}^\psi(\pi * \partial) = \xi(\pi * \partial) + \omega$

$\geq \{\xi(\pi * (\pi * \partial))\wedge\xi(\partial))\} + \omega$

$= \{\xi((\pi * \pi) * \partial)\wedge\xi(\partial)\} + \omega$

$\geq \{\xi(0)\wedge\xi(\partial)\} + \omega$

$= \{\xi(\pi)\wedge\xi(\partial)\} + \omega$

$\geq \{(\xi(\pi) + \omega)\wedge(\xi(\partial) + \omega)\}$

$= \{\xi_\omega{}^\psi(\pi)\wedge\xi_\omega{}^\psi(\partial)\}, \forall \pi, \partial \in \vartheta$

$\Rightarrow \xi_\omega{}^\psi$ is a fuzzy BP-sub-algebra of ϑ.

■

Theorem: 3.4

Let ω –FT $\xi_\omega{}^\psi$ of ξ is a fuzzy BP-sub-algebra of ϑ and $\omega\epsilon[0,1]$. Then ξ is a fuzzy BP-sub-algebra of ϑ.

Proof:

Assume that $\xi_\omega{}^\psi$ of ξ is a fuzzy BP-ideal of ϑ.

Now,

$\xi(\pi * \partial) + \omega = \xi_\omega{}^\psi(\pi * \partial)$

$\geq \{\xi_\omega{}^\psi(\pi * (\pi * \partial))\wedge\xi_\omega{}^\psi(\partial)\}$

$= \{\xi_\omega{}^\psi((\pi * \pi) * \partial)\wedge\xi_\omega{}^\psi(\partial)\}$

$\geq \{\xi_\omega{}^\psi(0)\wedge\xi_\omega{}^\psi(\partial)\}$

$= \{\xi_\omega{}^\psi(\pi)\wedge\xi_\omega{}^\psi(\partial)\}$

$= \{(\xi(\pi) + \omega)\wedge(\xi(\partial) + \omega)\}$

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$= \{\xi(\pi) \wedge \xi(\partial)\} + \omega$

$\Rightarrow \xi(\pi * \partial) \geq \{\xi(\pi) \wedge \xi(\partial)\}, \forall \pi, \partial \in \vartheta.$

$\therefore$ ξ is a fuzzy BP-sub algebra of ϑ.

Proposition: 3.5

Let ξ be a fuzzy BP-Ideal of BP-Algebra ϑ and $\omega \in [0,1]$. Then the ω-FM $\xi_\omega^{\,\varepsilon}$ of ξ is a fuzzy BP-Sub algebra of ξ.

Proof:

Let $\pi, \partial \in \vartheta$.

Now, $\xi_\omega^{\,\varepsilon}(\pi * \partial) = \omega\xi(\pi * \partial)$

$\geq \omega\{\xi(\pi * (\pi * \partial)) \wedge \xi(\partial)\}$

$\geq \omega\{\xi((\pi * \pi) * \partial) \wedge \xi(\partial)\}$

$= \omega\{\xi(0) \wedge \xi(\partial)\}$

$= \omega\{\xi(\pi) \wedge \xi(\partial)\}$

$= \{\omega\xi(\pi) \wedge \omega\xi(\partial)\}$

$\geq \{\xi_\omega^{\,\varepsilon}(\pi) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}, \forall \pi, \partial \in \vartheta.$

$\Rightarrow$ $\xi_\omega^{\,\varepsilon}$ is a fuzzy BP-Sub algebra of ϑ. ■

Theorem: 3.6

In the ω −FT $\xi_\omega^{\,\varepsilon}$ of ξ is a fuzzy BP-sub-algebra of ϑ and $\omega \epsilon [0,1]$. Then ξ is a fuzzy BP-sub-algebra of ϑ.

Proof:

Let $\xi_\omega^{\,\varepsilon}$ of ξ is a fuzzy BP-ideal of ϑ.

Then

$\omega\xi(\pi * \partial) = \xi_\omega^{\,\varepsilon}(\pi * \partial)$

$\geq \{\xi_\omega^{\,\varepsilon}(\pi * (\pi * \partial)) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}$

$= \{\xi_\omega^{\,\varepsilon}((\pi * \pi) * \partial) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}$

$\geq \{\xi_\omega^{\,\varepsilon}(0) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}$

$\geq \{\xi_\omega^{\,\varepsilon}(\pi) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}$

$= \{(\omega\xi(\pi)) \wedge (\omega\xi(\partial))\}$

$= \{\xi(\pi) \wedge \xi(\partial)\}$

$\Rightarrow \xi(\pi * \partial) \geq \{\xi(\pi) \wedge \xi(\partial)\}, \forall \pi, \partial \in \vartheta.$

$\therefore$ ξ is a fuzzy BP-sub algebra of ϑ. ■

Proposition: 3.7

Let ξ is a BP- ideal of ϑ.Then the fuzzy ω −FT $\xi_\omega^{\,\psi}(\pi)$ of ξ is a fuzzy BP- ideal of ϑ, $\forall \omega \epsilon [0,1]$.

Proof:

Let ξ be a fuzzy BP-ideal of ϑ and $\forall\ \omega \epsilon [0,1]$

Now,

(i) $\xi_\omega^{\,\psi}(o) = \xi(o) + \omega$

$\geq \xi(\pi) + \omega$

$\geq \xi_\omega^{\,\psi}(\pi)$

(ii) $\xi_\omega^{\,\psi}(\pi) = \xi(\pi) + \omega$

$\geq \{\xi(\pi * \partial) \wedge \xi(\partial)\} + \omega$

$\geq \{[\xi(\pi * \partial) + \omega] \wedge [\xi(\partial) + \omega]\}$

$= \{\xi_\omega^{\,\psi}(\pi * \partial) \wedge \xi_\omega^{\,\psi}(\partial)\}, \forall \pi, \partial \in \vartheta$

$\Rightarrow \xi_\omega^{\,\psi}$ of ξ is a fuzzy BP- ideal of ϑ, $\forall\ \omega \epsilon [0,1]$. ■

Theorem: 3.8

If ξ is a fuzzy subset of ϑ such that the ω − FT $\xi_\omega^{\,\psi}(\pi)$ of ξ ,where ξ is a fuzzy BP- ideal of ϑ and $\omega \epsilon [0,1]$. Then ξ is a fuzzy BP- ideal of ϑ.

Proof:

Let $\xi_\omega^{\,\psi}$ is a fuzzy BP- ideal of ϑ,$\forall\ \omega \epsilon [0,1]$.

Let $\pi, \partial \in \vartheta$

(i) $\xi(0) + \omega = \xi_\omega^{\,\psi}(0)$

$\geq \xi_\omega^{\,\psi}(\pi)$

$= \xi(\pi) + \omega$

$\Rightarrow \xi(0) \geq \xi(\pi)$

(ii) $\xi(\pi) + \omega = \xi_\omega^{\,\psi}(\pi)$

$\geq \{\xi_\omega^{\,\psi}(\pi * \partial) \wedge \xi_\omega^{\,\psi}(\partial)\}$

$= \{(\xi(\pi * \partial) + \omega) \wedge (\xi(\partial) + \omega)\}$

$= \{\xi(\pi * \partial) \wedge \xi(\partial)\} + \omega$

$\Rightarrow \xi(\pi) \geq \{\xi(\pi * \partial) \wedge \xi(\partial)\} \forall \pi, \partial \in \vartheta.$

$\therefore$ ξ is a fuzzy BP-ideal of ϑ. ■

Proposition: 3.9

Let ξ is a fuzzy BP-ideal of ϑ. Then the ω −FM $\xi_\omega^{\,\varepsilon}$ of ξ is a fuzzy BP-ideal of ϑ, $\forall\ \omega \epsilon [0,1]$.

Proof:

If ξ be a fuzzy BP- ideal of , $\forall \omega \epsilon [0,1]$

Now,

(i) $\xi_\omega^{\,\varepsilon}(0) = \omega\ \xi(0)$

$\geq \omega\xi(\pi)$

$= \xi_\omega^{\,\varepsilon}(\pi)$

(ii) $\xi_\omega^{\,\varepsilon}(\pi) = \omega\ \xi(\pi)$

$\geq \omega\{\xi(\pi * \partial) \wedge \xi(\partial)\}$

$= \omega\ \xi(\pi * \partial) \wedge \omega\xi(\partial)$

$= \xi_\omega^{\,\varepsilon}(\pi * \partial) \wedge \xi_\omega^{\,\varepsilon}(\partial), \forall \pi, \partial \in \vartheta.$

$\Rightarrow \xi_\omega^{\,\varepsilon}$ of ξ is a fuzzy BP-ideal of ϑ, $\forall\ \omega \epsilon [0,1]$. ■

Theorem: 3.10

A ξ is a fuzzy subset of ϑ such that the ω − FM $\xi_\omega^{\,\varepsilon}(\pi)$ of ξ is a fuzzy BP- ideal of ϑ and $\forall\ \omega \epsilon [0,1]$. Then ξ is a fuzzy BP- ideal of ϑ.

Proof:

Let $\xi_\omega^{\,\varepsilon}$ is a fuzzy BP- ideal of ,$\forall \omega \epsilon [0,1]$.

Let $\pi, \partial \in \vartheta$

Now,

(i) $\omega\xi(\pi) = \xi_\omega^{\,\varepsilon}(0)$

$\geq \xi_\omega^{\,\varepsilon}(\pi)$

$= \omega\xi(\pi)$

$\Rightarrow \xi(0) \geq \xi(\pi)$

(ii)$\omega\xi(\pi) = \xi_\omega^{\,\varepsilon}(\pi)$

$\geq \{\xi_\omega^{\,\varepsilon}(\pi * \partial) \wedge \xi_\omega^{\,\varepsilon}(\partial)\}$

$= \{[\omega\xi(\pi * \partial)] \wedge [\omega\xi(\partial)]\}$

$= \omega\{\xi(\pi * \partial) \wedge \xi(\partial)\}$

$\Rightarrow \xi(\pi) \geq \{\xi(\pi * \partial) \wedge \xi(\partial)\}, \forall \pi, \partial \in \vartheta.$

$\therefore$ ξ is a fuzzy BP-Ideal of ϑ. ■

Proposition: 3.11

Let ξ is a fuzzy BP-Sub algebra of ϑ and $\omega \in [0,1]$. Then the ω- FT $\xi_\omega^{\,\psi}(\pi)$ of ξ is also a fuzzy BP- sub algebra of ϑ.

Proof:

Let $\pi, \partial \in \vartheta$ and $\omega \epsilon [0,1]$

Then,$\xi(\pi * \partial) \geq \xi(\pi) \wedge \xi(\partial)$

Now

$\xi_\omega^{\,\psi}(\pi * \partial) = \xi(\pi * \partial) + \omega$

$\geq [\xi(\pi) \wedge \xi(\partial)] + \omega$

$= \{\xi(\pi) + \omega \wedge \xi(\partial) + \omega\}$

$= \xi_\omega^{\,\psi}(\pi) \wedge \xi_\omega^{\,\psi}(\partial), \forall \pi, \partial \in \vartheta$ ■

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Theorem: 3.12

In ξ be a fuzzy subset of ϑ such that the ω −FT $\xi_\omega{}^{\psi}(\pi)$ of ξ. Where ξ is a fuzzy sub algebra of ϑ and $\forall \omega \epsilon [0,1]$.Then ξ is a fuzzy BP-sub algebra of ϑ.

Proof:

Let $\xi_\omega{}^{\psi}(\pi)$ is a fuzzy sub algebra of ϑ,$\forall\ \omega \epsilon [0,1]$

Let $\pi, \partial \in \vartheta$

$$\xi(\pi * \partial) + \omega = \xi_\omega{}^{\psi}(\pi * \partial)$$
$$\geq \xi_\omega{}^{\psi}(\pi) \wedge \xi_\omega{}^{\psi}(\partial)$$
$$=$$
$$\{\xi(\pi) + \omega \wedge \xi(\partial) + \omega\}$$
$$= \{\xi(\pi) \wedge \xi(\partial)\} + \omega$$
$$\Longrightarrow \xi(\pi * \partial) \geq \xi(\pi) \wedge \xi(\partial),\ \forall\ \pi, \partial \in \vartheta.$$

$\therefore$ ξ is fuzzy sub algebra of ϑ. ■

Proposition: 3.13

Every fuzzy BP- sub algebra ξ of ϑ and $\omega \epsilon [0,1]$. If the ω-FM $\xi_\omega{}^{\varepsilon}(\pi)$ of ξ is a fuzzy BP-sub algebra of ϑ.

Proof:

Let $\pi, \partial \in \vartheta$ and $\omega \epsilon [0,1]$. Then

$\xi(\pi * \partial) \geq \xi(\pi) \wedge \xi(\partial)$

Now

$$\xi_\omega{}^{\varepsilon}(\pi * \partial) = \omega\, \xi(\pi * \partial)$$
$$\geq \omega\{\xi(\pi) \wedge \xi(\partial)\}$$
$$\geq \omega\xi(\pi) \wedge \omega\, \xi(\partial)$$
$$= \xi_\omega{}^{\varepsilon}(\pi) \wedge \xi_\omega{}^{\varepsilon}(\partial)$$
$$\Longrightarrow \xi_\omega{}^{\varepsilon}(\pi * \partial) \geq \xi_\omega{}^{\varepsilon}(\pi) \wedge \xi_\omega{}^{\varepsilon}(\partial), \forall\ \pi, \partial \in \vartheta$$

Hence $\xi_\omega{}^{\varepsilon}$ is a fuzzy BP- sub algebra of ϑ . ■

Proposition: 3.14

Every fuzzy subset ξ of ϑ and $\omega \epsilon [0,1]$. If the ω −FM $\xi_\omega{}^{\varepsilon}(\pi)$ of ξ is a fuzzy BP-sub algebra of ϑ.

Proof:

Let $\xi_\omega{}^{\varepsilon}(\pi)$ of ξ is a fuzzy BP- sub algebra of ϑ ,$\forall$ $\omega \epsilon [0,1]$

Let $\pi, \partial \in \vartheta$

$$\omega\ \xi(\pi * \partial) = \xi_\omega{}^{\varepsilon}(\pi * \partial)$$
$$\geq \{\xi_\omega{}^{\varepsilon}(\pi) \wedge \xi_\omega{}^{\varepsilon}(\partial)\}$$
$$= \{\omega\ \xi(\pi) \wedge \omega\ \xi(\partial)\}$$
$$= \omega\ \{\xi(\pi) \wedge \xi(\partial)\}$$
$$\Longrightarrow \xi(\pi * \partial) \geq \xi(\pi) \wedge \xi(\partial), \forall\ \pi, \partial \in \vartheta.$$

$\therefore$ ξ is a fuzzy BP- sub algebra of ϑ.■

IV. CONCLUSION

In this paper, the new explored idea of a ω −FT and ω −FM in BP-Algebras have been delineated. The idea of ω −FT and ω −FM has been described and the several related to the algebraic properties were mentioned the results.As future works, we shall defined generalized to Doubt ω − Fuzzy Translation and Multiplication in BP-Algebras some relations between other several algebraic properties. Also, we instated to study other kinds of ideals and apply the concept of Normalization of fuzzy BP-Ideal.

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