The Mathematical Formulas of 2-Cyclic Refined Duplets and Triplets

Josef Al Jumayel[1,*], Ahmad Khaldi[2]

[1]Faculty of Science, Beirut Arab University, Beirut, Lebanon

[2]Mutah University, Faculty of Science, Jordan

Emails: Josefjumayel113@gmail.com; khaldiahmad1221@gmail.com

Abstract

This work is dedicated to studying the problem of computing 2-cyclic refined neutrosophic duplets and triplets in the 2-cyclic refined neutrosophic ring of real numbers, where we present four different formulas that describe all possible duplets in this extended ring. Also, we present four different formulas for the computation of related triplets in the same ring.

Keywords: Neutrosophic triplet; Neutrosophic duplet; 2-cyclic refined neutrosophic ring; Neutrosophic number

1. Introduction

The concept of neutrosophic sets and neutrosophic structures is considered one of the most recent mathematical concepts with applications in many different scientific fields [1]. The n-cyclic refined neutrosophic structures were first defined in [9], where algebraic structures related to this definition were studied, such as rings and modules. Also, the groups and spaces generated by these mathematical systems were studied in [9-12,14]. Then in [2-4], some famous algebraic problems were studied for the n-cyclic refined neutrosophic rings, where some conjectures were put forward that discuss the classification of the group of units such as generalized Von Shtawzen's conjecture [5].

The problem of the group of units for 3-cyclic and 4-cyclic refined neutrosophic rings of integers was studied by many researchers [7-8, 13], where it was classified in [6] as a proof of first and second Von Shtawzen's conjectures. In [15], the problem of finding idempotent elements in some n-cyclic refined neutrosophic rings was studied and handled. The concept of neutrosophic duplets and triplets has been defined and studied by many authors, see [16-18].

In this work, we present a solution for the duplet and triplet problem in the 2-cyclic refined neutrosophic rings, where we present four different formulas that describe all possible duplets in this extended ring. Also, we present four different formulas for the computation of related triplets in the same ring.

2. Main discussion

Definition:

Let $R_2(I) = \{a_0 + a_1 I_1 + a_2 I_2 \,;\, a_i \in R \,, I_1 I_1 = I_2 \,, I_2 I_2 = I_1 \,, I_1 I_2 = I_2 I_1 = I_1 \}$ be any 2-cyclic refined neutrosophic ring, then $(x, y) \in R_2(I)$ is called aduplet if and only if $xy = yx = x$ with y acts as an identity, and$x \neq 0$.

DOI: https://doi.org/10.54216/GJMSA.0110206

Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024

Discussion:

For a commutative 2-cyclic refined neutrosophic ring $R_2(I)$, we have:

For $x = x_0 + x_1I_1 + x_2I_2$, $y = y_0 + y_1I_1 + y_2I_2$ with y acts as an identity: $xy = x$ implies:

$$\begin{cases} x_0y_0 = x_0 & (1) \\ x_0y_1 + x_1y_0 + x_1y_2 + x_2y_1 = x_1 & (2) \\ x_0y_2 + x_2y_0 + x_1y_1 + x_2y_2 = x_2 & (3) \end{cases}$$

The previous system of equations can be formulated as:

$$\begin{cases} x_0y_0 = x_0 \\ (x_0 + x_1 + x_2)(y_0 + y_1 + y_2) = x_0 + x_1 + x_2 \\ (x_0 - x_1 + x_2)(y_0 - y_1 + y_2) = x_0 - x_1 + x_2 \end{cases}$$

Thus (x_0, y_0), $(\sum_{i=0}^{2} x_i , \sum_{i=0}^{2} y_i)$, $(x_0 - x_1 + x_2, y_0 - y_1 + y_2)$ are duplets in R with $y_0, \sum_{i=0}^{2} y_i , y_0 - y_1 + y_2$ act as identities.

Remark:

For a ring with unity, we have to say that (x, y) is a non-trivial duplet if $xy = x$ and $y \neq 1, x \neq 0$.

Duplets in $Z_2(I)$:

Let $Z_2(I) = \{a_0 + a_1I_1 + a_2I_2 \, ; \, a_i \in \mathbb{Z}\}$ be the 2- cyclic refined neutrosophic ring of integers, then:

1) $x_0y_0 = x_0 \Leftrightarrow x_0 = 0 \text{ or } y_0 = 1$

2) $(x_0 + x_1 + x_2)(y_0 + y_1 + y_2) = x_0 + x_1 + x_2 \Leftrightarrow x_0 + x_1 + x_2 = 0 \text{ or } y_0 + y_1 + y_2 = 1$

3) $(x_0 - x_1 + x_2)(y_0 - y_1 + y_2) = x_0 - x_1 + x_2 \Leftrightarrow x_0 - x_1 + x_2 = 0 \text{ or } y_0 - y_1 + y_2 = 1$

For $\begin{cases} x_0 = 0 \\ x_0 + x_1 + x_2 = 0 \\ x_0 - x_1 + x_2 = 0 \end{cases}$ or $\begin{cases} y_0 = 1 \\ y_0 + y_1 + y_2 = 1 \\ y_0 - y_1 + y_2 = 1 \end{cases}$, we get: $x = 0 \text{ or } y = 1$ which are the trivial duplets.

We have to discuss the non-trivial cases:

For $x_0 = c \neq 0, x_0 + x_1 + x_2 = x_0 - x_1 + x_2 = 0$, we get:

$x_1 = 0, x_2 = -c$, then $X = c - cI_2 \, ; c \in \mathbb{Z}$

Also, $y_0 = 1,\ y_0 + y_1 + y_2 = b,\ y_0 - y_1 + y_2 = d$

Hence:$y_1 = \frac{1}{2}(b - d), y_2 = \frac{1}{2}(b + d) - 1 \quad ; b - d \in 2\mathbb{Z}$

So that $Y = 1 + \frac{1}{2}(b - d)I_1 + (\frac{1}{2}(b + d) - 1)I_2$

$x.y = c + \frac{1}{2}(bc - dc)I_1 + \left[\frac{1}{2}(bc + dc) - c\right] I_2 - cI_2 - \frac{1}{2}(bc - dc)I_1 + \left[\frac{-1}{2}(bc + dc) + c\right] I_2 = c - cI_2 = x,$ thus, the first duplet is $(c - cI_2, 1 + \frac{1}{2}(b - d)I_1 + \left[\frac{1}{2}(b + d) - 1\right] I_2)$.

For $x_0 = c \neq 0 \, , x_0 + x_1 + x_2 = 0 \, , x_0 - x_1 + x_2 = t \neq 0$, we get: $x_1 = \frac{-1}{2}t \, , x_2 = \frac{1}{2}t - c \, ; t \in 2\mathbb{Z}$.

Also, $y_0 = 1,\ y_0 + y_1 + y_2 = d,\ y_0 - y_1 + y_2 = 1$, then: $y_1 = \frac{1}{2}(d - 1), y_2 = \frac{1}{2}(d + 1) - 1 \quad ; d \notin 2\mathbb{Z}$.

Now, put $\begin{cases} X = c - \frac{1}{2}tI_1 + \left(\frac{1}{2}t - c\right) I_2 & t \in 2\mathbb{Z} \\ Y = 1 + \frac{1}{2}(d - 1)I_1 + [\frac{1}{2}(d + 1) - 1 \ ]I_2 & d \notin 2\mathbb{Z} \end{cases}$

DOI: https://doi.org/10.54216/GJMSA.0110206
Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024

$$x.y = c + \frac{1}{2}(dc-c)I_1 + \left[\frac{1}{2}(dc+c)-c\right]I_2 - \frac{1}{2}tI_1 - \frac{1}{4}(td-t)I_2 + \left[\frac{-1}{4}(td+t)+\frac{1}{2}t\right]I_1 + \left(\frac{1}{2}t-c\right)I_2$$
$$+\frac{1}{2}(d-1)\left(\frac{1}{2}t-c\right)I_1 + \left[\frac{1}{4}(td+t)-\frac{1}{2}t-\frac{1}{2}(dc+c)+c\right]I_2$$
$$= c + I_1\left[\frac{dc}{2}-\frac{c}{2}-\frac{t}{2}-\frac{td}{4}-\frac{t}{4}+\frac{t}{2}+\frac{td}{4}-\frac{dc}{2}-\frac{t}{4}+\frac{c}{2}\right]$$
$$+ I_2\left[\frac{dc}{2}+\frac{c}{2}-c-\frac{td}{4}+\frac{t}{4}+\frac{t}{2}-c+\frac{td}{4}+\frac{t}{4}-\frac{t}{2}-\frac{dc}{2}-\frac{c}{2}+c\right]$$
$$= c + I_1\left(-\frac{1}{2}t\right) + I_2\left(\frac{t}{2}-c\right) = x.$$

The second duplet is:

$(\mathrm{c}, -\frac{1}{2}tI_1 + \left(-\frac{1}{2}t-c\right)I_2, 1 + (\frac{d-1}{2})I_1 + \left(\frac{d+1}{2}-1\right)I_2)\ ; t \in 2\mathbb{Z}, d \in 2\mathbb{Z}.$

For $x_0 = c, x_0 + x_1 + x_2 = t, x_0 - x_1 + x_2 = 0$, we get: $x_1 = \frac{1}{2}t, x_2 = \frac{1}{2}t - c$, $y_0 = y_0 + y_1 + y_2 = 1$, $y_0 - y_1 + y_2 = d$, $y_1 = \frac{1-d}{2}, y_2 = \frac{1+d}{2} - 1\ ; d \notin 2\mathbb{Z}, t \in 2\mathbb{Z}$

The third duplet is:

$$\left(c + \frac{1}{2}tI_1 + \left(\frac{1}{2}t-c\right)I_2, 1 + \frac{1-d}{2}I_1 + \left(\frac{1+d}{2}-1\right)I_2\right); \begin{cases} d \notin 2\mathbb{Z} \\ t \in 2\mathbb{Z}\end{cases}$$

For $x_0 = 0, x_0 + x_1 + x_2 = t, x_0 - x_1 + x_2 = 0$, then: $x_1 = \frac{1}{2}t, x_2 = \frac{1}{2}t;\ t \in 2\mathbb{Z}$, $y_0 = a$, $y_0 + y_1 + y_2 = 1$, $y_0 - y_1 + y_2 = b$,thus: $y_1 = \frac{1-b}{2}, y_2 = \frac{1+b}{2} - a$, there for the duplet is:

$$\left(\frac{1}{2}tI_1 + \frac{1}{2}tI_2, a + \frac{1-b}{2}I_1 + \left(\frac{1+b}{2}-a\right)I_2\right);\ \begin{matrix} t \in 2\mathbb{Z} \\ b \notin 2\mathbb{Z}\end{matrix}$$

For $x_0 = 0, x_0 + x_1 + x_2 = 0, x_0 - x_1 + x_2 = t$, we get: $x_1 = \frac{-1}{2}t, x_2 = \frac{1}{2}t$, $y_0 = a$, $y_0 + y_1 + y_2 = b$, $y_0 - y_1 + y_2 = 1$,so that : $y_1 = \frac{b-1}{2}, y_2 = \frac{b+1}{2} - a$, and the duplet is: $\left(\frac{-1}{2}tI_1 + \frac{1}{2}tI_2, a + \frac{b-1}{2}I_1 + \left(\frac{b+1}{2}-a\right)I_2\right)$ with $t \in 2\mathbb{Z}, b \notin 2\mathbb{Z}$.

For $x_0 = 0, x_0 + x_1 + x_2 = t, x_0 - x_1 + x_2 = s$, we get: $x_1 = \frac{t-s}{2}, x_2 = \frac{t+s}{2}$, $y_0 = a$, $y_0 + y_1 + y_2 = y_0 - y_1 + y_2 = 1$, thus: $y_1 = 0, y_2 = 1 - a$, the duplet is: $\left(\frac{t-s}{2}I_1 + \frac{t+s}{2}I_2, a + (1-a)I_2\right);\ t + s \in 2\mathbb{Z}$.

Definition:

A triple (x, y, z) is called a triplet if and only if:

$$\begin{cases} xy = yx = x \\ yz = zy = z \\ xz = zx = y \end{cases}$$ with y acts as an identity.

Remark:

If (x, y, z) is a triplet, then $(x, y)(z, y)$ are duplets.

Remark:

In the 2-cyclic refined neutrosophic ring of integers $Z_2(I)$.

If $x = x_0 + x_1I_1 + x_2I_2, z = z_0 + z_1I_1 + z_2I_2$ such that: $x.z = y$, then:

$$\begin{cases} x_0z_0 = y_0 & (1) \\ (x_0 + x_1 + x_2)(z_0 + z_1 + z_2) = y_0 + y_1 + y_2 & (2) \\ (x_0 - x_1 + x_2)(z_0 - z_1 + z_2) = y_0 - y_1 + y_2 & (3) \end{cases}$$

Discussion for triplets in $Z_2(I)$:

From equation (1), we can see:

$x_0z_0y_0 = y_0^2 \implies x_0z_0 = y_0^2, \dots\ x_0z_0 = y_0^n$ for all $n \in \mathbb{N}$.

DOI: https://doi.org/10.54216/GJMSA.0110206
Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024

$$\begin{cases}(x_0+x_1+x_2)(z_0+z_1+z_2)=(y_0+y_1+y_2)^n\\(x_0-x_1+x_2)(z_0-z_1+z_2)=(y_0-y_1+y_2)^n\end{cases}\text{ for } n\in\mathbb{N}.$$

The first formula for duplets was:

$$\begin{cases}X=c-cI_2\ ;c\in\mathbb{Z}\\Y=1+\frac{1}{2}(b-d)I_1+(\frac{1}{2}(b+d)-1)I_2\end{cases};b-d\in 2\mathbb{Z}$$

Since $y_0=1$, then $z_0=x_0^{-1}=\frac{1}{c}\ ;c\neq 0$

$$\begin{cases}y_0+y_1+y_2=b\\y_0-y_1+y_2=d\end{cases}\text{the only possible cases are:}\begin{cases}b=1,d=0\\b=0,d=0\\b=0,d=1\\b=d=1\end{cases}$$

For $b=d=1, y=1$, and $(z_0+z_1+z_2)(0)=1, 0=1$

Which is a contradiction.

For $b=1,d=0$, then $0.(z_0-z_1+z_2)=1$, another contradiction.

For $b=d=0$, then $z_0+z_1+z_2=a', z_0-z_1+z_2=b'\ ;a',b'\in\mathbb{Z}$ and $Z=\frac{1}{c}+\left(\frac{a'-b'}{2}\right)I_1+\left(\frac{a'+b'}{2}-\frac{1}{c}\right)I_2\ ;\begin{matrix}c\in\{1,-1\}\\a'-b'\in 2\mathbb{Z}\end{matrix}$

Thus $Z=1+\frac{1}{2}(a'-b')I_1+\left(\frac{1}{2}(a'+b')-1\right)I_2$ *or* $Z=-1+\frac{1}{2}(a'-b')I_1+\left(\frac{1}{2}(a'+b')+1\right)I_2$ with $x=1-I_2$ *or* $x=-1+I_2$, $y=1-I_2$

The triplets are: $\left(1-I_2,1-I_2,1+\frac{a'-b'}{2}I_1+\left(\frac{a'+b'}{2}-1\right)I_2\right)$ and $\left(-1+I_2,1-I_2,-1+\frac{a'-b'}{2}I_1+\left(\frac{a'+b'}{2}+1\right)I_2\right), a'-b'\in 2\mathbb{Z}$

For $b=0,d=1$, we get a contradiction.

The second formula for duplets:

$$x=c-\frac{1}{2}tI_1+\left(\frac{1}{2}t-c\right)I_2, y=1+\frac{d-1}{2}I_1+\left(\frac{d+1}{2}-1\right)I_2\ ;\begin{cases}d\notin 2\mathbb{Z}\\t\in 2\mathbb{Z}\end{cases}$$

Since $y_0=1$, then $c=\mp 1, z_0=\mp 1$.

$$\begin{cases}y_0+y_1+y_2=d\\y_0-y_1+y_2=1\\x_0+x_1+x_2=0\\x_0-x_1+x_2=t\end{cases}\Rightarrow\begin{cases}z_0-z_1+z_2=\frac{1}{t}\in\{1,-1\}\\z_0+z_1+z_2=0\end{cases}$$

The only possible value for d is $d=0$.

$$\begin{cases}z_0-z_1+z_2=1\\z_0+z_1+z_2=0\end{cases}\Rightarrow\begin{cases}z_1=\frac{-1}{2}, z_2=\frac{1}{2}\mp 1\in\{\frac{-1}{2},\frac{3}{2}\}\\\text{which is a condradiction}\end{cases}$$

$$\begin{cases}z_0-z_1+z_2=-1\\z_0+z_1+z_2=0\end{cases}\text{ give us another contradiction.}$$

The third formula for duplets:

$$x=c+\frac{1}{2}tI_1+\left(\frac{1}{2}t-c\right)I_2, y=1+\frac{1-d}{2}I_1+\left(\frac{1+d}{2}-1\right)I_2\ ;\begin{cases}d\notin 2\mathbb{Z}\\t\in 2\mathbb{Z}\end{cases}$$

$y_0=1, x_0=c, z_0=\mp 1, c=\mp 1, x_0+x_1+x_2=t, y_0+y_1+y_2=1$, then $z_0+z_1+z_2=\mp 1, t=\mp 1$.

$y_0-y_1+y_2=d, x_0-x_1+x_2=0$, thus:

$$\begin{cases}x_1=\frac{1}{2}\ or\ x_1=\frac{-1}{2}\\\text{it is a contradiction}\end{cases}$$

DOI: https://doi.org/10.54216/GJMSA.0110206
Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024

The fourth formula for duplets is:

$$x=\frac{1}{2}tI_1+\frac{1}{2}tI_2\,,y=a+\frac{1-b}{2}I_1+\left(\frac{1+b}{2}-a\right)I_2\ ;\begin{cases}b\notin 2\mathbb{Z}\\ t\in 2\mathbb{Z}\end{cases}$$

$x_0=0, y_0=a, x_0z_0=a$, thus: $y_0=0, z_0=s$.

$$\begin{cases}x_0+x_1+x_2=t & and(x_0+x_1+x_2)(z_0+z_1+z_2)=1\Rightarrow t=\mp 1\\ y_0+y_1+y_2=1 & and\ z_0+z_1+z_2=\mp 1\end{cases}$$

Also, $\begin{cases}x_0-x_1+x_2=0\\ y_0-y_1+y_2=b\end{cases}\quad and(x_0-x_1+x_2)(z_0-z_1+z_2)=b$

Hence, $b=0\,, z_0-z_1+z_2=l$.

This means that:

$$\begin{cases}z_0=s\\ z_1+z_2=1-s\\ z_2-z_1=l-s\end{cases}\quad or\ \begin{cases}z_0=s\\ z_1+z_2=-1-s\\ z_2-z_1=l-s\end{cases}$$

Hence: $\begin{cases}z_0=s\\ z_2=\frac{1+l}{2}-s\\ z_1=\frac{1-l}{2}\end{cases}\quad or\ \begin{cases}z_0=s\\ z_2=\frac{l-1}{2}-s\\ z_1=\frac{-1-l}{2}\end{cases}$

Since $t\notin 2\mathbb{Z}$, we get a contradiction.

The fifth formula for duplets:

$$x=\frac{-1}{2}tI_1+\frac{1}{2}tI_2\,,y=a+\frac{b-1}{2}I_1+\left(\frac{b+1}{2}-a\right)I_2$$

$x_0=0, y_0=a, z_0x_0=a\Longrightarrow z_0=s, a=0.$

$x_0+x_1+x_2=0, y_0+y_1+y_2=b\Longrightarrow b=0, z_0+z_1+z_2=l.$

$x_0-x_1+x_2=t, y_0-y_1+y_2=1\Longrightarrow t=\mp 1, z_0-z_1+z_2=\mp 1.$

Which is a contradiction.

From the previous discussion, we get that the triplets in $Z_2(I)$ has two formulas (non-trivial) triplets:

$$\left.\begin{matrix}\left(-1+I_2,1-I_2,-1+\frac{a'-b'}{2}I_1+\left(\frac{a'+b'}{2}+1\right)I_2\right)\\ \left(1-I_2,1-I_2,1+\frac{a'-b'}{2}I_1+\left(\frac{a'+b'}{2}+1\right)I_2\right)\end{matrix}\right.\quad a'-b'\in 2\mathbb{Z}.$$

3. Conclusion

In this work, we presented a solution for the duplet and triplet problem in the 2-cyclic refined neutrosophic rings, where we presented four different formulas that describe all possible duplets in this extended ring. Also, we present four different formulas for the computation of related triplets in the same ring. In future, we aim to solve the same problem for 3-cyclic refined and 4-cyclic refined neutrosophic rings.

References

[1] Basheer, A., Ahmad, K., and Ali, R., “A Short Contribution to Von Shtawzen's Abelian Group in n-Cyclic Refined Neutrosophic Rings", Journal of Neutrosophic and Fuzzy Systems, 2022.

[2] Von Shtawzen, O., “Conjectures for Invertible Diophantine Equations of 3-Cyclic and 4-Cyclic Refined Integers", Journal of Neutrosophic and Fuzzy Systems, Vol.3, 2022.

[3] Von Shtawzen, O., “On a Novel Group Derived from a Generalization of Integer Exponents and Open Problems", Galoitica journal Of Mathematical Structures and Applications, Vol 1, 2022.

[4] Basheer, A., Ahmad, K., and Ali, R., “On Some Open Problems about n-Cyclic Refined Neutrosophic Rings and Number Theory", Journal of Neutrosophic and Fuzzy Systems, 2022.

DOI: https://doi.org/10.54216/GJMSA.0110206
Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024

[5] A. Alrida Basheer , Katy D. Ahmad , Rozina Ali., "Examples on Some Novel Diophantine Equations Derived from the Group of Units Problem in n-Cyclic Refined Neutrosophic Rings of Integers", Galoitica Journal Of Mathematical Structures And Applications, Vol.3, 2022.

[6] Sankari, H., and Abobala, M., “On the Group of Units Classification In 3-Cyclic and 4-cyclic Refined Rings of Integers and the Proof of Von Shtawzens' Conjectures", International Journal of Neutrosophic Science, 2023.

[7] Sankari, H., and Abobala, M., “On the Classification of the Group of Units of Rational and Real 2-Cyclic Refined Neutrosophic Rings", Neutrosophic Sets and Systems, 2023.

[8] Sankari, H., and Abobala, M., “On the Algebraic Homomorphisms between Symbolic 2-Plithogenic Rings And 2-cyclic Refined Rings", Neutrosophic Sets and Systems, 2023.

[9] Abobala, M., “n-Cyclic Refined Neutrosophic Algebraic Systems of Sub-Indeterminacies, an Application to Rings and Modules", International Journal of Neutrosophic Science, 2020.

[10] Aswad, M., "n-Cyclic Refined Neutrosophic Vector Spaces and Matrices", Neutrosophic Knowledge, 2021.

[11] Ali, R., "n-Cyclic Refined Neutrosophic Groups", International Journal of Neutrosophic Science, 2021.

[12] Sadiq. B., “A Contribution To The group Of Units Problem in Some 2-Cyclic Refined Neutrosophic Rings ", International Journal of Neutrosophic Science, 2022.

[13] Nabil Khuder Salman, Maikel Leyva Vazquez,Batista Hernández Noel. On The Classification of 3-Cyclic/4-Cyclic Refined Neutrosophic Real and Rational Von Shtawzen's Group. International Journal of Neutrosophic Science, (2024); 23 (2): 26-31.

[14] Ahmad Salama, Rasha Dalla, Malath Al Aswad, Rozina Ali. (2022). Some Results About 2-Cyclic Refined Neutrosophic Complex Numbers. Journal of Neutrosophic and Fuzzy Systems, 4 (1), 41-8 (Doi : https://doi.org/10.54216/JNFS.040105).

[15] Barry, W. Badjajian, N. (2024). Computing Idempotent Elements In 3-Cyclic and 4-Cyclic Refined Neutrosophic Rings of Integers. Journal of Neutrosophic and Fuzzy Systems, (), 31-38. DOI: https://doi.org/10.54216/JNFS.080104

[16] F. Smarandache, Neutrosophic Perspectives: Triplets, Duplets, Multisets, Hybrid Operators, Modal Logic, Hedge Algebras. And Applications. Pons Editions, Bruxelles, 323 p., 2017; CHAPTER IX: 127-134

[17] Florentin Smarandache and Mumtaz Ali, Neutrosophic Triplet Group, NeuralComputing and Applications, Springer, 1-7, 2016, https://link.springer.com/article/10.1007/s00521-016-2535-x; DOI: 10.1007/s00521-016-2535-x.

[18] Merkepci, H. D., K. (2022). On the Conditions of Imperfect Neutrosophic Duplets and Imperfect Neutrosophic Triplets. Galoitica: Journal of Mathematical Structures and Applications, (), 08-13. DOI: https://doi.org/10.54216/GJMSA.020201

DOI: https://doi.org/10.54216/GJMSA.0110206

Received: December 18, 2023 Revised: April 12, 2024 Accepted: August 02, 2024