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Structures of Pseudo - BG Algebra and Sime pseudo – BG - Algebra

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ABSTRACT

In this paper, we introduced the notion new types of algebras pseudo BG- algebra, pseudo sub BG –algebra, Pseudo Ideal and pseudo strong Ideal of Pseudo-BG-Algebras. We state some Proposition and examples which determine the relationships between these notions and some types of ideal and we introduced the notion semi pseudo BG- algebra, pseudo sub BG –algebra, Pseudo Ideal and pseudo strong Ideal of semi pseudo-BG-Algebras. We investigated a new notion, of algebra called semi pseudo BG- algebra. We state some Proposition and examples which determine the relationships between these notions and some types of ideals defined minimal and homomorphism and kernel.

1 Introduction

BCK-algebras and BCI-algebras were introduced by Imai. and Iseki as two classes of abstract algebras in 1966 [1, 2]. It is known that the class of BCK-algebras is a proper subclass of BCI-algebras. In 1983, BCH-algebras as a wide class of abstract algebras were introduced by Hu and Li [3,4]. In their study, it is given that the class of BCI-algebras are proper subclasses of BCH-algebras. In 1999, the notion of d-algebras that is another useful generalization of BCK-algebras was introduced by Neggers and Kim [5]. In 2001, a new notion called a Q-algebras was introduced by J. Neggers, S. S. Ahn and H. S. Kim [6]. At the same time pseudo-BCK-algebras as an extension of BCK-algebras was introduced by G. Geordscu, and A. Iorgulescu [7] In 2008, pseudo-BCK-algebras as a natural generalization of BCI-algebras and pseudo- BCK-algebras were introduced by W. A. Dudek and Y. B. Jun [8]. These algebras have also connections with other algebras of logics such as pseudo-MV-algebras and pseudo-BL-algebras defined by G. Georgesuc and A. Iorgulescu **[9]** and **[10]**, respectively. As a generalization of many algebras, these pseudo algebras have been studied by many researchers [11, 12, 13, 14, 15]. Bajalan and Ozbal introduced Some properties and homomorphisms of pseudo-Q algebras [16]. In this paper, we introduced the notion new types of algebras pseudo BG- algebra, pseudo sub BG –algebra, Pseudo Ideal and pseudo strong Ideal of Pseudo-BG-Algebras.

2 Preliminaries

2.1 Definition [20]

A $\boldsymbol{BG}$- algebra is a non-empty set $\boldsymbol{X}$ with a constant $\mathbf{0}$ and a binary operation $''*''$ satisfying the following axioms:

I. $x * x = 0$

II. $x * 0 = x$

III. $(\boldsymbol{x} * \boldsymbol{y}) * (\mathbf{0} * \boldsymbol{y}) = \boldsymbol{x}$, For all $\boldsymbol{x}, \boldsymbol{y} \in \boldsymbol{X}$

2.2 Definition [1]

2.3 A $\boldsymbol{BH}-$ algebra, we mean an algebra $(\boldsymbol{X}; *, \mathbf{0})$ of type (2,0) satisfying the following conditions:

I. $x * x = 0$,

II. $x * 0 = x$,

III. $x * y = 0$ and $y * x = 0$ imply $x = y \, \forall \, x, y \in X$.

2.4 Definition [2]

A pseudo BH-algebra is a non-empty set X with a constant 0 and two binary operations $"*"$ and $"\diamond"$ satisfying the following axioms:

(P1) $x * x = x \diamond x = 0$;

(P2) $x * 0 = x \diamond 0 = x$;

(P3) $x * y = y \diamond x = 0$ imply $x = y$ for all $x, y \in X$.

2.5 Definition [2]

Let $(X; *, \diamond\, 0)$ be a pseudo BH-algebra and let $\emptyset \neq I \subseteq X$. I is called a *pseudo subalgebra* of X if

$x*y, x\diamond y\in I$ whenever $x,y\in I$. I is called a *pseudo ideal* of X if it satisfies:

I. $0\in I$,

II. $x*y, x\diamond y \in I$ and $y\in I$ imply $x\in I, \forall\, x,y\in X$.

3 Pseudo – BG algebra

3.1 Definition

A pseudo- $\boldsymbol{BG}$ algebra is a structure $(\boldsymbol{X}, *, \diamond, \mathbf{0})$, where $*$ and $\diamond$ are two binary operation on a non-empty set $\boldsymbol{X}$ and satisfying the following axioms: for all $\boldsymbol{x},\boldsymbol{y}\in \boldsymbol{X}$,

P.1 $x*0 = x\between 0 = x$

P.2 $x*x = x\between x = 0$

P.3 $(x*y)\between(0*y) = (x\between y)*(0\between y) = x$

3.2 Properties

Let (X;$*$,$\between$,0) be a pseudo $-BG$ algebra then the following holds:

I. If $x*y = x\between y = 0$ then $x=y$ for any $x,y\in X$

II. If $(y*y)\between(0*y) = (y\between y)*(0\between y)$ then $(0\between y) = (0*y)$

Proof: I

If $x*y=0$ and $x\between y = 0$ then $(x*y)\between(0*y) = (x\between y)*(0\between y)$ By $P3$

We have that $0\between(0*y) = 0*(0\between y)$ then $(y*y)\between(0*y) = (y\between y)*(0\between y)$ we obtion $x=y$

Proof: II

If $(y*y)\between(0*y) = (y\between y)*(0\between y)$. Hence by (P.2) $0\between(0*y) = 0*(0\between y)$ since $y*y = y\between y = 0$ then $0\between((y*y)*y) = 0*((y\between y)\between y)$, which implies that $0\between y = 0*y$

3.3 Example

Let X= {0,1} we define the $(X;*,\between,0)$ as follows:

$x*y = x+y-2x.y$

And $x\between y = |x-y|$

For all $a, b\in X$ satisfy $P1$, $P2$ and $P3$

Hence $(X;*,\between,0)$ is pseudo – BG - Algebra

3.4 Example

Let X= {0,1,2} we define the $(X;*,\between,0)$ as follows:

Let $a*b = |a-b|(\sqrt{2})^{ab|a-b||b-2|}$ and $a\between b = |a-b|\,(3-b)^{\frac{(ab|a-b|)}{(3-b)}}$

For all $a, b\in X$ satisfy $P1$, $P2$ and $P3$

Hence $(X;*,\between,0)$ Is pseudo – BG algebra

3.5 Properties

Let $(X;*,\diamond\,0)$ be a pseudo BG-algebra. Then

I. the right cancellation law holds in X, i.e., $x*y = z\diamond y$ implies $x=z$,

II. $0*(0*x) = 0\diamond(0\diamond x) = x$ for all x ∈ X,

III. If $0*x = 0\diamond y$, then $x=y, \forall\, x,y\in X$,

IV. $\big(x*(0*x)\big)\diamond x = x, \forall x,y\in X$.

Proof:

I. Assume that $x*y = z\diamond y$. Then $x = (x*y)\diamond(0*y) = (z\diamond y)*(0\diamond y) = z$.

II. In axiom (P.3) for definition 3.1, replacing y by x, we have that $(x*x)\diamond(0*x) = (x\diamond x)\star(0\diamond x) = x$ since by (P.2) $0\diamond(0*x) = 0*(0\diamond x) = x$.

III. If $0*x = 0\diamond y$, then $x = (x*x)*(0*x) = (y*y)*(0*y) = y$ by the axiom (P3) for pseudo BG-algebra.

IV. $\big(x*(0*x)\big)\diamond x = \big(x*(0*x)\big)*\big(0*(0*x)\big) = x$ by the axiom (P3) and **Proposition 3.5 - (II).**

3.6 Pseudo Sub - BG algebra

Let X be pseudo BG- algebra then I is called a pseudo sub BG-algebra of X if $I\subseteq X$ *and* $x*y$ *or* $x\between y \in I$ when ever $x,y\epsilon I$.

3.7 Ideal Pseudo –BG - algebras

In a pseudo – BG algebras, we have a set I and $\emptyset\neq I\subseteq X$ then I is pseudo ideal of X if it satisfies,

1. $0\in I$
2. $x*y$, $x\between y\in I$ and $y\in I$ imply $x\in I$ for all $x,y\in X$. Obviously $\{0\}$ and X are pseudo ideal.

3.8 Definition

In pseudo -$\boldsymbol{BG}$-algebras Define the relation "≤" on X by ($x\le \boldsymbol{y}\leftrightarrow \boldsymbol{x}*\boldsymbol{y}=\mathbf{0}$) or (equivalent $\boldsymbol{x}\between\boldsymbol{y}=\mathbf{0}$).

3.9 Proposition

Let I be a pseudo ideal of a pseudo – BG algebra X, if $x\in I$ and $y\le x$, then $y\in I$.

Proof: Assume that $x\in I$ and $y\le x$.Then $y*x = 0$ and $y\between x = 0$. By definition **(2.4)** $0\in I; x*y, x\between y\in I$ and $y\in I$ imply $x\in I$ for all $x,y\in X$, we have $y\in I$.

3.10 Proposition

If J is a pseudo ideal of a $pseudo-BG\ algebra\ X$, then

i. $\forall\, x_1,x_2,x_3\in X, x_1,x_2\in J, x_3*x_2\le x_1\rightarrow x_3\in J$.

ii. $\forall a,b\ c\in X, a,b,\in J, c\between b\le a\rightarrow c\in J$.

Proof: If J is a pseudo ideal and let $x_1,x_2,x_3\in X$. Such that. $x_1,x_2\in J$ and $x_3*x_2\le x_1$. Then $(x_3*x_2)\between x_1 = 0\in J$. Since $x_1\in J$ and we have $x_3*x_2\in J$. Since $x_2\in J$ and J is a pseudo ideal of X, then $x_3\in J$.

3.11 Proposition

Let A be pseudo ideal of a pseudo $-BG\ algebra\ X$. If B is a pseudo ideal of A, then it is a pseudo ideal of X.

Proof:

Since B is a pseudo ideal of A, we have $0\in B$.Let $y, x*y, x\between y\in B$ for some $x\in X$. If $\in A$, then $x\in B$, since B is a pseudo ideal of A. If $x\in X-A$, then $y, x*y, x\between y\in B\subseteq A$ and so $x\in A$ because A is a pseudo ideal of X. Thus $x\in B$ since B is a pseudo ideal of A.This competes the proof.

3.12 Definition

An element w of a $pseudo-BG-algebra\ X$ is called a pseudo a tom if for every $x\in X$, $x\le w$ implies $x=w$. Obviously, 0 is a pseudo atom of X.

3.13 Lemma

A non-zero element $a\in X$ is a pseudo atom of X if $\{0,a\}$*is a pseudo* ideal of X.

3.14 Definition

A non-empty subset A of a $pseudo-BG-algebra$ X is called a pseudo strong ideal of X if it satisfies definition (3.6)

$(PI3)$ $(x*y)\lozenge z, y\in A$ imply $x*z\in A$;

$(PI3')$ $(x\lozenge y)*z, y\in A\ imply\ x,y,z\in X$.

Note that if X is a pseudo-$BG-algebra\ satisfying$ $x*y = x\lozenge y$ for all $x,y\in X$, then the notation of a pseudo strong ideal and a strong ideal consider .

3.15 Proposition

Every pseudo strong ideal is a pseudo ideal.

Proof: Putting $z = 0$ in by definition (**3.14**), we have $x*y, x\lozenge y, y\in A$ implied $x\in A$.

4 Sime Pseudo – BG algebra

4.1 Definition

Let X is a non–empty set, $''*''\ and\ ''\lozenge''$ are two binary operation satisfying the following axioms:

P.1 $x*x = x\lozenge x = 0$

P.2 $x*0 = x\lozenge 0 = x$

P.3 $(x*y)\lozenge(0*y) = (x\lozenge y)*(0\lozenge y)$

Then $(X;*,\lozenge,0)$ is semi $pseudo\ BG-algebra$

4.2 Example

Let X= {0,1,2} we define the $(X;*,\lozenge,0)$ as follows

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

$\diamond$	0	1	2
0	0	0	2
1	1	0	1
2	2	0	0

Then it is easy to show that $(X;*,0)$ and $(X;\lozenge,0)$ are not BG-algebras and $(X;*,\lozenge,0)$ is not a pseudo BG-algebra because $(2*1)\lozenge(0*1) = (2\lozenge 1)*(0\lozenge 1)\neq 2$, but $(X;*,\lozenge,0)$ is a semi pseudo BG-algebra.

4.3 Lemma

Let $(X;*,\lozenge,0)$ be a semi pseudo $-BG-$ algebra if $(y*y)\diamond(0*y) = (y\diamond y)*(0\diamond y)$ then $(0\diamond y) = (0*y)$

Proof: since $(y*y)\diamond(0*y) = (y\diamond y)*(0\diamond y)$ by P.1 we get $0\diamond(0*y) = 0*(0\diamond y)$.

4.4 Lemma

Let $(X;*,\lozenge,0)$ be a semi pseudo $-BG-$ algebra then

1. $(x\diamond 0)\diamond 0 = x\ and\ (x*0)*0 = x\ \forall\, x\in X$.
2. If $(0*x) = (0*y)\ and\ (0\diamond x) = (0\diamond y)$, then $x = y\ \forall x,y\in X$.
3. $(x*(0*x)*x = x$ and $(x\diamond(0\diamond x)\diamond x = x$

Proof: it is clearer

4.5 Definition

I is called a semi pseudo sub BG-algebra of X if $I\subseteq X\ and\ x*y\ or\ x\lozenge y\ \in I$ when ever $x,y\epsilon I$.

4.6 Definition

In a semi pseudo – BG algebras, let $\emptyset\neq I\subseteq X$ then I is pseudo ideal of X if it satisfies,

3. $0\in I$
4. $x*y$, $x\lozenge y\in I$ and $y\in I$ implies $x\in I$ for all $x,y\in X$. Obviously $\{0\}$ and X are semi pseudo ideal.

4.7 Theorem

The intersection two semi pseudo - BG – subalgebra is also semi pseudo -BG- subalgebra.

Proof: let $I\subset X$ and $J\subset X$ are semi Pseudo – BG – Algebra

Since $0\in I\ \&\ 0\in J$ then $0\in I\cap J$ and $I\ \&\ J\subset X$ then $\emptyset\neq I\cap J\in X$.

Let $x*y, x\diamond y\in I\cap J$ then $x*y, x\diamond y\in I$, and $x*y, x\diamond y\in J$

Since I and J are ideal semi Pseudo – BG – Algebra then $y\in I$ and $y\in J$ implies $x\in I$ and $\in J$, then $y\in I\cap J$ and implies $x\in I\cap J$.

4.8 Definition

In semi pseudo -$\boldsymbol{BG}$-algebras Define the relation "≤" on X by (x $\leq \boldsymbol{y} \leftrightarrow \boldsymbol{x*y=0}$) or (equivalent $\boldsymbol{x\lozenge y=0}$).

4.9 Theorem

Let $(X,*,\diamond,0)$ be a semi pseudo -$\boldsymbol{BG}$-algebras. If $x*(y*z) = x\diamond(y\diamond z)$, $\forall\, x,y,z\in X$ then $0*x = x = 0\diamond x$, $\forall\, x\in X$.

Proof: Let $x\in X$, where $x = x*0 = x*(x*x) = (x*x)*x = 0*x$

and where $0\diamond x = x$.

4.10 Theorem

Every semi pseudo -$\boldsymbol{BG}$-algebras $(X,*,\diamond,0)$ satisfy the associative law is a group under each operation "$*$" and "$\diamond$".

Proof: Putting $x = y = z$ in the associative law $(x*y)*z = x\diamond(y\diamond z)$ and using $0*x = x*x = x$. This means $0\in X, \forall x\in X$ has a sets inverse the element of X itself by definition 3.1 P2. There for $(X,*)$ and $(X,\diamond)$ are a group.

4.11 Definition

An element a of a semi pseudo -$\boldsymbol{BG}$-algebras. x is said to be minimal if $\forall x\in X$ the following implication $x\leq a\ \rightarrow x = a$

4.12 Property

Let x be a semi pseudo -$\boldsymbol{BG}$-algebras and let $a\in X$. If a is minimal then

$x\diamond(x*a) = a\quad and\quad x*(x\ \diamond a) = a$

Proof: let a is minimal [by $x\leq 0\ \rightarrow x = 0$]

$x\diamond(x*a)\leq a\ \ \forall x\in X.\ \ Since\ a\ is\ minimal$ then $x\diamond(x*a) = a$

5 Homomorphism

5.1 Definition

Let X and y be a semi pseudo BG-Algebra. A mapping $f{:}\,X\rightarrow Y$ is called a homomorphism of semi pseudo BG-Algebra if

$f(x*y) = f(x)*f(x)\ \ and\ \ f(x\diamond y) = f(x)\diamond f(y),\ \ \forall x,y\in X$

Note that: if $f{:}\,X\rightarrow Y$ is homomorphism of semi pseudo, then $f(0x) = 0y$, where $0x\ and\ 0y$ are zero elements of $x\ and\ y$ respectively

5.2 Example

Let $(X,*,\diamond,0)$ be a semi pseudo BG-Algebra then the function $f{:}\,X\rightarrow Y$ such that $f(x) = x*0$, for any $x\in X$ is a homomorphism of semi pseudo BG-Algebra

$f(x) * f(y) = (x * 0) * (y * 0) = (x * y) * 0 = f(x * y)$. And $f(x) \diamond f(y) = (x * 0) \diamond (y * 0) = (x \diamond y) = (x \diamond y) * 0 = f(x \diamond y)$.

5.3 Theorem

Let $f: X \longrightarrow Y$ be a homomorphism of semi pseudo BG-Algebra

I. If B is a semi pseudo ideal of $y \longrightarrow f^{-1}(B)$ is a pseudo ideal of x

II. If f is surjective and I is a semi pseudo ideal of x, then $f(I)$ is a semi pseudo ideal of y.

Proof: I. $0_y \in f^{-1}(B)$, let $y \in f^{-1}(B)$ and let $x_1, x_2 \in X$ be such that $x_1 * y \in f^{-1}(B)$ and $x_2 \diamond y \in f^{-1}(B)$. To show $x_1, x_2 \in f^{-1}(B)$?

$x_1 * y \in f^{-1}(B) \longrightarrow \exists\, b_1 \in B$ and $b_1 \in B$ such that

$f(x_1 * y) = b_1$ *and* $f(x_2 \diamond y) = b_2$ *also* $y \in f^{-1}(B), \exists\, b \in B$

Such that

$y = f^{-1}(b) \Longrightarrow f(y) = b$

$f(x_1) * f(y) = f(x_1 * y) = b_1$

$b_1 \in B \Longrightarrow f(x_1) \in B$

$f(x_2) \diamond f(y) = f(x_2 \diamond y) = b_2$

$b_2 \in B \Longrightarrow f(x_2) \in B$

Since B is semi pseudo ideal

$\therefore f(x_1) \in B$ & $f(x_2) \in B$ *in* $Y \Longrightarrow x_1 \in f^{-1}(B)$ & $x_2 \in f^{-1}(B)$ *in* X

$f^{-1}(B)$ is a semi pseudo ideal in X.

II. Assume that f is surjective and let I be a semi pseudo ideal of x obriousely, $0_y \in f(I)$. For every $y \in f(I)$. Let $a, b \in Y$ be such that $a * y \in f(I)$ and $b \diamond y \in f(I)$, then there exist $x_*, x_\diamond \in I$ such that $f(x_*) = a * y$ and $f(x_\diamond) = b \diamond y$. Since $y \in f(I)$ there exist $xy \in I, y = f(x_y)$. Also f is surjective. $\exists\, x_a, x_b \in X$ such that $f(x_a) = a$ and $f(x_b) = b$, $f(x_a * x_y) = f(x_a) * f(x_y) = a * y \in f(I)$ and $f(x_b * x_y) = f(x_b) * f(x_y) = b * y \in f(I)$

Which implies that $x_a * x_y \in I$ and $x_b \diamond x_y \in I$, since I is semi pseudo ideal of X we get $x_a, x_b \in I$ and $a = f(x_a)$, $b = f(x_b) \in f(I)$ $f(I)$ is semi pseudo ideal of X.

5.4 Corollary

Let $f: X \longrightarrow Y$ be a homomorphism of semi pseudo ideal. Then $\ker(f) = \{x \in X; f(x) = 0\}$ is a semi pseudo ideal of X.

5.5 Property

Let $f: (X, *_1, \diamond_1, 0) \longrightarrow (Y, *_2, \diamond_2, 0)$ be a homomorphism of semi pseudo BG-Algebra. Then $x *_1 y, x \diamond_1 y \in \ker(f)$ if $f(x) = f(y), \forall x, y \in X$

Proof: Assume that $f(x) = f(y)$. Then $f(x) *_2 f(y) = f(x *_1 y) = 0$ and $f(x) \diamond_2 f(y) = f(x \diamond_1 y) = 0$ Hence $x *_1 y, x \diamond_1 y \in \ker(f)$.

5.6 Theorem

Let $f: X \to Y$ is homomorphism of Semi pseudo ideal. Then f is monomorphism if f $\ker(f) = \{0\}$.

5.7 Theorem

Let X, Y, Z be a Semi pseudo ideal and $h: X \to Y$ be an onto homomorphism of Semi ideal and $g: Y \to Z$ be a homomorphism of semi pseudo BG-algebra. If $\ker(h) \subseteq \ker(g)$, $\exists$ a unique homomorphism of Semi pseudo ideal $f: X \to Z$ satisfy $f \circ h = g$.

Conclusion

we introduced the notion new types of algebras pseudo BG- algebra, pseudo sub BG –algebra, Pseudo Ideal and pseudo strong Ideal of Pseudo-BG-Algebras. We state some Proposition and examples which determine the relationships between these notions and some types of ideal and we introduced the notion semi pseudo BG- algebra, pseudo sub BG –algebra, Pseudo Ideal and pseudo strong Ideal of semi pseudo-BG-Algebras.

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تركيب الجبر الزائف – BG و الجبر شبة الزائف – BG

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الملخص

في هذا البحث ، قدمنا مفهوم أنواع جديدة من الجبر الزائف -BG الجبر ، الجبر شبه الزائف BG، الجبر المثالي الزائف والمثال القوي الزائف. نذكر بعض المقترحات والأمثلة التي تحدد العلاقات بين هذه المفاهيم وبعض أنواع المثالية وقدمنا فكرة شبه زائفة -BG الجبر ، شبه زائف – BG الجبر. مثالي شبه زائف -BG - الجبر. لقد بحثنا في مفهوم جديد للجبر يسمى شبه الجبر الزائف -BG. نذكر بعض المقترحات والأمثلة التي تحدد العلاقات بين هذه المفاهيم وبعض أنواع المثل العليا المحددة الحد الأدنى وتماثل الشكل والنواة.