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Generalization of Bi- Γ-Ideals in Ternary Γ-Semirings

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Abstract:

Murali Krishna Rao was presented the idea of Γ-semirings as a speculation of the thought of Γ-rings as well as of semirings. We have realized that the thought of Γ-semirings is a generality of the idea of semirings. During this paper we sum up the thought of summed up bi-Γ-ideals of Ternary Γ-semirings and examine a few related properties of summed up bi-Γ-ideals.

Keywords: Ternary Γ-Ideal, generalized bi- ternary Γ-ideal, bi- ternary Γ-ideal

Mathematics Subject Classification. 16Y30, 16Y99

1. Introduction and Preliminaries

The possibility of Γ-semirings was laid out and concentrated in 1995 by Murali Krishna Rao [10] as a speculation of the thought of Γ-rings as well as of semiring, and summed up bi-ideals was first presented for rings in 1970 by Szasz[12, 13] and afterward for semigroups by Lajos[8]. Many sorts of ideals on the mathematical designs were portrayed by a few creators, for example, In 2000, concentrated on the portrayal of semiprime ideals and irreducible ideals of Γ-semirings concentrated by Dutta and Sardar[3] and primitive ideals of Γ-semirings, Pianskool, Sangwirotjanapat and Tipyota[9] presented and concentrated on valuation of Γ-semirings and valuation of Γ-ideals of a Γ-semiring, and Chinram[1] gave a few properties of quasi-ideals in Γ-semirings.

Jagatap and Pawar [6] presented the idea of minimal quasi-ideals in Γ-semirings in 2009. A few properties of minimal quasi-ideals in Γ-semirings are given. In 2010, Ghosh and Samanta[5] concentrated on the connection between the fuzzy left (separately, right) ideals of Γ-semirings and that of operator semiring. In 2011, Dutta, Sardar and Goswami[4] presented various kinds of procedure on fuzzy ideals of Γ-semirings and demonstrated consequently that these activities bring about various designs like complete lattice, modular lattice on some limited class of fuzzy ideals of Γ-semirings. In 2012, Bektas, Bayrak and Ersoy[2] presented and concentrated on the portrayal of soft Γ-semirings and soft sub-Γ-semiring.

The view of ideals for some kinds of Γ-semirings is the truly significant and intrigued thing with regards to Γ-semirings. Hence, we will start and concentrate on summed up bi-Ternay Γ-ideals of Γ-semirings similarly as of bi-Γ-ideals of Ternary Γ-semirings which was concentrated by Kaushik, Moin and Khan[7].

"Throughout this paper generalized bi- ternary Γ-ideal- GBTΓI, smallest generalized bi- ternary Γ-ideal- SGBTΓI, Ternary Γ-semiring- TΓS, minimal generalized bi- Γ-ideal- MGBTΓI, Quasi ternary Γ-Ideal – QTΓI, partial ternary Γ-ideal- PTΓI"

Definition 1.1: Let U, Γ be two additive commutative semigroups. Then U is entitled a ***ternary gamma semiring*** presented ∃ a mapping $U\times\Gamma\times U\times\Gamma\times U\rightarrow U$ suiting the next conditions:

(1) $x\eta y\varsigma(z\lambda p\psi q)=x\eta(y\varsigma z\lambda p)\psi q=(x\eta y\varsigma z)\lambda p\psi q$

(2) $[(p+q)\eta r\varsigma s]=[(p\eta r\varsigma s]+[q\eta r\varsigma s]$

(3) $[p\eta(q+r)\varsigma s]=[(p\eta q\varsigma s]+[p\eta r\varsigma s]$

(4) $[p\eta q\varsigma(r+s)]=[(p\eta q\varsigma r]+[p\eta q\varsigma s]\forall p,q,r,s\in U\ \&\ \eta,\varsigma,\psi,\lambda\in\Gamma.$

Example: 1.2 Set N of natural numbers & Γ = {1, 2, 3}. Then (Γ, max) & (N, max) are commutative semigroups. Characterize the mapping $N\times\Gamma\times N\times\Gamma\times N\rightarrow N$, by $b\eta c\varsigma d=\min\{b,\eta,c,\varsigma,d\}\forall b,c,d\in N\ \&\ \eta,\varsigma\in\Gamma.$ Next N is a TΓS.

Example: 1.3 Rational numbers set (Q) & $\Gamma=N$ the set of natural numbers. Afterward (N, +), (Q, +) are commutative semigroups. Identify the mapping $Q\times\Gamma\times Q\times\Gamma\times Q\rightarrow Q$ by $b\eta c\varsigma d$ usual product $b,\eta,c,\varsigma,d\forall b,c,d\in Q\ \&\ \eta,\varsigma\in\Gamma.$ Followed by Q is a TΓS.

Example: 1.4 Rational numbers set (Q). The commutative semigroup (S, +) of all 2×3 matrices over Q & (Γ, +) commutative semigroup of all 3×2 matrices over Q. Classify $W\eta Y\varsigma X$ standard matrix product of $W,\eta,Y,\varsigma,X\ \forall W,Y,X\in S\ \&\ \forall\eta,\varsigma\in\Gamma.$

Afterward S is not a semiring & a TΓS.

Definition 1.5: A partial ternary Γ -semiring known to have a L (L_a, R) unity element afford $\exists\eta_i,\varsigma_i:i\in I,e_i:i\in I$ of M & of Γ ∋

$\sum e_i\eta_i e_i\varsigma_i c=c(\sum e_i\eta_i c\varsigma_i e_i=c,\sum c\eta_i e_i\varsigma_i e_i=c)$ for any $c\in$ M.

Definition 1.6: Let M be a partial ternary Γ-semiring. $A(\neq\phi)\subseteq M$ is known to be L (L_a, R) ***partial ternary Γ-ideal*** of M afford

(i) $(v_i:i\in I)$ is a sum able family & $v_i\in$ A $\forall i\in I\Rightarrow\sum_i v_i\in A$

(ii) $\forall u,v\in M\ \&\ q\in A\Rightarrow q\eta u\varsigma v\in$ A $(u\eta q\varsigma v\in$ A$,u\eta v\varsigma q\in$ A$)$

If A is L (L_a, R) PTΓI of M.

Definition 1.7: Let M be a TΓS. $A(\neq\phi)\subseteq M$ is known as a L (L_a, R) ***TΓI*** of M, if it satisfy the next:

(i) A is a L (L_a, R) PTΓI of M.

(ii) $v\in M\ \&\ w\in A\ni v\leq w$ then $v\in$ A.

If A is L (L_a, R) TΓI of M, afterward A is recognized as TΓI of M.

Definition1.8: A $O(\neq \phi) \subseteq N$ is entitled

(1) a BTΓI of N if O is a sub- Γ-semiring of N & $O\Gamma N\Gamma O\Gamma N\Gamma O \subseteq O$.

(2) a GBTΓI of N if $O\Gamma N\Gamma O\Gamma N\Gamma O \subseteq O$.

(3) a QTΓI of N if O is a sub- Γ-semiring of N &
$(N\Gamma O\Gamma O) \bigcap (O\Gamma N\Gamma O + O\Gamma O\Gamma N\Gamma O\Gamma O) \bigcap (O\Gamma O\Gamma N) \subseteq N$

Remark1.9: Let M be a TΓS. Then:

(1)Each QTΓI of M is a BTΓI.

(2)Each BTΓI of M is a GBTΓI.

Definition1.10: A TΓS is named a GB-simple TΓ-semiring if M is the unique GBTΓI of M.

2.Properties of GBTΓI's:

Before the portrayals of generalized bi-Γ-ideals of Γ-semirings for the primary outcomes, we give a few helper results which are vital in what follows.

Lemma2.1: Let U be a TΓS and $l \in U$. Then $l\Gamma l\Gamma U, l\Gamma U\Gamma l$ & $U\Gamma l\Gamma l$ are GBTΓI's of U.

Lemma2.2: Let M be a TΓS, $\{D_i / i \in I\}$ a non-empty family of GBTΓI's of M with $\bigcap_{i\in I} D_i \neq \phi$.

Then $\bigcap_{i\in I} D_i$ is a GBTΓI of M.

Proof: $\forall i \in I$, we have

$$(\bigcap_{i\in I} D_i)\Gamma M\Gamma(\bigcap_{i\in I} D_i)\Gamma M\Gamma(\bigcap_{i\in I} D_i)$$
$$\subseteq D_i\Gamma M\Gamma D_i\Gamma M\Gamma D_i \subseteq D_i$$

Thus

$$(\bigcap_{i\in I} D_i)\Gamma M\Gamma(\bigcap_{i\in I} D_i)\Gamma M\Gamma(\bigcap_{i\in I} D_i) \subseteq \bigcap_{i\in I} D_i.$$

Hence $\bigcap_{i\in I} D_i$ is a GBTΓI of M.

Lemma 2.3: Let M be a TΓS & $\phi \neq E \subseteq S$. Then $E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E$ is the SGBTΓI of S containing E.

Proof: Let $D = E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E$. Then $E \subseteq D$. Therefore

$$D\Gamma S\Gamma D\Gamma S\Gamma D = (E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E)\Gamma S\Gamma(E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E)\Gamma U\Gamma(E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E)$$
$$\subseteq [E(\Gamma S\Gamma S\Gamma)(E \bigcup E(\Gamma S\Gamma S\Gamma)E\Gamma S\Gamma E\Gamma S\Gamma E)] \bigcup$$
$$[E\Gamma S\Gamma E\Gamma S\Gamma E(\Gamma S\Gamma S\Gamma)E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E(\Gamma S\Gamma S\Gamma)E\Gamma S\Gamma E\Gamma S\Gamma E]$$
$$= E\Gamma S\Gamma E\Gamma S\Gamma E \subseteq E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E = D.$$

Thus $D = E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E$ is a GBTΓI of S. We shall explain that D is the SGBTΓI of S containing E. Let C be a GBTΓI of S. Then

$E\Gamma S\Gamma E\Gamma S\Gamma E \subseteq C\Gamma S\Gamma C\Gamma S\Gamma C \subseteq C.$

Thus $D = E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E \subseteq C.$

Hence D is the SGBTΓI of S having E.

$\therefore (E) = E \bigcup E\Gamma S\Gamma E\Gamma S\Gamma E$

It is also denoted the SGBTΓI of S containing {e} as (e).

Lemma 2.4: Let T be a sub TΓ-semiring of a TΓS M, $a \in M$ & $(a\Gamma T\Gamma a\Gamma T\Gamma a) \bigcap T \neq \phi$. Then $(a\Gamma T\Gamma a\Gamma T\Gamma a) \bigcap T$ is a GBTΓI of T.

Proof: Believe

$(a\Gamma T\Gamma a\Gamma T\Gamma a \bigcap T)\Gamma T\Gamma(a\Gamma T\Gamma a\Gamma T\Gamma a \bigcap T) \subseteq [(a\Gamma T\Gamma a\Gamma T\Gamma a)\Gamma T \bigcap T\Gamma T]\Gamma(a\Gamma T\Gamma a\Gamma T\Gamma a \bigcap T)$
$\subseteq [(a\Gamma T\Gamma a\Gamma T\Gamma a)\Gamma T \bigcap T]\Gamma(a\Gamma T\Gamma a\Gamma T\Gamma a \bigcap T)$
$\subseteq [[(a\Gamma T\Gamma a\Gamma T\Gamma a\Gamma T)\Gamma(a\Gamma T\Gamma a\Gamma T\Gamma a)] \bigcap [T\Gamma(a\Gamma T\Gamma a\Gamma T\Gamma a \bigcap T)]]$ Hence
$\subseteq [(a\Gamma T\Gamma a\Gamma T\Gamma a) \bigcap (T\Gamma a\Gamma T\Gamma a\Gamma T\Gamma a)] \bigcap T$
$\subseteq (a\Gamma T\Gamma a\Gamma T\Gamma a) \bigcap T.$
$(a\Gamma T\Gamma a\Gamma T\Gamma a) \bigcap T$ is a generalized bi- Γ-ideal of T.

Lemma 2.5: Let J be a TΓS & $j \in J$. Then $j \in j\Gamma J\Gamma j\Gamma J\Gamma j$ is a GBTΓI **of J.**

Proof: Consider

$(j\Gamma J\Gamma j\Gamma J\Gamma j)\Gamma I\Gamma(j\Gamma J\Gamma j\Gamma J\Gamma j)\Gamma J\Gamma(j\Gamma J\Gamma j\Gamma J\Gamma j)$
$= j\Gamma(J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J\Gamma j\Gamma J)\Gamma j$
$\subseteq j\Gamma J\Gamma\Gamma J\Gamma j$

Hence $j\Gamma J\Gamma j\Gamma J\Gamma j$ is a GBTΓI of J.

Proposition2.6: Let M be a TΓS & T a sub-TΓS of M. Then each subset of T having $M\Gamma M\Gamma T$ is a sub- TΓS of M.

Proof: Let $J \subseteq T \ni M\Gamma M\Gamma T \subseteq J.$

$\Rightarrow J\Gamma J\Gamma J \subseteq M\Gamma M\Gamma T \subseteq J.$

Consequently J is a sub- TΓS of M.

Proposition 2.7: Let Z be a TΓS & T is TΓI of M. Next each subset of T including $Z\Gamma Z\Gamma T \bigcup \Gamma T\Gamma Z \bigcup T\Gamma Z\Gamma Z$ is a TΓI of M.

Proof: Let $B \subseteq T \ni Z\Gamma Z\Gamma T \bigcup Z\Gamma T\Gamma Z \bigcup T\Gamma Z\Gamma Z \subseteq B.$

Then $Z\Gamma Z\Gamma B \subseteq Z\Gamma Z\Gamma T \subseteq Z\Gamma Z\Gamma T \bigcup Z\Gamma T\Gamma Z \bigcup T\Gamma Z\Gamma Z \subseteq B$

$Z\Gamma B\Gamma Z \subseteq Z\Gamma T\Gamma Z \subseteq Z\Gamma Z\Gamma T \bigcup Z\Gamma T\Gamma Z \bigcup T\Gamma Z\Gamma Z \subseteq B$

$B\Gamma Z\Gamma Z \subseteq T\Gamma Z\Gamma Z \subseteq Z\Gamma Z\Gamma T \bigcup Z\Gamma T\Gamma Z \bigcup T\Gamma Z\Gamma Z \subseteq B$

Thus B is a TΓI of Z.

Proposition 2.8: Let L be a TΓS & T is TΓI of L. Afterward each subset of T containing $(T\Gamma L\Gamma L) \bigcap (L\Gamma T\Gamma L + L\Gamma L\Gamma T\Gamma L\Gamma L) \bigcap (L\Gamma L\Gamma T)$ **is a QTΓI of L.**

Proof: Allow $C \subseteq T \ni (T\Gamma V\Gamma V) \bigcap (V\Gamma T\Gamma V + V\Gamma V\Gamma T\Gamma V\Gamma V) \bigcap (V\Gamma V\Gamma T) \subseteq C$. Then

$C\Gamma C\Gamma C \subseteq (T\Gamma L\Gamma L) \bigcap (L\Gamma T\Gamma L + L\Gamma L\Gamma T\Gamma L\Gamma L) \bigcap (L\Gamma L\Gamma T) \subseteq C$

And $(C\Gamma L\Gamma L) \bigcap (L\Gamma C\Gamma L + L\Gamma L\Gamma C\Gamma L\Gamma L) \bigcap (L\Gamma L\Gamma C) \subseteq (T\Gamma L\Gamma L) \bigcap (L\Gamma T\Gamma L + L\Gamma L\Gamma T\Gamma L\Gamma L) \bigcap (L\Gamma L\Gamma T) \subseteq C.$

So C is a QTΓI of L.

Proposition 2.9: Let M be a TΓS & T be BTΓI of M. Afterward each subset of T holding $T\Gamma M\Gamma T\Gamma M\Gamma T$ **and all of its images is a BTΓI of M.**

Proof: Permit $I \subseteq T \ni T\Gamma M\Gamma T\Gamma M\Gamma T \subseteq I \,\&\, I\Gamma I\Gamma I \subseteq I.$

$\Rightarrow I\Gamma M\Gamma I\Gamma M\Gamma I \subseteq T\Gamma M\Gamma T\Gamma M\Gamma T \subseteq I.$

Consequently I is a BTΓI of M.

Proposition 2.10. Let M be a TΓS & T is a GBTΓI **of M. Then each subset of T holding** $T\Gamma M\Gamma T\Gamma M\Gamma T$ **is a** GBTΓI **of M.**

Proof: Permit $E \subseteq T \ni T\Gamma M\Gamma T\Gamma M\Gamma T \subseteq E.$

Then $E\Gamma M\Gamma E\Gamma M\Gamma E \subseteq T\Gamma M\Gamma T\Gamma M\Gamma T \subseteq E.$

$\therefore$ E is a GBTΓI of M.

Theorem2.11. Let M be a TΓS. Then the next declarations are correspondent.

(1)M is a GB-simple Γ-semiring.

(2) $h\Gamma M\Gamma h\Gamma M\Gamma h = M \forall h \in M.$

(3) $(h) = M \forall h \in M.$

Proof: $(1) \Rightarrow (2)$ Believe that M is a GB-simple TΓS & $h \in M.$

$h\Gamma M\Gamma h\Gamma M\Gamma h$ is a GBTΓI of M by lemma 2.5,

$\because$ M is a GB-simple TΓ-semiring, $M = h\Gamma M\Gamma h\Gamma M\Gamma h.$

$(2) \Rightarrow (3)$ Believe that $M = h\Gamma M\Gamma h\Gamma M\Gamma h \forall h \in M$ & let $h \in M.$ Then, by (2.2), we cover

$(h) = \{h\} \bigcup h\Gamma M\Gamma h\Gamma M\Gamma h = \{h\} \bigcup M = M.$

$(3) \Rightarrow (1)$ Assume that (h)=M for all $h \in M$, and let H be a GBTΓI of M & $h \in H.$ $\Rightarrow (h) \subseteq H.$ With statement, $M = (h) \subseteq H \subseteq M.$

Thus M=H. $\therefore$ M is a GB-simple TΓ-semiring.

Lemma 2.12: Let B be a GBTΓI of a TΓS M & T a sub-TΓ-semiring of M. If T is a GB-simple TΓ-semiring $\ni T \cap B \neq \phi,$ **then** $T \subseteq B.$

Proof: Presume T is a GB-simple TΓ-semiring $\ni T \cap B \neq \phi$ & let $h \in T \cap \mathrm{B}.$

Via Lemma 2.3, $T = \{h\} \cup h\Gamma T\Gamma h\Gamma T\Gamma h \subseteq \mathrm{B} \cup \mathrm{B}\Gamma M\Gamma \mathrm{B}\Gamma M\Gamma \mathrm{B} \subseteq \mathrm{B} \cup \mathrm{B} \subseteq \mathrm{B}.$

Hence $T \subseteq \mathrm{B}.$

Theorem 2.13: Let V be a TΓS, B be a GBTΓI of V & $G(\neq \phi) \subseteq V$ **then** $G\Gamma G\Gamma B, G\Gamma B\Gamma G$ & $B\Gamma G\Gamma G$ **are GBTΓI of V.**

Proof: $\because$ B is a GBTΓI of V,

$\Rightarrow (B\Gamma G\Gamma G)\Gamma V\Gamma(B\Gamma G\Gamma G) = (B\Gamma(G\Gamma G\Gamma V)\Gamma B)\Gamma G \subseteq B\Gamma G\Gamma G$

$(G\Gamma B\Gamma G)\Gamma V\Gamma(G\Gamma B\Gamma G) = (G\Gamma(B\Gamma G\Gamma V\Gamma G\Gamma B)\Gamma G) \subseteq G\Gamma B\Gamma G$

$Similarly (G\Gamma G\Gamma B)\Gamma V\Gamma(G\Gamma G\Gamma B) \subseteq G\Gamma G\Gamma B$ are GBTΓI of V.

Theorem2.14: Let M be a TΓS. Subsequently $i\Gamma \mathrm{M}\Gamma i\Gamma \mathrm{M}\Gamma i = \mathrm{M} \forall i \in \mathrm{M}$ **iff M is a GB-simple TΓ-semiring.**

Proof: Presume $i\Gamma \mathrm{M}\Gamma i\Gamma \mathrm{M}\Gamma i = \mathrm{M} \forall i \in \mathrm{M}$ & let B is a GBTΓI of M & $b \in \mathrm{B}.$

By hypothesis, $\mathrm{M} = b\Gamma \mathrm{M}\Gamma b\Gamma \mathrm{M}\Gamma b \subseteq \mathrm{B}\Gamma \mathrm{M}\Gamma \mathrm{B}\Gamma \mathrm{M}\Gamma \mathrm{B} \subseteq \mathrm{B} \subseteq \mathrm{M}.$

Hence M=B, so M is a GB- simple TΓ-semiring.

On the contrary, assume that M is a GB- simple TΓ-semiring $i \in \mathrm{M}.$ By Lemma 2.1 and Theorem 2.13, we have $i\Gamma \mathrm{M}\Gamma i\Gamma \mathrm{M}\Gamma i$ is a GBTΓI of M. $\because$ M is a GB-simple TΓ-semiring ,

$\Rightarrow i\Gamma \mathrm{M}\Gamma i\Gamma \mathrm{M}\Gamma i = \mathrm{M}.$

Theorem2.15: Let Q be a TΓS & D a BTΓI of Q. Then D is a MGBTΓI of Q iff D is a GB-simple TΓ-semiring.

Proof: Presume that D is a MGBTΓI of Q. Via supposition, D is a TΓS.

Let B be a GBTΓI of D. Next $B\Gamma D\Gamma B\Gamma D\Gamma B \subseteq B \subseteq D.$

$\because$ D is a GBTΓI of Q & by Th 2.13, cover $B\Gamma D\Gamma B\Gamma D\Gamma B$ is a GBTΓI of Q. As D is a MGBTΓI of Q, we get $B\Gamma D\Gamma B\Gamma D\Gamma B = D.$ Via (2.3), D=B. So D is GB-simple TΓ-semiring.

Permit B be a GBTΓI of Q $\ni B \subseteq Q.$

$\Rightarrow B\Gamma D\Gamma B\Gamma D\Gamma B \subseteq B\Gamma Q\Gamma B\Gamma Q\Gamma B \subseteq B.$

Consequently C is a GBTΓI.

$\because$ D is a GB-simple TΓ-semiring, enclose D=B.

$\therefore$ D is a MGBTΓI of Q.

Theorem2.16: Let M be a TΓS having a proper GBTΓI. Afterward each proper GBTΓI of M is minimal iff the intersection of any two distinct proper GBTΓI's is empty.

Proof: Similar to the above theorem

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