Ternary Γ-SO-semirings-3

Bhagyalakshmi Kothuru, V.Amarendra Babu

Abstract: ***"In this paper we are introducing the notions of subtractive and strong subsets in partial ternary Γ - semirings.***

We show that in a ternary Γ - SO semiring satisfying that every non-zero ideal is strong and subtractive Further we will show that join of any two ideals is equal to the sum of those two ideals in a ternary Γ - SO semiring satisfying the decomposition property. In a ternary Γ - SO semiring satisfying the decomposition property then ideal(R) is a distributive lattice".

Keywords: Subtractive, strong, austere, join, entire.

I. INTRODUCTION

The notion of ideals in SO-rings studied by G.V.S Acharyulu [1] and M.MuralikrishnaRao[8] studied ideals in Γ - semirings. Further ideals of SO-Partial Γ - semirings investigated by Sivamala.M, Siva Prasad.K [19]. Recently the study of ideals in ternary Γ - semiring [12].

II. PRELIMINARIES

Throughout this paper ternary Γ-SO –semiring refers to TΓSS. And CTΓ-SS refers to complete ternary Γ-SO –semiring. From below some important definitions is given:

Definition2.1: [8] "Let R and Γ be two additive commutative semi groups. R is said to be a ***ternary Γ-semiring*** if there exist a mapping from R ×Γ× R×Γ× R⟶ R which maps $(x_1,\alpha,x_2,\beta,x_3)\longrightarrow[x_1\alpha x_2\beta x_3]$ satisfying the conditions

(i) $(a\alpha b\beta c)\gamma d\delta e = a\alpha(b\beta c\gamma d)\delta e = a\alpha b\beta(c\gamma d\delta e)$

(ii) $[(a+b)\alpha c\beta d] = [a\alpha c\beta d] + [b\alpha c\beta d]$

(iii) $[a\alpha(b+c)\beta d] = [a\alpha b\beta d] + [a\alpha c\beta d]$

(iv) $[a\alpha b\beta(c+d)] = [a\alpha b\beta c] + [a\alpha b\beta d]$

for all $a, b, c, d\in R$ and $\alpha,\beta,\gamma,\delta\in\Gamma$".

Definition2.2:[12] "Let M be a ternary Γ-SO-semiring. A non-empty subset A of M is known as ***left (lateral, right) ternary Γ-ideal*** of M, if it satisfies the following:

(i) A is a left (lateral, right) partial ternary Γ-ideal of M.

(ii) $x\in$ M and $y\in$ A such that $x\leq y$ then $x\in$ A.

If A is left, lateral as well as right ternary Γ-ideal of M, then A is known as ternary Γ-ideal of M".

Definition2.3: [12] "A partial ternary Γ -semiring said to have a ***left (lateral, right) unity element*** provided there exist a family $(e_i : i\in I)$ of M and $(\alpha_i,\beta_i : i\in I)$ of Γ ∋ $\sum e_i\alpha_i e_i\beta_i a = a(\sum e_i\alpha_i a\beta_i e_i = a, \sum a\alpha_i e_i\beta_i e_i = a)$ for any $a\in$ M".

Definition2.4:[12] "A TΓSS M is said to be **CTΓ-SS** (***complete ternary Γ-SO-semiring)*** if every family of elements in M is sum able".

And for more preliminaries the references [12] [13] [14] [15][16][17] and [18].

III. MAIN RESULTS

Definition3.1: U is known as non empty subset PTΓS ("partial ternary Γ - semiring") if u_1 , $u_2\in$R, $u_1 + u_2\in$U and $u_2\in$U ⇒$u_1\in$U then R is called ***subtractive.***

Definition3.2: U is known as non empty subset of a PTΓS R is known as ***strong*** if $u_1, u_2\in$R, $u_1+u_2\in$U ⇒ u_1, $u_2\in$U. Since strong subset is clearly subtractive.

Example: 3.3: Let R= $\{0,u_1,u_2,u_3,u_4,u_5\}$, Γ = {α, β}

by using R, Σ is described.

$$\sum_i x_i = \begin{cases} x_j \text{ if } x_i = 0\ \forall i\neq j, \text{ for some } j \\ z \text{ if } x_j = u_1, x_k = u_2 \text{ for some } j,k \text{ and } x_i = 0 \forall i\neq j,k \\ \infty, \text{otherwise} \end{cases}$$

Γ –monoid is defined by R.

R ×Γ× R×Γ× R⟶ R is mapped as given below:

α	0	u_1	u_2	u_3	u_4	u_5
0	0	0	0	0	0	0
u_1	0	0	0	0	0	0
u_2	0	0	0	0	0	0
u_3	0	0	0	0	0	0
u_4	0	0	0	0	0	0
u_5	0	0	0	0	0	0

β	0	u_1	u_2	u_3	u_4	u_5
0	0	0	0	0	0	0
u_1	0	u_1	0	u_3	0	u_1
u_2	0	0	u_2	0	u_4	u_2
u_3	0	0	u_3	0	u_1	u_3
u_4	0	u_4	0	u_2	0	u_4
u_5	0	u_1	u_2	u_3	u_4	u_5

Then R is a PTΓS. Here the subset $\{0, u_1,u_2,u_5\}$ is strong. Therefore it is subtractive subset.

Example 3.4: In example 3.3 the subset U= $\{0, u_3,u_5\}$ is subtractive but not strong because $u_1 + u_2 = u_5$ and both u_1 , $u_2\notin$U.

Theorem3.5: In a TΓSS R every non-zero ideal is strong and hence subtractive.

Revised Manuscript Received on October 10, 2019

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Proof: R is non zero which is ideal in condition. Let $x, y \in R$ such that $x+y$ exists in R and $x+y \in X$.

Since X is an ideal and $x \leq x+y$, $y \leq x+y \Rightarrow x, y \in X$. Therefore X is a strong ideal of R.

Definition3.6: "A PTΓS R is said to be ***left austere.*** R has no non-zero subtractive left partial ideals. A TΓSS R is left Austere if it has no non-zero left ideals".

Definition3.7: **A** PTTS R is said to be **entire** If it satisfies the conditions $a\alpha b\beta c = 0 \Rightarrow$either b=0 and a=0 and c=0 where $\forall$ $a, b, c \in R$, $\alpha, \beta \in \Gamma$.

Theorem3.8: If R is a left austere TΓSS with left unity then R is entire.

Proof: Let $x, y, z \in$ R. Suppose $x\alpha y\beta z = 0\ \forall \alpha, \beta \in \Gamma$.

Let us take A= $\{r \in R / r\alpha y\beta z = 0\ \forall \alpha, \beta \in \Gamma\}$

First we show that A is a left ideal of R.

Clearly $0 \in A$. Suppose $x \neq 0$ then $x \in A \neq \{0\}$.

Let $\{a_i : i \in I\}$ in R and $a_i \in A\ \forall\ i \in I$

then for all $\alpha, \beta \in \Gamma$ each $a_i\alpha y\beta z = 0$

$\Rightarrow \forall \alpha, \beta \in \Gamma\ (\sum_i a_i)\ \alpha y\beta z = 0 \Rightarrow \sum_i a_i \in A$.

Let $s \in$R, and $t \in A$ such that $s \leq t$ since $t \in A$,

$t\alpha y\beta z = 0\ \forall \alpha, \beta \in \Gamma$. Since $s \leq t$

$\Rightarrow s\alpha y\beta z \leq t\alpha y\beta z \forall \alpha, \beta \in \Gamma$

$\Rightarrow s\alpha y\beta z = 0\ \forall \alpha, \beta \in \Gamma \Rightarrow s \in A$.

Let q, $r \in$R, $\gamma, \delta \in \Gamma$ and $x \in A$.

Here $x \in A \Rightarrow x\alpha y\beta z = 0\ \forall \alpha, \beta \in \Gamma$

Consider

$(q\gamma r\delta x)\alpha y\beta z = q\gamma r\delta(x\alpha y\beta z) = q\gamma r\delta(0) = 0 \forall \alpha, \beta \in \Gamma$

$\Rightarrow q\gamma r\delta x \in A$.

The value of R is obtained as ideal in left position if the value of A is maintained at non zero condition.

Since R has left unity, then there exist a family $(e_i : i \in I)$ in R and γ_i, $\beta_i \in \Gamma$ such that $\sum_i e_i\gamma_i e_i\beta_i r = r\ \ \forall\ r \in R$. Since A=R, and hence $(e_i : i \in I) \in A$. $\Rightarrow e_i\alpha y\beta z = 0$ $\forall \alpha, \beta \in \Gamma$.

Therefore in particular $e_i\gamma_i y\beta_i z = 0\ \forall\ i \in I$

$\Rightarrow \sum_i e_i\gamma_i y\beta_i z$=0 $\Rightarrow$ y=0 or z=0.

Hence R is entire.

Note3.9: In general 3.8 theorem is converse which is not true for this consider the following example.

Example3.10: Let R= [0, 1] is the real number for unit interval. $(a_i : i \in I)$ is the family in R which defines $\sum_i a_i = Sup\{a_i / i \in I\}$ and after that partial ternary monoid R is defined. If we take Γ=W then R is a partial ternary Γ-monoid. Consider the mapping $(x, \alpha, y, \beta, z) \rightarrow \inf(x, \alpha, y, \beta, z)$ of R ×Γ× R×Γ× R⟶ R then R is a PTΓS. Then R is a TΓSS with usual $\leq$ of real numbers. For any non-zero $x \in R$, [0, x] is a non-zero ideal of R and hence R is not left Austere. Since $x\alpha y\beta z$=$\inf(x, \alpha, y, \beta, z)$=0 $\forall \alpha, \beta \in \Gamma \Rightarrow x$=0 or y=0 or z=0. And hence R is an entire TΓSS.

Theorem3.11: CTT-SSR is the principal idea to join the two principles of CTT-SSR.

Remark3.12: In any CTΓ-SS $\vee_i$<a_i>=<$\sum_i a_i$>.

Definition3.13: Let X, Y be two ideals of a TΓSS then X+Y={x+y/$x \in X$, $y \in Y$}.

Definition3.14: **A** TΓSS R is known as have the ***decomposition property*** iff for any a_1 , $a_2, a_3 \in$ R, $a_1 \leq a_2 + a_3$ then there exist b_1 , $b_2 \in$ R such that $0 \leq b_1 \leq a_2$, $0 \leq b_2 \leq a_3$, and $a_1 = b_1 + b_2$.

Theorem3.15: let a TΓSS R satisfying the decomposition property and P+Q is obtained for the ideal value of R.

Proof: First we show that R is an ideal value for P+Q. In R the summable family is assumed as (x_i /i $\in$ I) and $x_i \in P + Q\ \forall\ i \in I$ then x_i=a_i+b_i for some $a_i \in P$ and $b_i \in Q\ \forall\ i \in I$

$\Rightarrow \sum_i x_i$=$\sum_i a_i$+$\sum_i b_i$ where $\sum_i a_i \in P$ and $\sum_i b_i \in Q$.

$\Rightarrow \sum_i x_i \in P + Q$

Let $x \in R$, $b \in P + Q$ for some $p \in P$ and $q \in Q$ *the value* $x \leq b \Rightarrow x \leq b = p + q$.

By decomposition property there exist $0 \leq p_1 \leq p$, $0 \leq q_1 \leq q$ such that x=p_1+q_1.

Since $p_1 \leq p, p \in P \Rightarrow p_1 \in P$ and $q_1 \leq q$,

$q \in Q \Rightarrow q_1 \in Q$

Therefore x=p_1+$q_1 \in P + Q$.

Let $r_1, r_2 \in R, x \in P + Q$ and $\alpha, \beta \in \Gamma$

then $r_1, r_2 \in R$, x=p + q where $p \in P$, $q \in Q$ and $\alpha, \beta \in \Gamma$.

Consider

$r_1\alpha r_2\beta x = r_1\alpha r_2\beta(p + q) = r_1\alpha r_2\beta p + r_1\alpha r_2\beta q$

Where $r_1\alpha r_2\beta p \in P$, $r_1\alpha r_2\beta q \in$Q.

$\Rightarrow r_1\alpha r_2\beta x \in P + Q$ And

$r_1\alpha x\beta r_2 = r_1\alpha(p + q)\beta r_2 = r_1\alpha p\beta r_2 + r_1\alpha q\beta r_2$

where $r_1\alpha p\beta r_2 \in P$, $r_1\alpha q\beta r_2 \in$Q

$\Rightarrow r_1\alpha x\beta r_2 \in P + Q$

Now

$x\alpha r_1\beta r_2 = (p + q)\alpha r_1\beta r_2 = p\alpha r_1\beta r_2 + q\alpha r_1\beta r_2$

where $p\alpha r_1\beta r_2 \in P$, $q\alpha r_1\beta r_2 \in$Q

$\Rightarrow x\alpha r_1\beta r_2 \in P + Q$. Hence P+Q is an ideal of R.

Since $P \subseteq P + Q$, $Q \subseteq P + Q$.

P+Q⊆K is obtained based on P⊆K & Q⊆K, when R is the ideal value. Here P and Q is obtained as the smallest value of R which is given as P+Q.

Note3.16: A TΓSS R which does not satisfy the decomposition property then there exist two ideals P and Q such that R is independent of P+Q.

Example3.17: "Let R= $\{0, r_1, r_2, r_3, r_4, r_5\}$, Γ = {$\alpha$, β} define Σ on R as

$$\sum_i x_i = \begin{cases} x_j \text{ if } x_i = 0\ \forall\ i \neq j \text{, for some } j \\ \text{undefined, otherwise} \end{cases}$$

Then R is a ternary SO -monoid.

Define the mapping R ×Γ× R×Γ× R⟶ R as follows:

α	0	r_1	r_2	r_3	r_4	r_5
0	0	0	0	0	0	0
r_1	0	0	0	0	0	0
r_2	0	0	0	0	0	0
r_3	0	0	0	0	0	0
r_4	0	0	0	0	0	0
r_5	0	0	0	0	0	0

β	0	r_1	r_2	r_3	r_4	r_5
0	0	0	0	0	0	0
r_1	0	0	0	0	0	r_1
r_2	0	0	0	0	0	r_2
r_3	0	0	0	0	0	r_3
r_4	0	0	0	0	0	r_4
r_5	0	r_1	r_2	r_3	r_4	r_5

Then R is a TΓSS. In R we have $r_3 \leq r_4 = r_1 + r_2$ and there exist no *x*, *y*$\in R$ such that $0 \leq x \leq r_1, 0 \leq y \leq r_2$ and $r_3 = x + y$ implies that the decomposition property fails. Take P= {0,r_1}, Q= {0,r_2}. Then P, Q are ideals of R and P+Q= {0, r_1,r_2, r_4} is not ideal. Since $r_3 \leq r_4$ and $r_3 \notin${0, r_1,r_2, r_4}".

Theorem3.18: "Let R be a TΓSS satisfying the decomposition property then ideal(R) is a distributive lattice".

Proof: Note that ideal(R) together with set inclusion forms a lattice where inf{I, J, K}=I∧J∧K, sup{I, J}=I∨J. Let J, K, L, M are the ideal values of R.

Let $x \leq p + q$ *is obtained for*

$x \in (J \wedge K \wedge L) \vee (J \wedge K \wedge M)$

where $q \in (J \wedge K \wedge M)$, p$\in (J \wedge K \wedge L) \Rightarrow x \leq p + q$

where $p, q \in J, p, q \in K, p \in W$ and $q \in Y$. Since *p*, *q* are in J, K and J, K implies the ideals of R that is given as $p + q \in J$ &$p + q \in K$. So $x \in J, x \in K$.

Since $x \leq p + q, p \in W$Land $q \in M$

$\Rightarrow x \leq p + q \in L + M = L \vee M$.

$\Rightarrow x \in L \vee M$. Therefore $x \in J \wedge K \wedge (L \vee M)$.

Hence $(J \wedge K \wedge L) \vee (J \wedge K \wedge M) \subseteq J \wedge K \wedge (L \vee M)$.

Let $x \in J \wedge K \wedge (L \vee M) \Rightarrow x \in J, x \in K$ and

$x \in L \vee M$ then by theorem3.11 $L \vee M = L + M$

And the value $x = p + q$ for some $p \in L$ and $q \in M$,

Since we have $p, q \in J, p, q \in K$ for $p \leq p + q$,

$q \leq p + q$. Therefore for

p$\in (J \wedge K \wedge L)$,

$q \in (J \wedge K \wedge M)$ *the value* $x = p + q$

$\Rightarrow x \in (J \wedge K \wedge L) \vee (J \wedge K \wedge M)$

Thus $J \wedge K \wedge (L \vee M) \subseteq (J \wedge K \wedge L) \vee (J \wedge K \wedge M)$

Hence $J \wedge K \wedge (L \vee M) = (J \wedge K \wedge L) \vee (J \wedge K \wedge M)$

Note3.19: The decomposition property in a TΓSS fails then the lattice of ideals is not distributive for this considers the following example. Consider the TΓSS R given in example 3.17 take A= {0,r_1}, B= {0,r_2}, C= {0,r_3}, Q= {0,r_4}. Then A∧B∧ (C∨D) = {0,r_1}, whereas (A∧B∧C)∨(A∧B∧D)={0}.

Theorem3.20: "Let R be a CTΓ-SS R then ideal(R) forms a complete lattice with supremum as ∨ and infimum as ∧".

Proof: Obviously, ideal(R) with set inclusion forms a lattice with {0} as the least element and R as the greatest element $\{R_i / i \in I\}$ family of ideals of R, $\underset{i\in I}{\wedge} R_i$ and $\underset{i\in I}{\vee} R_i$ are ideals of R. So inf$\{R_i / i \in I\}$ and sup$\{R_i / i \in I\}$ are in ideal(R) and hence ideal (R) is a complete lattice.

Theorem3.21: "For any ideals A, B, C, D of CTΓ-SS R, AΓBΓ (C∨D) = (AΓBΓC) ∨ (AΓBΓD)".

Proof: Let *x*$\in A\Gamma B\Gamma(C \vee D)$ then *x*$\leq \sum_i a_i\, \alpha_i b_i \beta_i c_i$ for some $a_i \in A, b_i \in B$, $c_i \in C \vee D$ and α_i, $\beta_i \in \Gamma$. Since $c_i \in C \vee D$, $c_i \leq d_i + e_i$ for some $d_i \in C$ and $e_i \in D$. So *x*$\leq \sum_i a_i\, \alpha_i b_i \beta_i (d_i + e_i)$

$\Rightarrow$ *x*$\leq \sum_i a_i\, \alpha_i b_i \beta_i d_i + \sum_i a_i\, \alpha_i b_i \beta_i e_i$

where$a_i \in A, b_i \in B, d_i \in C$, $e_i \in D$ and $\alpha_i, \beta_i \in \Gamma$.

$\Rightarrow$ *x*$\in (A\Gamma B\Gamma C) \vee (A\Gamma B\Gamma D)$.

Conversely if $x \in$(AΓBΓC)∨(AΓBΓD) then $x \leq x_1 + x_2$ where $x_1 \in$AΓBΓC and $x_2 \in$AΓBΓD

Since $x_1 \in$AΓBΓC, $x_1 \leq \sum_i a_i\, \alpha_i b_i \beta_i c_i$ for some $a_i \in A, b_i \in B, c_i \in C$ and α_i, $\beta_i \in \Gamma$

Since $x_2 \in$AΓBΓD, $x_2 \leq \sum_j d_j\, \gamma_j e_j \delta_j f_j$

where $d_j \in A, e_j \in B, f_j \in C$ and γ_j, $\delta_j \in \Gamma$.

Therefore *x*$\leq \sum_i a_i\, \alpha_i b_i \beta_i c_i + \sum_j d_j\, \gamma_j e_j \delta_j f_j \leq$

$\sum_i \sum_j (a_i + d_j)(\alpha_i + \gamma_j)(c_i + f_j)(\beta_j + \delta_j)(b_i + e_j)$

Where $(a_i + d_j) \in A$, $(b_i + e_j) \in B$, $(c_i + f_j) \in C \vee D$ and $(\alpha_i + \gamma_j), (\beta_i + \delta_j) \in \Gamma$

$\Rightarrow$ *x*$\in A\Gamma B\Gamma(C \vee D)$ and hence

$A\Gamma B\Gamma\,(C \vee D)$= (AΓBΓC)∨(AΓBΓD)

IV. CONCLUSION

Mainly we introduced in this paper about regular TΓSS and characterized TΓSS. In this paper we introduce the notions of subtractive and strong subsets in partial ternary Γ- semirings. We conclude that join of any two ideals is equal to the sum of those two ideals in a TΓSS

ACKNOWLEDGMENT

we are very thank full to Dr. D. MadhusudhanaRao, Professor in Mathematics, VSR & NVR College, Tenali and Dr. P. Siva Prasad, Associate Professor, Vignan University, Vadlamudi, Guntur(Dt).

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