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On Intuitionistic Fuzzy Almost Regular α Generalized Continuous Mappings

Nivetha M[1], Jayanthi D[2]

[1]Department of mathematics, Avinashilingam University,
Coimbatore, Tamil Nadu, India
nivethathana@gmail.com

[2] Department of mathematics, Avinashilingam University,
Coimbatore, Tamil Nadu, India
jayanthimaths@rediffmail.com

Abstract: *The purpose of this paper is to introduce and study the concept of intuitionistic fuzzy almost regular α generalized continuous mapping in intuitionistic fuzzy topological spaces and study some of their properties.*

Keywords: Intuitionistic fuzzy set, Intuitionistic fuzzy topology, Intuitionistic fuzzy topological space, Intuitionistic fuzzy regular α generalized closed set, Intuitionistic fuzzy regular α generalized continuous mappings, Intuitionistic fuzzy almost regular α generalized continuous mappings.

1. INTRODUCTION

The Intuitionistic fuzzy sets was introduced by Atanassov [1]. Using the notion of intuitionistic fuzzy sets, Coker [2] introduced the notion of intuitionistic fuzzy topological space. In 2010, K. Sakthivel [8] introduced intuitionistic fuzzy alpha generalized continuous mappings and intuitionistic fuzzy regular α generalized continuous mappings was introduced by Nivetha M and Jayanthi D [7]. In this paper we introduce the notion of intuitionistic fuzzy almost regular α generalized continuous mappings and study their behaviour and properties in intuitionistic fuzzy topological spaces. Also we obtain some interesting theorems.

2. PRELIMINARIES

Definition 2.1:[1] An intuitionistic fuzzy set (IFS in short) A in X is an object having the form $A = \{\langle x, \mu_A(x), \nu_A(x)\rangle / x \in X\}$ where the function $\mu_A : X \to [0,1]$ and $\nu_A : X \to [0,1]$ denote the degree of membership (namely $\mu_A(x)$) and the degree of non-membership (namely $\nu_A(x)$) of each element $x \in X$ to the set A, respectively, and $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ for each $x \in X$.

Definition 2.2: [1] Let A and B be two IFSs of the form $A = \{\langle x, \mu_A(x), \nu_A(x)\rangle / x \in X\}$ and $B = \{\langle x, \mu_B(x), \nu_B(x)\rangle / x \in X\}$. Then

a) $A \subseteq B$ if and only if $\mu_A(x) \leq \mu_B(x)$ and $\nu_A(x) \geq \nu_B(x)$ for all $x \in X$
b) $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$
c) $A^c = \{\langle x, \nu_A(x), \mu_A(x)\rangle / x \in X\}$
d) $A \cap B = \{\langle x, \mu_A(x) \wedge \mu_B(x), \nu_A(x) \vee \nu_B(x)\rangle / x \in X\}$
e) $A \cup B = \{\langle x, \mu_A(x) \vee \mu_B(x), \nu_A(x) \wedge \nu_B(x)\rangle / x \in X\}$

For the sake of simplicity, we shall use the notation $A = \langle x, \mu_A, \nu_A\rangle$ instead of $A = \{\langle x, \mu_A(x), \nu_A(x)\rangle / x \in X\}$. The IFS $0_\sim = \{\langle x, 0, 1\rangle / x \in X\}$ and $1_\sim = \{\langle x, 1, 0\rangle / x \in X\}$ are respectively the empty set and the whole set of X.

Definition 2.3: [2] An intuitionistic fuzzy topology (IFT in short) on X is a family τ of IFS in X satisfying the following axioms:

a) $0_\sim , 1_\sim \in \tau$
b) $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$
c) $\cup G_i \in \tau$ for any family $\{ G_i / i \in J\} \subseteq \tau$

In this case the pair (X,τ) is called an intuitionistic fuzzy topological space (IFTS in short) and any IFS in τ is known as an intuitionistic fuzzy open set (IFOS in short) in X. The complement A^c of an IFOS A in (X,τ) is called an intuitionistic fuzzy closed set (IFCS in short) in X.

Definition 2.4: [2] Let (X,τ) be an IFTS and $A = \langle x, \mu_A, \nu_A\rangle$ be an IFS in X. Then the intuitionistic fuzzy interior and intuitionistic fuzzy closure are defined by

$int(A) = \cup \{ G / G$ is an IFOS in X and $G \subseteq A\}$

$cl(A) = \cap \{K / K$ is an IFCS in X and $A \subseteq K\}$

Note that for any IFS A in (X,τ), we have $cl(A^c) = (int(A))^c$ and $int(A^c) = (cl(A))^c$.

Corollary 2.5:[2] Let A, $A_i (i \in J)$ be intuitionistic fuzzy sets in X and B, $B_j (j \in K)$ be intuitionistic fuzzy sets in Y and $f : X \to Y$ be a function.

Then

a) $A_1 \subseteq A_2 \Rightarrow f(A_1) \subseteq f(A_2)$
b) $B_1 \subseteq B_2 \Rightarrow f^{-1}(B_1) \subseteq f^{-1}(B_2)$
c) $A \subseteq f^{-1}(f(A))$ [If f is injective , then $A=f^{-1}(f(A))$]
d) $f(f^{-1}(B)) \subseteq B$ [If f is surjective , then $B=f(f^{-1}(B))$]
e) $f^{-1}(\cup B_j) = \cup f^{-1}(B_j)$
f) $f^{-1}(\cap B_j) = \cap f^{-1}(B_j)$
g) $f^{-1}(0\sim) = 0\sim$
h) $f^{-1}(1\sim) = 1\sim$
i) $f^{-1}(B^c) = (f^{-1}(B))^c$

Definition 2.6:[3] An IFS A in an IFTS (X,τ) is said to be an

(i) intuitionistic fuzzy semi closed set (IFSCS in short) if $int(cl(A)) \subseteq A$

(ii)intuitionistic fuzzy α closed set (IFαCS in short) if $cl(int(cl(A))) \subseteq A$

(iii) intuitionistic fuzzy pre closed set (IFPCS in short) if $cl(int(A)) \subseteq A$

(iv) intuitionistic fuzzy regular closed set (IFRCS in short) if $cl(int(A)) = A$

Definition 2.7:[5] An IFS A of an IFTS (X,τ) is called intuitionistic fuzzy regular α generalized closed set (IFRαGCS in short) if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFROS in X.

Definition 2.8:[6] An IFS A of an IFTS (X,τ) is called intuitionistic fuzzy regular α generalized open set (IFRαGOS in short) if $\alpha int(A) \supseteq U$ whenever $A \supseteq U$ and U is an IFRCS in X.

The family of all IFRαGOSs of an IFTS (X,τ) is denoted by IFRαGO(X).

Definition 2.9:[3] Let f be a mapping from an IFTS (X,τ) into an IFTS (Y,σ). Then f is said to be an intuitionistic fuzzy continuous (IF continuous in short) mapping if $f^{-1}(B) \in IFO(X)$ for every $B \in \sigma$.

Definition 2.10:[4] Let f be a mapping from an IFTS (X,τ) into an IFTS (Y,σ). Then f is

said to be an

(i) intuitionistic fuzzy semi continuous (IFS continuous in short) mapping if $f^{-1}(B) \in IFSO(X)$ for every $B \in \sigma$

(ii)intuitionistic fuzzy α continuous (IFα continuous in short) mapping if $f^{-1}(B) \in IF\alpha O(X)$ for every $B \in \sigma$

(iii) intuitionistic fuzzy pre continuous (IFP continuous in short) mapping if $f^{-1}(B) \in IFPO(X)$ for every $B \in \sigma$

3. INTUITIONISTIC FUZZY ALMOST REGULAR α GENERALIZED CONTINUOUS MAPPINGS

In this section we introduce intuitionistic fuzzy almost regular α generalized continuous mapping and investigate some of its properties.

Definition 3.1: A mapping $f : X \to Y$ is said to be an intuitionistic fuzzy almost regular α generalized continuous (IFaRαG continuous in short) mapping if $f^{-1}(A)$ is an IFRαGCS in X for every IFRCS A in Y.

Example 3.2: Let X = {a,b}, Y = {u,v} and $G_1 = \langle x, (0.6,0.7), (0.4,0.2)\rangle$ where $\mu_a=0.6$, $\mu_b=0.7$, $\nu_a=0.4$, $\nu_b=0.2$ and $G_2 = \langle x, (0.2,0.2), (0.7,0.7)\rangle$ where $\mu_a=0.2$, $\mu_b=0.2$, $\nu_a=0.7$, $\nu_b=0.7$ and $G_3 = \langle y, (0.6,0.7), (0.3,0.1)\rangle$ where $\mu_u=0.6$, $\mu_v=0.7$, $\nu_u=0.3$, $\nu_v=0.1$ and $G_4 = \langle y, (0.1,0.1), (0.8,0.8)\rangle$ where $\mu_u=0.1$, $\mu_v=0.1$, $\nu_u=0.8$, $\nu_v=0.8$. Then $\tau = \{0\sim, G_1, G_2, 1\sim\}$ and $\sigma = \{0\sim, G_3, G_4, 1\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X,\tau) \to (Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $G_3^c = \langle y, (0.3,0.1), (0.6,0.7)\rangle$ is an IFRCS in Y. Then $f^{-1}(G_3^c) = \langle x, (0.3,0.1), (0.6,0.7)\rangle$ where $\mu_a=0.3$, $\mu_b=0.1$, $\nu_a=0.6$, $\nu_b=0.7$ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c)) = G_1^c \subseteq G_1$. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X. Thus f is an IFaRαG continuous mapping.

Theorem 3.3: Every IF continuous mapping is an IFaRαG continuous mapping but not conversely.

Proof: Let $f : (X,\tau) \to (Y,\sigma)$ be an IF continuous mapping. Let V be an IFRCS in Y. Since every IFRCS is an IFCS, V is an IFCS in Y. Then $f^{-1}(V)$ is an IFCS in X, by hypothesis. Since every IFCS is an IFRαGCS [5],$f^{-1}(V)$ is an IFRαGCS in X. Hence f is an IFaRαG continuous mapping.

Example 3.4: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.5,0.7), (0.4,0.2)⟩, G_2 = ⟨x, (0.2,0.2), (0.7,0.7)⟩, G_3 = ⟨y, (0.6,0.6), (0.3,0.2)⟩ and G_4 = ⟨y, (0.2,0.2), (0.8,0.8)⟩. Then τ = {0~, G_1, G_2, 1~} and σ = {0~, G_3, G_4, 1~} are IFTs on X and Y respectively. Define a mapping f : (X,τ) → (Y,σ) by f(a) = u and f(b) = v. The IFS G_3^c = ⟨y, (0.3,0.2), (0.6,0.6)⟩ is an IFRCS in Y. Then $f^{-1}(G_3^c)$ = ⟨x, (0.3,0.2), (0.6,0.6)⟩ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c))$ = ⟨x, (0.4,0.2), (0.5,0.6)⟩ ⊆ G_1. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X but not an IFCS in X, since G_3^c is an IFCS in Y but $cl(f^{-1}(G_3^c)) = G_1^c \neq f^{-1}(G_3^c)$. Therefore f is an IFaRαG continuous mapping but not an IF continuous mapping.

Theorem 3.5: Every IFα continuous mapping is an IFaRαG continuous mapping but not conversely.

Proof: Let f : (X,τ) → (Y,σ) be an IFα continuous mapping. Let V be an IFRCS in Y. Since every IFRCS is an IFCS, V is an IFCS in Y. Then $f^{-1}(V)$ is an IFαCS in X, by hypothesis. Since every IFαCS is an IFRαGCS [5], $f^{-1}(V)$ is an IFRαGCS in X. Hence f is an IFaRαG continuous mapping.

Example 3.6: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.4,0.4), (0.4,0.2)⟩, G_2 = ⟨x, (0.3,0.2), (0.5,0.5)⟩, G_3 = ⟨y, (0.5,0.5), (0.3,0.2)⟩ and G_4 = ⟨y, (0.2,0.2), (0.8,0.8)⟩. Then τ = {0~, G_1, G_2, 1~} and σ = {0~, G_3, G_4, 1~} are IFTs on X and Y respectively. Define a mapping f : (X,τ) → (Y,σ) by f(a) = u and f(b) = v. The IFS G_3^c = ⟨y, (0.3,0.2), (0.5,0.5)⟩ is an IFRCS in Y. Then $f^{-1}(G_3^c)$ = ⟨x, (0.3,0.2), (0.5,0.5)⟩ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c)) = G_1^c \subseteq G_1$. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X but not an IFαCS in X, since G_3^c is an IFCS in Y but $cl(int(cl(f^{-1}(G_3^c)))) = G_1^c \not\subseteq f^{-1}(G_3^c)$. Therefore f is an IFaRαG continuous mapping but not an IFα continuous mapping.

Remark 3.7: IFP continuous mapping and IFaRαG continuous mapping are independent to each other.

Example 3.8: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.5,0.4), (0.5,0.3)⟩, G_2 = ⟨x, (0.1,0.2), (0.8,0.8)⟩, G_3 = ⟨y, (0.6,0.6), (0.3,0.3)⟩, G_4 = ⟨y, (0.1,0.1), (0.9,0.9)⟩. Then τ = {0~, G_1, G_2, 1~} and σ = {0~, G_3, G_4, 1~} are IFTs on X and Y respectively. Define a mapping f : (X,τ) → (Y,σ) by f(a) = u and f(b) = v. The IFS G_3^c = ⟨y, (0.3,0.3), (0.6,0.6)⟩ is an IFRCS in Y. Then $f^{-1}(G_3^c)$ = ⟨x, (0.3,0.3), (0.6,0.6)⟩ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c)) = G_1^c \subseteq G_1$. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X but not an IFPCS in X, since G_3^c is an IFCS in Y but $cl(int(f^{-1}(G_3^c))) = G_1^c \not\subseteq f^{-1}(G_3^c)$. Therefore f is an IFaRαG continuous mapping but not an IFP continuous mapping.

Example 3.9: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.8,0.6), (0.2,0.2)⟩, G_2 = ⟨x, (0.2,0.3), (0.6,0.6)⟩, G_3 = ⟨y, (0.7,0.8), (0.1,0.2)⟩, G_4 = ⟨y, (0,0), (0.9,0.9)⟩ . Then τ = {0~, G_1, G_2, 1~} and σ = {0~, G_3, G_4, 1~} are IFTs on X and Y respectively. Define a mapping f : (X,τ) → (Y,σ) by f(a) = u and f(b) = v. The IFS G_3^c = ⟨y, (0.1,0.2), (0.7,0.8)⟩ is an IFRCS in Y. Then $f^{-1}(G_3^c)$ = ⟨x, (0.1,0.2), (0.7,0.8)⟩ is an IFS in X. Then G_3^c is an IFCS in Y. Now $cl(int(f^{-1}(G_3^c))) = 0\sim \subseteq f^{-1}(G_3^c)$. Therefore $f^{-1}(G_3^c)$ is an IFPCS in X but not an IFRαGCS in X, since $\alpha cl(f^{-1}(G_3^c)) = G_2^c \not\subseteq G_2$ but $f^{-1}(G_3^c) \subseteq G_2$ where G_2 is an IFROS in X. Therefore f is an IFP continuous mapping but not an IFaRαG continuous mapping.

Remark 3.10: IFS continuous mapping and IFaRαG continuous mapping are independent to each other.

Example 3.11: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.5,0.5), (0.3,0.2)⟩, G_2 = ⟨x, (0.1,0.2), (0.6,0.6)⟩, G_3 = ⟨y, (0.5,0.5), (0.3,0.1)⟩, G_4 = ⟨y, (0.1,0.1), (0.8,0.8)⟩. Then τ = {0~, G_1, G_2, 1~} and σ = {0~, G_3, G_4, 1~} are IFTs on X and Y respectively. Define a mapping f : (X,τ) → (Y,σ) by f(a) = u and f(b) = v. The IFS G_3^c = ⟨y, (0.3,0.1), (0.5,0.5)⟩ is an IFRCS in Y. Then $f^{-1}(G_3^c)$ = ⟨x, (0.3,0.1), (0.5,0.5)⟩ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c)) = G_1^c \subseteq G_1$. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X but not an IFSCS in X, since G_3^c is an IFCS in Y but $int(cl(f^{-1}(G_3^c))) = G_2 \not\subseteq f^{-1}(G_3^c)$. Therefore f is an IFaRαG continuous mapping but not an IFS continuous mapping.

Example 3.12: Let X = {a,b}, Y = {u,v} and G_1 = ⟨x, (0.6,0.7), (0.2,0.2)⟩, G_2 = ⟨x, (0.2,0.2), (0.7,0.7)⟩,

$G_3 = \langle y, (0.2,0.2), (0.6,0.7)\rangle$, $G_4 = \langle y, (0.6,0.6), (0.4,0.4)\rangle$. Then $\tau = \{0\sim, G_1, G_2, 1\sim\}$ and $\sigma = \{0\sim, G_3, G_4, 1\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X,\tau) \to (Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $G_3^c = \langle y, (0.6,0.7), (0.2,0.2)\rangle$ is an IFRCS in Y. Then $f^{-1}(G_3^c) = \langle x, (0.6,0.7), (0.2,0.2)\rangle$ is an IFS in X. Then G_3^c is an IFCS in Y. Now $int(cl(f^{-1}(G_3^c))) = G_1 \subseteq f^{-1}(G_3^c)$. Therefore $f^{-1}(G_3^c)$ is an IFSCS in X but not an IFRαGCS in X, since $\alpha cl(f^{-1}(G_3^c)) = G_2^c \nsubseteq G_1$ but $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Therefore f is an IFS continuous mapping but not an IFaRαG continuous mapping.

Theorem 3.13: A mapping $f : X \to Y$ is an IFaRαG continuous mapping if and only if the inverse image of each IFROS in Y is an IFRαGOS in X.

Proof: Necessity: Let A be an IFROS in Y. This implies A^c is an IFRCS in Y. Since f is an IFaRαG continuous mapping, $f^{-1}(A^c)$ is an IFRαGCS in X. Since $f^{-1}(A^c) = (f^{-1}(A))^c$, $f^{-1}(A)$ is an IFRαGOS in X.

Sufficiency: Let A be an IFRCS in Y. This implies A^c is an IFROS in Y. By hypothesis, $f^{-1}(A^c)$ is an IFRαGOS in X. Since $f^{-1}(A^c) = (f^{-1}(A))^c$, $f^{-1}(A)$ is an IFRαGCS in X. Hence f is an IFaRαG continuous mapping.

Theorem 3.14: Let $f : X \to Y$ be a mapping where $f^{-1}(V)$ is an IFRCS in X for every IFCS in Y. Then f is an IFaRαG continuous mapping but not conversely.

Proof: Let V be an IFRCS in Y. Since every IFRCS is an IFCS, V is an IFCS in Y. Then $f^{-1}(V)$ is an IFRCS in X. Since every IFRCS is an IFRαGCS [5], $f^{-1}(V)$ is an IFRαGCS in X. Hence f is an IFaRαG continuous mapping.

Example 3.15: Let X = {a,b}, Y = {u,v} and $G_1 = \langle x, (0.7,0.7), (0.3,0.2)\rangle$, $G_2 = \langle x, (0.1,0.1), (0.9,0.9)\rangle$, $G_3 = \langle y, (0.7,0.7), (0.2,0.1)\rangle$, $G_4 = \langle y, (0,0), (0.9,0.9)\rangle$. Then $\tau = \{0\sim, G_1, G_2, 1\sim\}$ and $\sigma = \{0\sim, G_3, G_4, 1\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X,\tau) \to (Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $G_3^c = \langle y, (0.2,0.1), (0.7,0.7)\rangle$ is an IFRCS in Y. Then $f^{-1}(G_3^c) = \langle x, (0.2,0.1), (0.7,0.7)\rangle$ is an IFS in X. Then $f^{-1}(G_3^c) \subseteq G_1$ where G_1 is an IFROS in X. Now $\alpha cl(f^{-1}(G_3^c)) = G_1^c \subseteq G_1$. Therefore $f^{-1}(G_3^c)$ is an IFRαGCS in X but not an IFRCS in X, since G_3^c is an IFCS in Y but $cl(int(f^{-1}(G_3^c))) = G_1^c \neq f^{-1}(G_3^c)$. Therefore f is an IFaRαG continuous mapping, but not the mapping as in Theorem 3.14.

Theorem 3.16: Let $f : X \to Y$ be a mapping. If $f^{-1}(\alpha int(B)) \subseteq \alpha int(f^{-1}(B))$ for every IFS B in Y, then f is an IFaRαG continuous mapping.

Proof: Let B be an IFROS in Y. By hypothesis, $f^{-1}(\alpha int(B)) \subseteq \alpha int(f^{-1}(B))$. Since B is an IFROS, it is an IFαOS in Y. Therefore $\alpha int(B) = B$. Hence $f^{-1}(B) = f^{-1}(\alpha int(B)) \subseteq \alpha int(f^{-1}(B)) \subseteq f^{-1}(B)$. Therefore $f^{-1}(B) = \alpha int(f^{-1}(B))$. This implies $f^{-1}(B)$ is an IFαOS in X and hence $f^{-1}(B)$ is an IFRαGOS[8] in X. Thus f is an IFaRαG continuous mapping.

Remark 3.17: The converse of the above theorem 3.16 is true if B is an IFROS in Y and X is an $IF_{r\alpha}T_{1/2}$ space.

Proof: Let f be an IFaRαG continuous mapping. Let B be an IFROS in Y. Then $f^{-1}(B)$ is an IFRαGOS in X. Since X is an $IF_{r\alpha}T_{1/2}$ space, $f^{-1}(B)$ is an IFαOS in X. This implies $f^{-1}(B) = \alpha int(f^{-1}(B))$. Now $f^{-1}(\alpha int(B)) \subseteq f^{-1}(B) = \alpha int(f^{-1}(B))$. Therefore $f^{-1}(\alpha int(B)) \subseteq \alpha int(f^{-1}(B))$.

Theorem 3.18: Let $f : X \to Y$ be a mapping. If $\alpha cl(f^{-1}(B)) \subseteq f^{-1}(\alpha cl(B))$ for every IFS B in Y, then f is an IFaRαG continuous mapping.

Proof: Let B be an IFRCS in Y. By hypothesis, $\alpha cl(f^{-1}(B)) \subseteq f^{-1}(\alpha cl(B))$. Since B is an IFRCS, it is an IFαCS in Y. Therefore $\alpha cl(B) = B$. Hence $f^{-1}(B) = f^{-1}(\alpha cl(B)) \supseteq \alpha cl(f^{-1}(B)) \supseteq f^{-1}(B)$. Therefore $f^{-1}(B) = \alpha cl(f^{-1}(B))$. This implies $f^{-1}(B)$ is an IFαCS in X and hence $f^{-1}(B)$ is an IFRαGCS[5] in X. Thus f is an IFaRαG continuous mapping.

Remark 3.19: The converse of the above theorem 3.18 is true if B is an IFRCS in Y and X is an $IF_{r\alpha}T_{1/2}$ space.

Proof: Let f be an IFaRαG continuous mapping. Let B be an IFRCS in Y. Then $f^{-1}(B)$ is an IFRαGCS in X. Since X is an $IF_{r\alpha}T_{1/2}$ space, $f^{-1}(B)$ is an IFαCS in X. This implies $\alpha cl(f^{-1}(B)) = f^{-1}(B)$. Now $f^{-1}(\alpha cl(B)) \supseteq f^{-1}(B) = \alpha cl(f^{-1}(B))$. Therefore $f^{-1}(\alpha cl(B)) \supseteq \alpha cl(f^{-1}(B))$.

Theorem 3.20: Let $f : X \to Y$ be a mapping where X is an $IF_{r\alpha}T_{1/2}$ space. If f is an IFaRαG continuous mapping, then $cl(int(cl(f^{-1}(B)))) \subseteq f^{-1}(\alpha cl(B))$ for every IFRCS B in Y.

Proof: Let B be an IFRCS in Y. By hypothesis, $f^{-1}(B)$ is an IFRαGCS in X. Since X is an $IF_{r\alpha}T_{1/2}$ space, $f^{-1}(B)$ is an IFαCS in X. This implies $\alpha cl(f^{-1}(B)) = f^{-1}(B)$. Now $cl(int(cl(f^{-1}(B)))) \subseteq f^{-1}(B) \cup cl(int(cl(f^{-1}(B)))) \subseteq$

$\alpha cl(f^{-1}(B)) = f^{-1}(B) = f^{-1}(\alpha cl(B))$, as every IFRCS is an IFαCS. Hence $cl(int(cl(f^{-1}(B)))) \subseteq f^{-1}(\alpha cl(B))$.

Theorem 3.21: Let $f : X \to Y$ be a mapping where X is an $IF_{r\alpha}T_{1/2}$ space. If f is an IFaRαG continuous mapping, then $f^{-1}(\alpha int(B)) \subseteq int(cl(int(f^{-1}(B))))$ for every IFROS B in Y.

Proof: This theorem can be easily proved by taking complement in Theorem 3.20.

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