

General Results of Neutrosophic Bass-Rings

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Abstract. In this paper, we study and present a new view of Neutrosophic Bass-ring (N- Bass-ring) and neutrosophic of Semi-Bass ring. Bass-ring means; if any module M of R has max- submodule. One of the important results of N-strongly Bass -ring is, if M is a N- V-module, R is N- strongly Bass-ring. We proved the if $(M \cup I)$ is N- V-module, $(R \cup I)$ is a N- S-Bass- ring. Also, if $(N \cup I) = (J \cup I)(M \cup I)$ over a N- Boolean ring, then every $(N \cup I) \leq (M(I))$ is a N-semi-maximal and so $(M \cup I)$ is N- semi-Bass ring. Finally, some properties and more new results have been presented.

1. INTRODUCTION

All rings are based to be associative. Neutrosophic theory role a vital in all branches of algebra. In 1965, Zadeh [1] presented fuzzy theorem as a new concept in abstract algebra upon. Zadeh presented more information of fuzzy concept introduced in order to developing the mathematical structures. Fuzzy set with more information in [2, 3]. In 1998, Samarandach [4] developed this theory by presenting a new, new concept namely N- set as an extension Fuzzy set. Also, Samarandach addressed all the definitions of algebraic structures same neutrosophic set, neutrosophic group, neutrosophic ring and neutrosophic modules. We should care to fuzzy set. W. B. Vasantha Kandasamy and Florentin Smarandache introduced more concepts like N- group, N-rings and neutrosophic semigroups. [5–8]. N- multiplication module in [9, 10]. M is injective if $N(M$ is a submodule of module M , for all linear isomorphic $f : V \rightarrow M$ (homomorphism)

Received: Jan. 20, 2026.

2020 *Mathematics Subject Classification.* 16E60, 08A72.

Key words and phrases. neutrosophic set; neutrosophic group; neutrosophic ring; V-module; Baaass ring.

$\exists g : M \rightarrow M \ni g \mid N = f$ [11]. In other words, an isomorphism from submodule into injective module can extend to complete module.

In this article N- Bass-ring and N- of semi-Bass ring have been introduced and we obtained that if M is a N- V -module, R is N- strongly Bass-ring.

2. PRELIMINARIES

In this part we present more tools from N- theory in order to use it in our topic. We refer to N- set by $B = \langle u, (\mu_B(u), \beta_B(u), \delta_B(u)) \rangle : u \in U; \mu, \beta, \delta : \rightarrow [0, 1]$ are (True), indeterminacy (False) of U .

Definition 2.1. [12] Let $I^2 = I$ and let $(G, *)$ be a group $\ni \langle G \cup I \rangle = \{x + yI : x, y \in G\}$. So the set $(G \cup I) = \{\langle G \cup I \rangle, *\}$ is N- group.

Definition 2.2. [7] $(R \cup I) = \{\langle R \cup I \rangle, +, *\} = \{x + yI : x, y \in R\}$ is N- ring and $\langle R, I \rangle$ with R is a ring:

- (1) $(a + bI) + (c + dI) = (a + c) + (b + d)I$
- (2) $-(a + bI) * (c + dI) = ac + (bc + ad + bd)I$.

Definition 2.3. $(M \cup I)$ is called N- of module if $(M \cup I) = \langle M \cup I \rangle$ is neutrosophic and $\langle R, I \rangle$, if $(M \cup I)$ over $(R \cup I)$, $(N \cup I)$ is a strong of $(M \cup I)$ if $(N \cup I)$ is also strong.

Example 2.1. $(R \cup I)$ is neutrosophic ring.

Definition 2.4. M said to be strongly coatomic (S- coatomic) if $N \leq M$ is coatomic.

Definition 2.5. A N- ring $(R \cup I)$ is called N- V -ring if a N- module $(M \cup I)$ is a N- injective.

Example 2.2. Z_n and N- ring of rational numbers are called Neutrosophic $(Z \cup I)$, $(Z_n \cup I)$ and $(Q \cup I)$ respectively.

3. THE MAIN RESULTS

In this part we present and explore new implication of N- strongly Bass-ring and N- semi-max Bass-ring.

Definition 3.1. N- strongly coatomic module over R means $\exists N \leq M \ni N$ is neutrosophic coatmic.

Theorem 3.1. Let $nI \in (Z \cup I)$ be a N- element and let $(M \cup I)$ be a N- module over N- ring $(R \cup I)$. If $(M \cup I) = (M_0 \cup I) \supseteq (M_1 \cup I) \supseteq \dots (M_n \cup I) = 0I$ is a N- submodule of $(M \cup I) \ni \frac{(M_{i-1} \cup I)}{(M_i \cup I)}$ is a N- coatomic $\forall iI ; 1I \leq iI \leq nI$, so $(R \cup I)$ is a N- strongly Bass-ring.

Proof. Suppose that $(N \cup I) \leq (M \cup I)$ and let $(N \cup I) = [(N \cup I) \cap (M_0 \cup I) \supseteq \dots \supseteq [(N \cup I) \cap (M_n \cup I)]] = oI$. Note that $\forall iI \leq iI \leq nI$;

$$\begin{aligned} \frac{(N \cup I) \cap (M_{i-1} \cup I)}{(N \cup I) \cap (M_i \cup I)} &= \frac{(N \cup I) \cap (M_{i-1} \cup I)}{(N \cup I) \cap (M_{i-1} \cup I) \cap (M_i \cup I)} \\ &\cong \frac{(N \cup I) \cap (M_{i-1} \cup I) + (M_i \cup I)}{(N \cup I) \cap (M_{i-1} \cup I) \cap (M_i \cup I)} \\ &\leq \frac{(M_{i-1} \cup I)}{(M_i \cup I)} \end{aligned}$$

and therefore, is a neutrosophic. Hence $\frac{(N \cup I) \cap (M_{i-1} \cup I)}{(N \cup I) \cap (M_i \cup I)}$ is also neutrosophic coatmic. So, $(N \cup I)$ is a neutrosophic coatmic in $(M \cup I)$. Then $(M \cup I)$ is a neutrosophic coatmic module. Thus $(R \cup I)$ is a neutrosophic strongly Bss-ring. Now we, moving on to a new concept called a neutrosophic V-ring in order to be another way to get neutrosophic strongly Bass-ring. \square

Definition 3.2. Any N- ring $(R \cup I)$ is called N- V-ring if a neutrosophic module $(M \cup I)$ is a N- injective module.

Example 3.1. A N- $(a \cup I)$ is a N- field F is N- injective module.

Example 3.2. A N- vector space on N- field F is N- injective module.

Remark 3.1.

- (1) Every Neutrosophic free module $(M \cup I)$ is not necessarily injective module.
- (2) Every Neutrosophic injective $(M \cup I)$ is Neutrosophic torsioless, but not N- finitely generated.
- (3) For all N- module $(M \cup I)$, there exists N- injective hull $(E \cup I)$ and it is the smallest N- injective module which contain it.

Again, we need to return to a neutrosophic V-ring. N- V-ring is a N- ring (almost commutative)

Remark 3.2. Every N- simple module on N- ring $(R \cup I)$ is a N- injective module (i.e. every N- simple module $(M \cup I)$ as $(R \cup I)$ - module has a proper which named extend of linear isomorphic).

Example 3.3. Every N- semi simple ring $(R \cup I)$ is N- V-ring.

Example 3.4. $(Z \cup I)$ as a N- integer number not N- V-ring, because $\frac{Z \cup I}{Z_p \cup I}$ is N- simple module and not N- injective module on $(Z \cup I)$.

Note that every N- V-ring not contain zero N- elements divided zero divisors if $(R \cup I)$ is a comm. N- ring. Also, N- V-ring has strongly relation with N- semi- V-rings (N-simple Artinian rings).

Definition 3.3. Any N- ring $(R \cup I)$ is N- V-ring if every N- simple is N- injective.

Remark 3.3. If $(R \cup I)$ is N- V-ring, $(M \cup I)$ is N- S-coatomic also $(R \cup I)$ is N- V-ring if $(R \cup I)$ is N- regular, means $(M \cup I)$ is N- injective module.

Theorem 3.2. If $(M \cup I)$ is N- V-module, $(R \cup I)$ is a N- s-Bass- ring.

Proof. $(M \cup I)$ is a N- V-module let $(N \cup I) \leq (M \cup I)$. Let $0I \neq (N \cup I)$ and $(H \cup I) \leq (N \cup I)$ such that $aI \in \frac{(N \cup I)}{(H \cup I)}$.

So,

$$(aI + (H \cup I)(R \cup I)) = \frac{(aI(R \cup I) + (N \cup I))}{(R \cup I)}$$

is N- cyclic. Hence $(M \cup I)$ has N- maximal submodule $\frac{(K \cup I)}{(H \cup I)}$; $(K \cup I) \leq (M \cup I) \supseteq (H \cup I)$. Then $\frac{(aI(R \cup I) + (H \cup I))}{(K \cup I)}$ e module and is a N- simple $(M \cup I)$ injective. Therefore $\frac{(aI(R \cup I) + (H \cup I))}{(K \cup I)}$ is N- $\frac{(N \cup I)}{(K \cup I)}$ -injective. Then

$$\frac{N \cup I}{K \cup I} = \left[\frac{(aI(R \cup I) + (H \cup I))}{(K \cup I)} \right] \oplus \frac{(N \cup I)}{(K \cup I)}$$

is N- maximal of $(N \cup I)$.

Hence $(N \cup I)$ is N- coatom and then $(M \cup I)$ is N- strongly coatomic. Thus $(R \cup I)$ is N- S-Bass-ring. \square

4. NEUTROSOPHIC SEMI-BASS-RINGS

The main concern of this section is to present some new results of N- semi-Bass- ring and to give some sufficient and conditions for N- submodules.

Definition 4.1. A N- $(R \cup I)$ -module $(M \cup I)$ is called N- Semi-simple if it is a direct sum of N- simple, such that N- simple means has no proper N- submodules.

Now some properties of N- semi-max -submodules as following:

Definition 4.2. A N- submodule $(N \cup I)$ of a N- $(R \cup I)$ -module $(M \cup I)$ is called N- semi-max-submodule iff $\frac{(M \cup I)}{(N \cup I)}$ is semi- simple module. Note that any N- ring $(R \cup I)$ is N- semi-Bass if every N- submodule of $(R \cup I)$ -module $(M \cup I)$ is N- semi-maximal $(M \cup I)$ in $(R \cup I)$ is N-maximal.

Example and Remarks 4.1.

- (1) For each positive integer $nI > 1I$, $(Z \cup I)$ is a neutrosophic semi-maximal submodule of $(Z \cup I)$ -module $(Z \cup I)$ if and only if nI is a neutrosophic squar-free.
- (2) Every N- maximal submodule is a N- semi maximal and the converse is not true in general, for example: $6I(Z \cup I)$ is a N- semi-maximal submodule $(Z \cup I)$ -module $(Z \cup I)$, it is not Neutrosophic maximal submodule.
- (3) In general, not N- module has N- semi-maximal submodule.

Corollary 4.1. If $(N \cup I) = (J \cup I)(M \cup I)$ over a Neutrosophic Boolean ring, then every $(N \cup I) \leq (M \cup I)$ is a N- semi-maximal and so $(M \cup I)$ is N- Semi -Bass ring.

Proposition 4.1. Let $(M \cup I)$ be a Neutrosophic finitely generated $(R \cup I)$ - module such that ann if a Neutrosophic semi maximal ideal of $(R \cup I)$ and $xI \in (M \cup I)$. So every $(N \cup I) \leq (M \cup I)$ is a N- semi-maximal $(R \cup I)$ is a N- semi-Bass-ring.

Proof. Assume that $(M \cup I) = (m_1 I, m_2 I, \dots, m_n I)$, where $m_i I \in (M \cup I), i = 1I, 2I, \dots nI$. Let $(N \cup I) \leq (M \cup I)$. It is clear that

$$[(N \cup I) : (M \cup I)] = \text{ann}_{(R \cup I)}((M \cup I)/(N \cup I)) = n_i I = \cap \text{ann}_{(R_i \cup I)}(mI)$$

$\frac{(R \cup I)}{[(M \cup I) : (N \cup I)]} = \frac{(R \cup I)}{(n_i I)} = \cap \text{ann}_{(R_i \cup I)}(mI)$, which is isomorphic to N- submodule of $\frac{(R \cup I)}{(n_i I)} = \oplus \text{ann}_{(R_i \cup I)}(mI)$ and $\text{ann}_{(R \cup I)}(m_i I)$ is a N-semi maximal ideal in $(R(I))$, for each $i = 1I, 2I, \dots nI$. Also $\frac{(R \cup I)}{\text{ann}_{(R \cup I)}(mI)}$ is a N- semi simple ring. Hence $\frac{(R \cup I)}{[(M \cup I) : (N \cup I)]}$ is N- semi simple ring, whence $[(M \cup I) : (N \cup I)]$ is a N- semi maximal ideal $(R \cup I)$. Hence $(N \cup I)$ is a N- semi $(M \cup I)$. Thus $(R \cup I)$ is a N- semi -Bass ring. \square

Theorem 4.1.

(1) Every N- multiplication finitely generated $(R(I)$ -module contains maximal submodule. According to Neutrosophic modules which contain Neutrosophic submodules.

(2) A N- semi- maximal submodule not to be N- prime:

$6I (Z \cup I) \leq (Z \cup I) \ni 6I(Z \cup I)$ is a N- semi-maximal $(Z \cup I)$ -module $(Z \cup I)$ which is not N- prime.

Recall that an $(R \cup I)$ -module $(M \cup I)$ is N- prime if $\text{ann}_{(R \cup I)}(M \cup I) = \text{ann}_{(R \cup I)}(N \cup I), \forall 0 \neq (N \cup I)$ is a N- submodule of $(M \cup I)$.

Note that, before the next proposition we need use a concept which namely N- semi-maximal $(N \cup I)$ of a Neutrosophic $(M \cup I)$ as following:

Proposition 4.2. Let $(N \cup I)$ a N- semi -maximal of a N- $(R \cup I)$ module $(M \cup I)$. If $(P \cup I)$ is a N- prime of $(M \cup I)$ and $(N \cup I) \leq (P \cup I)$, containing $(N \cup I)$, then $(P \cup I)$ is a N- maximal of $(M \cup I)$ and so $(R \cup I)$ N- semi- Bass ring.

Proof. We know that $(P \cup I)$ is a N- semi maximal of $(M \cup I)$ and hence $\frac{(M \cup I)}{(P \cup I)}$ is a N- semi-simple $(R \cup I)$ -module. On the other hand $(P \cup I)$ is a N- prime in $(R \cup I)$. Therefore, $\frac{(M \cup I)}{(P \cup I)}$ is a N- prime module. So $\frac{(M \cup I)}{(P \cup I)}$ is a N- simple module. Then $(P \cup I)$ is a N- maximal of $(M \cup I)$. $(R \cup I)$ is a N- semi-Bas-ring. \square

Corollary 4.2. If $(N \cup I)$ is a N- prime and semi-maximal submodule of $(R \cup I)$ -module. Hence, $(N \cup I)$ is a N- maximal in $(M \cup I)$ and then $(R \cup I)$ is a N- Bass-ring.

Theorem 4.2. Let $(N \cup I)$ be a N- submodule of a N- $(R \cup I)$ -module $(M \cup I)$. Then $(N \cup I)$ is a N- semi-maximal if and only if $(A \cup I) \leq (B \cup I) \leq (N \cup I) \ni (A \cup I) + (B \cup I) = (M \cup I)$ and $(A \cup I) \cap (B \cup I) \subseteq (N \cup I)$.

Proof. Let $(N \cup I)$ is a N- semi-maximal in $(M \cup I)$. also $(A \cup I)$ is N in $(M \cup I)$. Then $\frac{(A \cup I) + (N \cup I)}{(N \cup I)}$ is a N- submodule of $\frac{(M \cup I)}{(N \cup I)}$. Also, since $\frac{(M \cup I)}{(N \cup I)}$ is a N- semi simple $(R \cup I)$ -module, then $\frac{(A \cup I) + (N \cup I)}{(N \cup I)}$ is a N- direct summand of $\frac{(M \cup I)}{(N \cup I)}$.

Hence

$$\frac{(M \cup I)}{(N \cup I)} = \frac{(A \cup I) + (N \cup I)}{(N \cup I)} \oplus \frac{(B \cup I)}{(N \cup I)},$$

for some N- submodule $(A \cup I)$ and N- $(B \cup I)$ of $(M \cup I)$ which containing $(N \cup I)$. Therefore $(M \cup I) = (A \cup I) + (B \cup I)$.

Next if $xI \in (A \cup I) \cap (B \cup I)$, then $xI + (N \cup I) \in \left(\frac{(A \cup I) + (N \cup I)}{(N \cup I)}\right) \cap \frac{(A \cup I) + (N \cup I)}{(N \cup I)}$. Then $xI + (N \cup I) = (N \cup I)$ and hence $xI \in (N \cup I)$. Therefore $(A \cup I) \cap (B \cup I) \subseteq (N \cup I)$. Now the converse:

Let $\frac{(A \cup I)}{(N \cup I)}$ be a N- submodule of $\frac{(M \cup I)}{(N \cup I)}$. Hence; $(A \cup I)$ is a N- submodule of $(M \cup I)$. Hence there exist a N- submodule of $(B \cup I)$ of $(M \cup I)$ such that $(A \cup I) + (B \cup I) = (M \cup I)$ and $(A \cup I) \cap (B \cup I) \subseteq (N \cup I)$. Hence $\frac{(M \cup I)}{(N \cup I)} = \frac{(A \cup I)}{(N \cup I)} + \frac{(B \cup I) + (N \cup I)}{(N \cup I)}$, so, $\frac{(A \cup I)}{(N \cup I)}$ is a N- semi simple $(N \cup I)$ -module.

Recall that N- supplemented module, N- supplement of $(A \cup I) \leq (M \cup I)$ is a N- weak supplement in $(M \cup I)$ if $\exists (B \cup I) \leq ((M \cup I) \ni (A \cup I) + (B \cup I) = (M \cup I))$ and $(A \cup I) \cap (B \cup I) \ll (M \cup I)$.

Also, $(M \cup I)$ is called N- w- supplemented $(R \cup I)$ -module if N- submodule $(N \cup I)$ of $(M \cup I)$ is a N- weak supplement[9] where a N- submodule $(N \cup I)$ of $(M \cup I)$ is called N- small in $(M \cup I)$ if $(N \cup I) + (K \cup I) \neq (M \cup I)$ for all proper $(K \cup I)$ of $(M \cup I)$ [5]. \square

Corollary 4.3. *If $(M \cup I)$ is a N- w- supplemented $(R \cup I)$ -module and $J[(M \cup I)] \neq (M \cup I)$, $J[(M \cup I)]$ is a N- semi-maximal of $(M \cup I)$.*

Proof. Let $(A \cup I)$ be a N- submodule of $(M \cup I)$. Then $\exists (B \cup I) \leq ((M \cup I) \ni (A \cup I) + (B \cup I) = (M \cup I))$ and $(A \cup I) \cap (B \cup I) \ll (M \cup I)$. Hence,

$$(A \cup I) \cap (B \cup I) \subseteq J[(M \cup I)].$$

Therefore $J[(M \cup I)]$ is a Neutrosophic semi-maximal in $(M \cup I)$. \square

Theorem 4.3. *Let $(N \cup I)$ N- submodule in $(R \cup I)$ -module $(M \cup I)$. Then $(N \cup I)$ is a N- semi-maximal in $(M \cup I)$ iff \exists N- submodules $(A \cup I)$ and $(B \cup I)$ of $(M \cup I)$ such that $(M \cup I) = (A \cup I) \oplus (B \cup I)$ with $(A \cup I)$ is a N- semi simple $(N \cup I)$ is a N- essential and semi-maximal in $(B \cup I)$.*

Proof. Suppose $(N \cup I)$ is a N- semi-maximal in $(M \cup I)$ and $(A \cup I)$ is a complement of $(N \cup I)$ in $(M \cup I)$. Then $(A \cup I) \oplus (N \cup I)$ is a N- essential submodule of $(A \cup I) ((B \cup I))$. Also $\frac{(A \cup I) \oplus (N \cup I)}{(N \cup I)}$ is a N- submodule of $\frac{(M \cup I)}{(N \cup I)}$. So,

$$\frac{(M \cup I)}{(N \cup I)} = \frac{(A \cup I) \oplus (N \cup I)}{(N \cup I)} \oplus \frac{(B \cup I)}{(N \cup I)}$$

for some N- submodule $(B \cup I)$ of $(M \cup I)$ which containing $(N \cup I)$. We claim that $(M \cup I) = (A \cup I) + (B \cup I)$. Let $xI \in [(A \cup I) \cap (B \cup I)]$, So $xI \in (A \cup I)$ and $xI \in (B \cup I)$.

Then

$$xI + (N \cup I) \in \frac{[(A \cup I) \oplus (N \cup I)]}{(N \cup I)} \text{ and } xI + (N \cup I) \in \frac{(B \cup I)}{(N \cup I)}.$$

Therefore,

$$xI + (N \cup I) \in \frac{[(A \cup I) \oplus (N \cup I)]}{(N \cup I)} \oplus \frac{(B \cup I)}{(N \cup I)}.$$

Thus

$$xI + (N \cup I) = . \text{ So } xI \in (N \cup I).$$

Hence

$$(A \cup I) \cap (B \cup I) \subseteq (N \cup I).$$

Then $(A \cup I) \cap (B \cup I) \neq 0I$ and this contradiction. Hence $(A \cup I) \cap (B \cup I) = 0I$. So,

$$(M \cup I) = (A \cup I) \oplus (B \cup I).$$

Now, let $(C \cup I)$ be a nontrivial N -submodule of $(B \cup I) \ni (C \cup I) \cap (N \cup I) = 0I$. Then $(C \cup I) \subseteq (A \cup I) \cap (B \cup I) = 0I$, which is contradiction. Therefore $(N \cup I)$ is N -essential of $(B \cup I)$.

Moreover, $\frac{(B \cup I)}{(N \cup I)}$ is a N -semi simple of $(R \cup I)$ -module because $\frac{(B \cup I)}{(N \cup I)}$ is a N -semi simple $(R \cup I)$ -module and hence $(N \cup I)$ is a N -semi maximal in $(B \cup I)$. Conversely, let $(N \cup I)$ be a N -submodule of $(M \cup I)$. By hypothesis $(M \cup I) = (A \cup I) \oplus (B \cup I)$ with $(A \cup I)$ is a N -semi simple and $(N \cup I)$ is a N -semi-maximal in $(B \cup I)$. Therefore

$$\frac{(B \cup I)}{(N \cup I)} = \frac{(A \cup I) \oplus (B \cup I)}{(N \cup I)}$$

is a N -semi simple $(R \cup I)$ -module and hence $(N \cup I)$ is a N -semi-Bass-ring. \square

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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