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A STUDY ON INTUITIONISTIC FUZZ PRIME IDEAL OF NEAR RING

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ABSTRACT: In this paper we further study the theory of Intuitionistic fuzzy ideals and intuitionistic fuzzy prime ideals. We have investigated these notions and shown a new result using the intuitionistic fuzzy points and a membership and non-membership functions.

Keywords: Intuitionistic fuzzy ring, Intuitionistic fuzzy ideal, Intuitionistic fuzzy prime ideal, Intuitionistic fuzzy point.

1 INTRODUCTION

In 1986 Atanassov introduced the notion of a intuitionistic fuzzy set as a generalization of Zadeh's fuzzy sets [15]. After the introduction of the notion of intuitionistic fuzzy subring by Hur, Kang and Song [4], many researchers have tried to generalize the notion of intuitionistic fuzzy subring. Marashdeh and Salleh [11] introduced the notion of intuitionistic fuzzy rings based on the notion of fuzzy space, Near-rings were first studied by Fittings in 1932. It is a generalization of a ring. If in a ring we ignore the commutativity of addition and one distributive law then we get a near-ringHur, K., Kang, H. W. & Song, H. K. [4], Hur, K., Jang, S. Y. & Kang, H. W. [5] and many other researchers have contributed and are contributing the near-ring theory. A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function which assigns to each object a grade of membership ranging between zero and one. The notions of inclusion, union, intersection, complement, relation, convexity, etc., are extended to such sets, and various properties of these notions in the context of fuzzy sets are established. Sharma [13] introduced the notion of translates of intuitionistic fuzzy subrings. The purpose of this paper is to improve the concept of intuitionistic fuzzy ideals of a ring given a new characterization using the intuitionistic fuzzy points and to show some results of fuzzy prime ideal.

2 PRELIMINARIES

First we give the concept of intuitionistic fuzzy set defined by Atanassov as a generalization of the concept of fuzzy set given by Zadeh.

Definition : The intuitionistic fuzzy sets (in shorts IFS) are defined on a non-empty set X as objects having the form $A = \{\langle x, \mu(x), \vartheta(x)\rangle \mid x \in X\}$

Where the functions μ : X → [0, 1] and : X → [0, 1] denote the degrees of membership and of non-membership of each element x ∈ X to the set A, respectively, and $0 \leq \mu(x) + \vartheta(x) \leq 1$for all x ∈ X.

For the sake of simplicity, we shall use the symbol$< \mu, \vartheta >$ for the intuitionistic fuzzy set

$$A = \{\langle x, \mu(x), \vartheta(x)\rangle \mid x \in X\}$$

Definition: Let X be a nonempty set and let A=$< \mu_A, \vartheta_A >$ and B = =$< \mu_B, \vartheta_B >$be IFSs of X. Then

$(i) A \subset B$ iff $\mu_A \leq \mu_B$ and $\nu_A \geq \nu_B$

$(ii) A = B$ iff $A \subset B$ and $B \subset A$

(iii) $A^c = \langle \nu_A, \mu_A\rangle$

(iv)$A \cap B = \langle \mu_A \wedge \mu_B, \nu_A \vee \vartheta_B\rangle$

(v) $A \cup B = \langle \mu_A \vee \mu_B, \nu_A \wedge \nu_B\rangle$

(vi)$\Box A = \langle \mu_A, 1 - \mu_A\rangle$, $\diamond A = \langle 1 - \vartheta_A, \nu_A\rangle$

Example: Let G be Klein 4-group { e , a , b , ab } , where = b^2 = e and ab = ba. Define

A = { < e , 0.9, 0.1 > , < a , 0.65 ,0.3 > , < b , 0.61, 0.29 > , < ab, 0.6, 0.31 >} be IFS in G.

Example : Let G = S3 = { i , (12) ,(13) ,(23) ,(123),(132)}be the symmetric groupConsider the functions μ_A:S_3 →[0, 1] andν_A : S_3 →[0, 1] defined

$$\mu_A(x) = \begin{cases} 1; & \text{if } x = i \\ 0; & \text{if } x^2 = i \\ 0.6; & \text{if } x^3 = i \end{cases} \text{ and } \nu_A(x) = \begin{cases} 0; & \text{if } x = i \\ 0.5; & \text{if } x^2 = i \\ 0.3; & \text{if } x^3 = i \end{cases}$$

Is intuitionistic fuzzy set A of S_3 .

Definition:. Let α, β ∈ [0, 1] with α + β ≤ 1. An intuitionistic fuzzy point, written as $x_{(\alpha,\beta)}$ is defined to be an intuitionistic fuzzy subset of R, given by

$$x_{(\alpha,\beta)}(y) = \begin{cases} (\alpha,\beta), \text{ if } x = y \\ (0,1), \text{ if } x \neq y \end{cases}$$

An intuitionistic fuzzy point $x_{(\alpha,\beta)}$ is said to belong in IFS $< \mu, \vartheta >$ denoted by $x_{(\alpha,\beta)} \in < \mu, \vartheta >$if $\mu(x) \geq \alpha$ and $\vartheta(x) \leq \beta$ and we have for x, y ∈ R

$$x_{(t,s)} + y_{(\alpha,\beta)} = (x+y)_{(t\wedge\alpha, s\vee\beta)}$$
$$x_{(t,s)} y_{(\alpha,\beta)} = (xy)_{(t\wedge\alpha, s\vee\beta)}$$

Definition: Let R be a ring. An intuitionistic fuzzy set A ={ $\langle x, \mu(x), \vartheta(x) \rangle$ | $x \in R$ }of R is said to be an intuitionistic fuzzy subring of R (in short, IFSR) of R if ∀x, y ∈R

$$(i)\ \mu(x-y) \geq \mu(x) \wedge \mu(y)$$

(ii) $\vartheta(x-y) \leq \vartheta(x) \vee \vartheta(y)$

(iii) $\mu(xy) \geq \mu(x) \wedge \mu(y)$

(iv) $\vartheta(xy) \leq \vartheta(x) \vee \vartheta(y)$

Definition : Let R be a ring. An intuitionistic fuzzy set A ={ $\langle x, \mu(x), \vartheta(x) \rangle$ | $x \in R$ }of R is said to be an intuitionistic fuzzy ideal of R (in short, IFI) of R if ∀x, y ∈R

(i)$\mu(x-y) \geq \mu(x) \wedge \mu(y)$

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(ii) $\vartheta(x-y) \leq \vartheta(x) \vee \vartheta(y)$,

(iii) $\mu(xy) \geq \mu(x) \vee \mu(y)$

iv) $\vartheta(xy) \leq \vartheta(x) \wedge \vartheta(y)$

Definition: An intuitionistic fuzzy ideal P $=< \mu_p, \vartheta_{Ap} >$of a ring R, not necessarily nonconstant, is called intuitionistic fuzzy prime ideal, if for any intuitionistic fuzzy ideals A $=< \mu_A, \vartheta_A >$and

B $=< \mu_B, \vartheta_B >$of R the condition AB ⊂ P implies that either A ⊂ P or B ⊂ P.

3.1 Intuitionistic fuzzy ideal

Let R be the subset of all intuitionistic fuzzy points of R, and let A denote the set of all intuitionistic fuzzy points contained in A $= < \mu_A, \vartheta_A >$ That is,

$$A = \{x_{(\alpha,\beta)} \in R | \mu_A \geq \alpha,\ \vartheta_A \leq \beta\}$$

Theorem (1): A $=< \mu_A, \vartheta_A >$ is an intuitionistic fuzzy ideal of R if and only if

(i)$\forall x_{(\alpha,\beta)}, y_{(\alpha',\beta')} \in \langle \mu_A, \vartheta_A \rangle, x_{(\alpha,\beta)} - y_{(\alpha',\beta')} \in \langle \mu, \vartheta \rangle$

ii) $\forall x_{(\alpha,\beta)} \in \underset{-}{R}, \forall y_{(\alpha',\beta')} \in \langle \mu, \vartheta \rangle, x_{(\alpha,\beta)} y_{(\alpha',\beta')} \in \langle \mu, \vartheta \rangle$.

Proof. **(⇒)** Suppose that $< \mu_A, \vartheta_A >$ is an intuitionistic fuzzy ideal, so we have for all $x_{(\alpha,\beta)}, y_{(\alpha',\beta')} \in \langle \mu, \nu \rangle$

$\mu(x-y) \geq \mu(x) \wedge \mu(y) \geq \alpha \wedge \alpha'$ and $\vartheta(x-y) \leq \vartheta(x) \vee \vartheta(y) \leq \beta \vee \beta'$ then $x_{(\alpha,\beta)} - y_{(\alpha',\beta')} = (x-y)_{(\alpha\wedge\alpha',\beta\vee\beta')} \in \langle \mu, \nu \rangle$and we have for all $x_{(\alpha,\beta)} \in \underset{-}{R}, \forall y_{(\alpha',\beta')} \in \langle \mu, \nu \rangle$

$$\mu(xy) \geq \mu(x) \vee \mu(y) \geq \mu(y) \geq \alpha' \geq \alpha \wedge \alpha'$$

And $\vartheta(xy) \leq \vartheta(x) \wedge \vartheta(y) \leq \vartheta(y) \leq \alpha' \leq \alpha \vee \alpha'$

Hence $(x.y)_{(\alpha\wedge\alpha',\beta\vee\beta')} = x_{(\alpha,\beta)} y_{(\alpha',\beta')} \in \langle \mu, \vartheta \rangle$

$\Leftarrow) let x, y \in R x_{(\mu(x)\wedge\mu(y), \nu(x)\vee\nu(y))} \in \langle\mu, \vartheta\rangle$ *and* $y_{(\mu(x)\wedge\mu(y), \nu(x)\vee\nu(y))} \in \langle\mu, \vartheta\rangle$ Then, using the assumption we have

$$x_{(\mu(x)\wedge\mu(y), \nu(x)\vee\nu(y))} - y_{(\mu(x)\wedge\mu(y), \nu(x)\vee\nu(y))} \in \langle\mu, \vartheta\rangle$$

Hence $\mu(x-y) \geq \mu(x) \wedge \mu(y)$ and $\nu(x-y) \leq \vartheta(x) \vee \vartheta(y)$

Now we will show that $\mu(xy) \geq \mu(x) \vee \mu(y)$ and $\vartheta(xy) \leq \vartheta(x) \wedge \vartheta(y)$.

$let x, y \in R$Suppose that $\mu(y) \geq \mu(x)$ and $\vartheta(x) \leq \vartheta(y)$. so for

$$\alpha = \alpha' = \mu(x) \vee \mu(y), \text{ and } \beta = \beta' = \vartheta(x) \wedge \vartheta(y)$$
$$we\ have\ \ y_{(\alpha\vee\alpha', \beta\wedge\beta')} \in \langle\mu, \vartheta\rangle$$

since $x_{(\alpha\vee\alpha', \beta\wedge\beta')} \in$ RImplies that

$$x_{(\alpha\vee\alpha', \beta\wedge\beta')} \cdot y_{(\alpha\vee\alpha', \beta\wedge\beta')} \in \langle\mu, \vartheta\rangle$$

Hence $\mu(xy) \geq \mu(x) \vee \mu(y)$ and $\nu(xy) \leq \vartheta(x) \wedge \vartheta(y)$ the same is true

$\mu(x-y) \geq \mu(x) \wedge \mu(y)$

3.2 Intuitionistic fuzzy prime ideal

Theorem(2:) An intuitionistic fuzzy ideal$< \mu, \vartheta >$ of R is an intuitionistic fuzzy prime ideal if and only if for any two intuitionistic fuzzy points $x_{(\alpha,\beta)})$, $y_{(\alpha',\beta')}\in$ R, $x_{(\alpha,\beta)}.y_{(\alpha',\beta')} \in \langle\mu, \vartheta\rangle$. implies either $x_{(\alpha,\beta).} \in \langle\mu, \vartheta\rangle$. or$y_{(\alpha',\beta')} \in \langle\mu, \vartheta\rangle$

Theorem(3) : A subset $< \mu, \vartheta >$ of R is said to be an intuitionistic fuzzy prime ideal if only if

(i) $\mu(x-y) \geq \mu(x) \wedge \mu(y)$

(ii) $\nu(x-y) \leq \nu(x) \vee \nu(y)$

iii) $\mu(xy) = \mu(x) \vee \mu(y)$,

(iv) $\nu(xy) = \nu(x) \wedge \nu(y)$

Proof: Let $<\mu,\vartheta>$be an intuitionistic fuzzy prime ideal. Suppose that $\mu(xy) > \mu(x) \vee \mu(y)$and $\mu(x) \geq \mu(y)$

and suppose that $\mu(xy) < \mu(x) \wedge \mu(y)$ and $\mu(x) \leq \mu(y)$

Then $\mu(xy) > \mu(x) \geq \mu(y)$ and $\vartheta(xy) < \vartheta(x) \leq \vartheta(y)$ which implies that

$x_{(\mu(xy),\nu(xy))} \notin \langle\mu,\nu\rangle$ and $y_{(\mu(xy),\nu(xy))} \notin \langle\mu,\nu\rangle$

Using the previous theorem, we have

$x_{(\mu(xy),\nu(xy))}.\, y_{(\mu(xy),\nu(xy))} \notin \langle\mu,\nu\rangle$

Which is Sabsurd. Then

$\mu(xy) = \mu(x) \vee \mu(y)$ and $\nu(xy) = \nu(x) \wedge \nu(y)$

Conversely, let $x_{(\alpha,\beta)}$, $y_{(\alpha',\beta')}$ be two intuitionistic fuzzy points of R, such that $x_{(\alpha,\beta)}$, $y_{(\alpha',\beta')}\in<\mu,\vartheta>$. Suppose that $x_{(\alpha,\beta)} \notin<\mu,\vartheta>$and that $y_{(\alpha',\beta')} \notin<\mu,\vartheta>$ for α = α' = μ(xy) and β = β' = ϑ (xy). We have μ (x) <μ (xy) and μ(y) <μ(xy) and ϑ (x) > ϑ (xy) and ϑ (y) > ϑ (xy). This implies *that* $x_{(\mu(xy),\nu(xy))} \notin \langle\mu,\nu\rangle$ and $y_{(\mu(xy),\nu(xy))} \notin \langle\mu,\nu\rangle$

Which is contradicts to $\langle\mu,\nu\rangle$being an intuitionistic fuzzy prime ideal.

Lemma 1: If A is a non constant IF weakly prime ideals of N, then A(1,0) is a prime left ideal on N.

Proof: Let A be a non constant IF weakly prime ideal of N. Let C,D be left ideals of N such $C.D \subseteq A_{(1,0)}, A_{(1,0)} \subseteq C$ and $A_{(1,0)} \subseteq D$ Define IFSs I, J as

$$l(x) = \begin{cases} (1,0) & \text{if } x \in C \\ (t,t') & \text{otherwise} \end{cases} \quad J(x) = \begin{cases} (1,0) & \text{i } fx \in D \\ (t,t') & \text{otherwise} \end{cases}$$

Clearly I, J are IF strong left ideals of N,A⊆ I, A ⊆ J.

$$(IJ)(x) = \begin{cases} (1,0) & \text{if } x \in C.D \\ (t,t') & \text{if } x = yz, y \notin C or z \notin D \\ (0,1) & \text{otherwise} \end{cases}$$

Therefore I.J ⊆ A implies I = A or J = A. Thus C = I or D = J. Hence $A_{(1,0)}$ is a weakly prime left ideal of N.

Remark:Every strong ideal of N is an ideal of N, but the converse need not be true.

Remark: A prime left ideal is always a weakly prime left ideal and the converse is not true.

Theorem 3.. Let A be a non constant IF left ideal of N. Then A is an IF weakly prime left ideal of N if and only if

(i) $ImA = \{(1,0),(t,t')\}$, where $(1,0) > (t,t') \geq (0,1)$

$(ii)A_{(1,0)}$is a weakly prime left ideal of N.

Proof: If A is an IF weakly prime left ideal of N, then (i),(ii) is true from Lemma 3.13 and Lemma 3.14. Conversely, if there exist IF left ideals I, J of N containing A such that I.J ⊆ A with I ≠A and J ≠A. Therefore there exist a,b∈ N such that

$I(a) = (s_1, s_1') > (t,t') = A(a)$ and $J(b) = (s_2, s_2') > (t,t') = A(b)$thus $a \in I_{(s_1,\zeta_1)}$ and $a \notin A_{(1,0)}$, b∈ $J_{(s_2,s_j')}$. but $a \notin A_{(1,0)}$

Clearly $I_{(s_1,\zeta_1)}J_{(s_2,s_j')}$) are strong left ideals. Let x ∈$A_{(1,0)}$. As A ⊆ I,A(x) = (1,0), then

I(x) = (1,0) Thus I (x) ≥ (s_1,s_1'). Therefore $A_{(1,0)}$⊆$I_{(s_1,s_1')}$ similarly

$$A_{(1,0)} \subseteq J_{(s_2,s_j')}. \text{If } I_{(s_1,s_1)} \cdot J_{(s_2,s_3)} \subseteq, \text{ then } I_{(s_1,s_1')} = I_{(s_1,s_1')} \cdot J_{(s_2,s_2)} \notin A_{(1,0)}.$$

Then $cd \notin A_{(1,0)}$ for some $c \in I_{(s_1,s_1')}$and for some d ∈$J_{(s_2,s_3)}$ Thus A(cd) =(t,t')

$$(I.J)(cd) \geq I(c) \wedge J(d) = (s_1, s_1') \wedge (s_2, s_2') > (t,t') = A(cd)$$

Which is a contradiction to I.J⊆ A. Therefore A is an IF weakly prime left ideals of N.

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Theorem (4): Let A be a non-constant IF strong left ideal of N. Then A is an IF prime left ideal of N if and only if (i) IMA = {(1,0),$(t,t^{'})$} (ii)$A_{(1,0)}$) is a prime left ideal of N.

Proof: Let A be an IF prime left ideal of N. Then A is an IF weakly prime left ideal of N. From Lemma (1) IMA =$\{(1,0),(t,t^{'})\}$, where $(1,0) > (t,t^{'}) \geq (0,1)$ LetC,D be strong left ideals of N such that C.D ⊆$A_{(1,0)}$) . Thenχ_c, χ_D are the IF strong left ideals of N.

$$(\chi_c \cdot \chi_D)(x) = \begin{cases} (1,0) & \text{if } x \in C.D \\ (0,1) & \text{otherwise} \end{cases}$$

$Therefore\ \chi_C \cdot \chi_D \subseteq A$ and so $\chi_c \subseteq A$ or $\chi_D \subseteq A.$ Hence $C \subseteq A$ or$D \subseteq A$

Hence $A_{(1,0)}$ is a prime left ideals of N. Conversely, if there exist IF left ideals I, J of N containing A such $I.J \subseteq A$ with $I \nsubseteq A$ and $J \nsubseteq A.$

Therefore there exist a,b∈ N such that $I(a) = (s_1, s_1^{'}) > (t,t^{'}) = A(a)$and

$$J(b) = (s_2, s_2^{'}) > (t,t^{'}) = A(b)$$

. Thus a ∈ I $(s_1, s_1^{'})$ but $A_{(1,0)}$ and $b \in J_{(s_2,s_2)}$ but $b \notin A_{(1,0)}$. Clearly $I_{(s_1,s_1)}$,$J_{(s_2,s_2^{'})}$) are strong left ideals. Let x ∈$A_{(1,0)}$

As A ⊆ I,A(x) = (1,0), then I(x) = (1,0). Thus I(x) ≥ (s1,s 0 1). Therefore A(1,0) ⊆ I(s1,s 0 1) . Similarly,

$A_{(1,0)} \subseteq J_{(s_2,s_2)}$. If $I_{(s_1,s_1)} \cdot J_{(s_2,s_2^{'})} \subseteq$, then $I_{(s_1,s_1)} \subseteq A_{(1,0)}$ or $A_{(1,0)} \subseteq J_{(s_2,s_2)}$

Which is a contradiction. ThusIf $I_{(s_1,s_1)} \cdot J_{(s_2,s_2^{'})} \nsubseteq A_{(1,0)}$. Then cd∉ $A_{(1,0)}$) for some c ∈ $I_{(s_1,s_1)}$ and for some d ∈ $J_{(s_2,s_2^{'})}$) . Thus A(cd) = $(t,t^{'})$.

$$(I.J)(cd) \geq I(c) \wedge J(d) = (s_1, s_1^{'}) \wedge (s_2, s_2) > (t,t^{'}) = A(cd)$$

. Which is contradiction to I.J ⊆ A. Therefore A is an IF prime left ideals of N.

4 Conclusion: In this paper the notion of Intuitionistic fuzzy prime ideals of a near ringare discussed .In the future, further research suggest some future research to investigate other properties of intuitionistic fuzzy prime ideals and to expand their applications.

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