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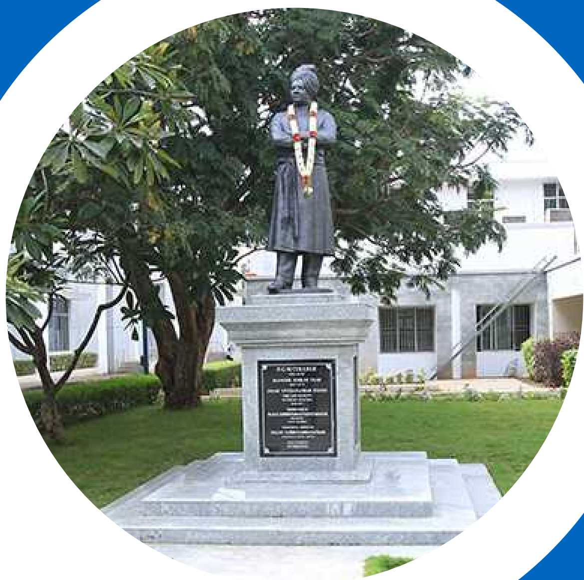

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Department of Biological Science, Physical Science and Computational Science

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ABOUT THE INSTITUTION

A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

ABOUT CONFERENCE

The International conference on “Emerging Trends in Science and Technology (ETIST-2021)” is being jointly organized by Departments of Biological Science, Physical Science and Computational Science - Nallamuthu Gounder Mahalingam College, Pollachi along with ISTE, CSI, IETE, IEE & RIYASA LABS on 27th OCT 2021. The Conference will provide common platform for faculties, research scholars, industrialists to exchange and discus the innovative ideas and will promote to work in interdisciplinary mode.

A STUDY ON WEAKLY *ğ* CONTINUOUS AND IRRESOLUTE MAPPINGS IN INTUITIONISTIC FUZZY TOPOLOGICAL SPACES

S. EARNEST RAJADURAI

ABSTRACT: In this study the notions of intuitionistic fuzzy weakly *ğ* closed sets, intuitionistic fuzzy weakly *ğ* continuous mappings, intuitionistic fuzzy weakly *ğ* irresolute mappings, intuitionistic fuzzy weakly *ğ* closed mappings, intuitionistic fuzzy weakly *ğ* open mappings, intuitionistic fuzzy weakly *ğ* homeomorphisms and some of their characterizations

Keywords: Intuitionistic fuzzy closed set, intuitionistic fuzzy open set, intuitionistic fuzzy weakly *ğ* continuous mappings, intuitionistic fuzzy weakly *ğ* irresolute mappings, intuitionistic fuzzy weakly *ğ* closed mappings, intuitionistic fuzzy weakly *ğ* open mappings, intuitionistic fuzzy weakly *ğ* homeomorphisms

1. INTRODUCTION

Continuity is a property of transformation which enables to preserve some spatial characteristics while transforming one space to another. It is a natural curiosity to study how does the 'fuzziness of continuity' passes the information of spatial characteristics under transformation. In 1997, Gurcay, Coker and Haydar [6] have introduced continuous mappings in 2007 and P. Rajarajeswari and L.Senthil Kumar [8] have introduced regular weakly generalized continuous mappings in intuitionistic fuzzy topological spaces. In this chapter, we study weakly ğ continuous mappings and intuitionistic fuzzy weakly ğ irresolute mappings in intuitionistic fuzzy topological spaces.

2. PRELIMINARIES

Throughout this dissertation, (X, τ), (Y, σ) and (Z, δ) (or simply X, Y and Z) denote the intuitionistic fuzzy topological spaces (IFTS in short) on which no separation axioms are assumed unless otherwise explicitly mentioned. For a subset A of X, the closure, the interior and the complement of A are denoted by $cl(A)$, $int(A)$ and A^c respectively. We recall some basic definitions that are used in the sequel.

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Definition 2.1. [1] Let X be a non-empty set. An intuitionistic fuzzy set (IFS in short) A in X is an object having the form A = $\{(x, \mu_A(x), \nu_A(x)) : x \in X\}$, where the functions $\mu_A : X \rightarrow [0,1]$ and $\nu_A : X \rightarrow [0,1]$ 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 $x \in X$. Denote by IFS(X), the set of all intuitionistic fuzzy sets in X.

Definition 2.2. [1] Let A and B be IFSs of the form

$A = \{(x, \mu_A(x), \nu_A(x)) : x \in X\}$ and $B = \{(x, \mu_B(x), \nu_B(x)) : x \in X\}$. Then

- $A \subseteq B$ if and only if $\mu_A(x) \leq \mu_B(x)$ and $\nu_A(x) \geq \nu_B(x)$ for all $x \in X$,
- A = B if and only if $A \subseteq B$ and $B \subseteq A$,
- $A^c = \{(x, \nu_A(x), \mu_A(x)) : x \in X\}$,
- $A \cap B = \{(x, \mu_A(x) \wedge \mu_B(x), \nu_A(x) \vee \nu_B(x)) : x \in X\}$
- $A \cup B = \{(x, \mu_A(x) \vee \mu_B(x), \nu_A(x) \wedge \nu_B(x)) : x \in X\}$

The intuitionistic fuzzy sets $0_\sim = \{(x, 0, 1): x \in X\}$ and $1_\sim = \{(x, 1, 0): x \in X\}$ are respectively the empty set and the whole set in X.

Definition 2.3. [4] An intuitionistic fuzzy topology (IFT in short) on X is a family τ of IFSs in X satisfying the following axioms.

- $0_\sim, 1_\sim \in \tau$,
- $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$,
- $\cup G_i \in \tau$ 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 an IFTS (X, τ) is called an intuitionistic fuzzy closed set (IFCS in short) in X.

Note:

For the sake of simplicity, we shall use the notation $A = (x, \mu_A, \nu_A)$ instead of $A = \{(x, \mu_A(x), \nu_A(x)): x \in X\}$.

Definition 2.4. [4] Let (X, τ) be an IFTS and $A = (x, \mu_A, \nu_A)$ be an IFS in X.

Then

- 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 $A \subseteq K\}$,
- $cl(A^c) = (int(A))^c$,
- $int(A^c) = (cl(A))^c$

Definition 2.5. [7] Let $A = (x, \mu_A, \nu_A)$ be an IFS in an IFTS (X, τ). Then

- αint(A) = $\cup\{G$: G is an IFαOS in X and $G \subseteq A\}$,
- αcl(A) = $\cap\{K$: K is an IFαCS in X and $A \subseteq K\}$,

Definition 2.6. [6] An IFS $A = (x, \mu_A, \nu_A)$ in an IFTS (X, τ) is said to be an

- intuitionistic fuzzy semi-closed set (IFSCS in short) if $int(cl(A)) \subseteq A$,
- intuitionistic fuzzy semi-open set (IFSOS in short) if $A \subseteq cl(int(A))$,
- intuitionistic fuzzy α-closed set (IFαCS in short) if $cl(int(cl(A))) \subseteq A$,

- intuitionistic fuzzy α-open set (IFαOS in short) if $A \subseteq int(cl(int(A)))$,
- intuitionistic fuzzy regular closed set (IFRCS in short) if $cl(int(A)) = A$,
- intuitionistic fuzzy regular open set (IFROS in short) if $A = int(cl(A))$.
- intuitionistic fuzzy pre closed set (IFPCS in short) if $cl(int(A)) \subseteq A$,
- intuitionistic fuzzy pre-open set (IFPOS in short) if $A \subseteq int(cl(A))$,

Definition 2.7. An IFS $A = (x, \mu_A, \nu_A)$ in an IFTS (X, τ) is called an

- intuitionistic fuzzy generalized closed set (IFGCS in short) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFOS in X. The complement of an IFGCS is an IFGOS [10],
- intuitionistic fuzzy semi generalized closed set (IFSGCS in short) if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFSOS in X. The complement of an IFSGCS is an IFSGOS [17],
- intuitionistic fuzzy weakly generalized closed set (IFWGCS in short) if $cl(int(A)) \subseteq U$ whenever $A \subseteq U$ and U is an IFOS in X. The complement of an IFWGCS is an IFGWOS [14],
- intuitionistic fuzzy regular weakly generalized closed set (IFRWGCS in short) if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFROS in X. The complement of an IFRWGCS is an IFRGWOS [7],

Definition 2.8. Let f be a mapping from an IFTS (X, τ) into an IFTS (Y, σ). Then is said to be an

- intuitionistic fuzzy continuous mapping (IF continuous mapping in short) if $f^{-1}(B) \in IFO(X)$ for every $B \in \sigma$ [6],
- intuitionistic fuzzy generalized continuous mapping(IFGcontinuousmapping inshort) if $f^{-1}(B) \in IFGO(X)$ for every $B \in \sigma$ [19],
- intuitionistic fuzzy precontinuous mapping(IFP continuous mapping in short) if $f^{-1}(B) \in IFPGO(X)$ for every $B \in \sigma$ [13],
- intuitionistic fuzzy weakly generalized continuous mapping (IFW continuous mapping in short) if $f^{-1}(B) \in IFWGO(X)$ for every $B \in \sigma$ [8],
- intuitionistic fuzzy regular weakly generalized continuous mapping (IFRG continuous mapping in short) if $f^{-1}(B) \in IFRWGO(X)$ for every $B \in \sigma$ [21],

Definition 2.9. Let f be a mapping from an IFTS (X, τ) into an IFTS (Y, σ). Then is said to be an

- intuitionistic fuzzy closed mapping (IF closed mapping in short) if f(A) is an IFCS in Y for each IFCS A in X [6],
- intuitionistic fuzzy generalized closed mapping (IFG closed mapping in short) if f (A) is an IFGCS in Y for each IFCS A in X [20],
- intuitionistic fuzzy α-closed mapping(IFα closed mapping in short) if f(A) is an IFαCS in Y for each IFCS in X [12],
- intuitionistic fuzzy pre closed mapping(IFP closed mapping in short) if f(A) is an IFPCS in Y for each IFCS in X [15],
- intuitionistic fuzzy weakly generalised closed mapping(IFWG closed mapping in short) if f(A) is an IFWGCS in Y for each IFCS in X [15].

Definition 2.10.Let f be a bijection mapping from an IFTS(X, τ) into an IFTS (Y, σ). Then f is said to be an

- intuitionisticfuzzyhomeomorphism(IFhomeomorphisminshort)iff and f^{-1} are IF continuous mappings [18],

- intuitionistic fuzzy weakly generalized homeomorphism (IFWG homeomorphism in short) if f and f^{-1} are IFWG continuous mappings[16].

3. INTUITIONISTIC FUZZY WEAKLY ğ CONTINUOUS MAPPINGS

In this section, we study the notion of intuitionistic fuzzy weakly ğ continuous mappings and investigate some of their properties.

Definition 3.1. A mapping f: $(X, \tau) \rightarrow (Y, \sigma)$ is called an intuitionistic fuzzy weakly ğ continuous (IFWğ continuous in short) mapping if $f^{-1}(V)$ is an IFWğ CS in (X, τ) for every IFCS V of (Y, σ).

Theorem 3.2. Every IF continuous mapping is an IFWğ continuous mapping, but not conversely.

Proof: Let f: $(X, \tau) \rightarrow (Y, \sigma)$ be an IF continuous mapping and A be an IFCS in Y. Then f^{-1} (A) is an IFCS in X. Since every IFCS is an IFWğ CS, f^{-1} (A) is an IFWğ CS in X. Hence f is an IFWğ continuous mapping.

Example 3.3. Let X = {a, b}, Y = {u, v} and A = (x, (0.5, 0.6), (0.5, 0.4)), B = (y, (0.6, 0.6), (0.4, 0.4)). Then τ = {0~, A, 1~}, σ = {0~, B, 1~} are intuitionistic fuzzy topologies on X and Y respectively. Define a mapping f: $(X, \tau) \rightarrow (Y, \sigma)$ by f(a) = u and f(b) = v. Then IFS S = (y, (0.4, 0.4), (0.6, 0.6)) is IFCS in Y and $f^{-1}(S)$ is IFWğ CS but not an IFCS in X. Therefore f is an IFWğ continuous mapping but not an IF continuous mapping.

Theorem 3.4. Every IFWğ continuous mapping is an IFG continuous mapping, but not conversely.

Proof: Let f: $(X, \tau) \rightarrow (Y, \sigma)$ be an IFWğ continuous mapping. Let A be an IFCS in Y. Then f^{-1} (A) is an IFWğ CS in X. Since every IFWğ CS is an IFGCS, f^{-1} (A) is an IFGCS in X. Hence f is an IFG continuous mapping.

Example 3.5. Let X = {a, b}, Y = {u, v} and A = (x, (0.8, 0.8), (0.2, 0.1)), B = (y, (0.1, 0.3), (0.8, 0.7)). Then τ = {0~, A, 1~}, σ = {0~, B, 1~} are intuitionistic fuzzy topologies on X and Y respectively. Define a mapping f: $(X, \tau) \rightarrow (Y, \sigma)$ by f(a) = u and f(b) = v. Then IFS S = (y, (0.8, 0.7), (0.1, 0.3)) is IFCS in Y and $f^{-1}(S)$ is an IFGCS but not an IFWğ CS in X. Therefore f is an IFG continuous mapping but not an IFWğ continuous mapping.

Theorem 3.6. Every IFWğ continuous mapping is an IFW continuous mapping, but not conversely.

Proof: Let f: $(X, \tau) \rightarrow (Y, \sigma)$ be an IFWğ continuous mapping and A be an IFCS in Y. Then f^{-1} (A) is IFWğ CS in X. Since every IFWğ CS is an IFWCS, f^{-1} (A) is an IFWCS in X. Hence f is an IFW continuous mapping.

Example 3.7. Let X = {a, b}, Y = {u, v} and A = (x, (0.7, 0.7), (0.3, 0.3)), B = (y, (0.6, 0.6), (0.4, 0.4)). Then τ = {0~, A, 1~}, σ = {0~, B, 1~} are intuitionistic fuzzy topologies on X and Y respectively. Define a mapping f: $(X, \tau) \rightarrow (Y, \sigma)$ by f(a) = u and f(b) = v. Then IFS S = (y, (0.4, 0.4), (0.6, 0.6)) is IFCS in Y and $f^{-1}(S)$ is an IFWCS but not an IFWğ CS in X. Therefore f is an IFW continuous mapping but not an IFWğ continuous mapping.

Theorem 3.8. Every IFWğ continuous mapping is an IFGα continuous mapping, but not conversely.

Proof: Let f: $(X, \tau) \rightarrow (Y, \sigma)$ be an IFWğ continuous mapping and A be an IFCS in Y. Then f^{-1} (A) is an IFWğ CS in X. Since every IFWğ CS is an IFGα CS, f^{-1}(A) is an IFG α CS in X. Hence f is an IFG α continuous mapping.

Example 3.9. Let X = {a, b}, Y = {u, v} and A = (x, (0.3, 0.2), (0.7, 0.7)), B = (y, (0.3, 0.4), (0.6, 0.6)). Then τ = {0~, A, 1~}, σ = {0~, B, 1~} are intuitionistic fuzzy topologies on X and Y respectively. Define a mapping f: $(X, \tau) \rightarrow (Y, \sigma)$ by

$f(a)=u$ and $f(b)=v$. Then IFS $S=(y,(0.6,0.6),(0.3,0.4))$ is IFCS in Y and $^{-1}(S)$ is an IFGαCS but not an IFWğ CS in X. Therefore f is an IFGα continuous mapping but not an IFWğ continuous mapping.

Theorem 3.10. Every IFWğ continuous mapping is an IFRG continuous mapping, but not conversely.

Proof: Let f: $(X,\tau)\rightarrow(Y,\sigma)$ be an IFWğ continuous mapping. Let A be an IFCS in Y. Then f^{-1} (A) is an IFWğ CS in X. Since every IFWğ CS is an IFRGCS, f^{-1} (A) is an IFRGCS in X. Hence f is an IFRG continuous mapping.

Example 3.11. Let $X=\{a,b\}, Y=\{u,v\}$ and $A=(x,(0.8,0.8),(0.2,0.1))$, $B=(y,(0.1,0.3),(0.9,0.7))$. Then $\tau=\{0_\sim, A, 1_\sim\}$, $\sigma=\{0_\sim, B, 1_\sim\}$ are intuitionistic fuzzy topologies on X and Y respectively. Define a mapping f: $(X,\tau)\rightarrow(Y,\sigma)$ by $f(a)=u$ and $f(b)=v$. Then IFS $S=(y,(0.9,0.7),(0.1,0.3))$ is IFCS in Y and $f^{-1}(S)$ is an IFRGCS but not an IFWğ CS in X. Therefore f is an IFRG continuous mapping but not an IFWğ continuous mapping.

Theorem 3.12. A mapping f: $(X,\tau)\rightarrow(Y,\sigma)$ is an IFWğ continuous if and only if the inverse image of every IFOS in Y is an IFWğ OS in X.

Proof: Let A be an IFOS in Y. Then A^c is an IFCS in Y. Since f is IFWğ continuous mapping, $f^{-1}(A^c)$ is an IFWğ CS in X. Since $f^{-1}(A^c)=(f^{-1}(A))^c$, $f^{-1}(A)$ is an IFWğ OS in X.

Theorem 3.2.13. If f : $(X,\tau)\rightarrow(Y,\sigma)$ is IFWğ continuous and g : $(Y,\sigma)\rightarrow(Z,\delta)$ is IF continuous, then gof : $(X,\tau)\rightarrow(Z,\delta)$ is IFWğ continuous.

Proof: Let f : $(X,\tau)\rightarrow(Y,\sigma)$ be IFWğ continuous and g : $(Y,\sigma)\rightarrow(Z,\delta)$ be IF continuous. Let A be an IFCS in Z. Then $g^{-1}(A)$ is an IFCS in Y because g is IF continuous. Also $f^{-1}(g^{-1}(A))$ is an IFWğ CS in X because f is IFWğ continuous. Therefore $(gof)^{-1}(A)=f^{-1}(g^{-1}(A))$ is an IFWğ CS in X. Hence gof is an IFWğ continuous mapping.

Definition 3.2.14. Let (X, τ) be an IFTS and A be an IFS in X. Then intuitionistic fuzzy weakly ğ interior and intuitionistic fuzzy weakly ğ closure of A are defined as

- wğcl(A)=∩{K:K is an IFWğ CS in X and $A\subseteq K$},
- wğint(A)=∪{G:G is an IFWğ OS in X and $G\subseteq A$}.

Result 3.2.15. If A is IFWğ CS, then wğcl(A)=A.

Theorem 3.2.16. Let f : $(X,\tau)\rightarrow(Y,\sigma)$ be an IFWğ continuous mapping. Then the following conditions are hold:

- f(wğcl(A)) ⊆ cl(f(A)), for every IFS A in X,
- wğcl(f^{-1}(B)) ⊆ f^{-1}(cl(B)), for every IFS B in Y.

Proof: i) Let f: $(X,\tau)\rightarrow(Y,\sigma)$ be IFWğ continuous. Let A be an intuitionistic fuzzy set in X. Then cl(f(A)) is an IFCS in Y. Since f is IFWğ continuous, f^{-1}(cl(f(A))) is an IFWğCS in X. Also A ⊆ f^{-1}(cl(A)). Thus, wğcl(A) ⊆ wğcl(f^{-1}(cl(f(A)))) = f^{-1}(cl(f(A))) because f^{-1}(cl(f(A))) is intuitionistic fuzzy weakly ğ closed. Hence f(wğcl(A)) ⊆ cl(f(A)) for every IFS A in X.

ii) Replacing A by f^{-1}(B) in (i), we have f(wğcl(f^{-1}(B))) ⊆ cl(f(f^{-1}(B))) ⊆ cl(B). Hence wğcl(f^{-1}(B)) ⊆ f^{-1}(cl(B)), for every IFS B in Y.

4. INTUITIONISTIC FUZZY WEAKLY ğ IRRESOLUTE MAPPINGS

In this section, we study the notion of intuitionistic fuzzy weakly ğ irresolute mappings and investigate some of their properties.

Definition 4.1. A mapping f: (X, τ) → (Y, σ) is said to be an intuitionistic fuzzy weakly ğ irresolute (IFWğ irresolute in short) mapping if $f^{-1}(V)$ is an IFWğ CS in (X, τ) for every IFWğ CS V of (Y, σ).

Theorem 4.2. Let f: (X, τ) → (Y, σ) be an IFWğ irresolute mapping, then f is an IFWğ continuous mapping.

Proof: Let f: (X, τ) → (Y, σ) be an IFWğ irresolute mapping and A be an IFCS in Y. Since every IFCS is an IFWğ CS, A is an IFWğ CS in Y. By hypothesis $f^{-1}(A)$ is an IFWğ CS in X. Hence f is an IFWğ continuous mapping.

Theorem 4.3. Let f: (X, τ) → (Y, σ) be an IFWğ irresolute mapping, then f is an IF irresolute mapping if X is an is an IFWğ″ T ½ space.

Proof: Let A be an IFCS in Y. Since every IFCS is an IFWğCS, A is an IFWğ CS in Y. By hypothesis $f^{-1}(A)$ is an IFWğCS in X. Since X is an IFWğ″ T ½ space, $f^{-1}(A)$ is an IFCS in X. Hence f is an IF irresolute mapping.

Theorem 4.4. Let f : (X, τ) → (Y, σ) and g : (Y, σ) → (Z, δ) be IFW ğ irresolute mappings, then gof : (X, τ) → (Z, δ) is an IFWğirresolute mapping.

Proof: Let A be an IFWğCS in Z. Then $g^{-1}(A)$ is an IFWğCS in Y. Since f is an IFWğ irresolute mapping, $f^{-1}(g^{-1}(A))$ is an IFWğ CS in X. Hence gof is an IFWğ irresolute mapping.

Theorem 4.3.5. Let f : (X, τ) → (Y, σ) be a mapping from an IFTS X into an IFTS Y. Then the following conditions are equivalent if X and Y are IFWğ$T_{1/2}$ spaces.

- f is an IFWğ irresolute mapping,
- $f^{-1}(B)$ is an IFWğOS in X for each IFWğOS B in Y,
- cl $(f^{-1}(B)) \subseteq f^{-1}(cl(B))$ for each IFS B of Y.

Proof : (i) ⇒ (ii) . Obvious.

(ii) ⇒ (iii). Let B be any IFS in Y and B ⊆ cl (B). Then $f^{-1}(B) \subseteq f^{-1}(cl(B))$.

Since cl(B) is an IFCS in Y, cl(B) is an IFWğCS in Y. Therefore $f^{-1}(cl(B))$ is an IFWğCS in X, by hypothesis. Since X is an IFW ğ$T_{1/2}$ space, $f^{-1}(cl(B))$is an IFCS in X. Hence $cl(f^{-1}(B)) \subseteq cl(f^{-1}(cl(B)))$. That is $cl(f^{-1}(B)) \subseteq f^{-1}(cl(B))$.

(iii)⇒ (i). Let B be an IFWğCS in Y .Since Y is IFWğ$T_{1/2}$ space, B is an IFCS in Y and cl(B) = B. Hence $f^{-1}(B) = f^{-1}(cl(B)) \supseteq cl(f^{-1}(B))$. But clearly $f^{-1}(B) \subseteq cl(f^{-1}(B))$. Therefore $cl(f^{-1}(B)) = f^{-1}(B)$. Which implies $f^{-1}(B)$ is an IFCS and hence it is an IFWğCS in X. Thus f is an IFWğ irresolute mapping.

Theorem 4.3.6. Let f: (X, τ) → (Y, σ) be an IFWğirresolute and g: (Y, σ) → (Z, δ) be an IFWğ continuous mapping, then gof : (X, τ) → (Z, δ) is an IFWğcontinuous mapping.

Proof: Let A be an IFCS in Z. Then $g^{-1}(A)$ is an IFWğCS in Y. Since f is an IFWğ irresolute mapping, $f^{-1}(g^{-1}(A))$ is an IFWğCS in X. Hence gof is an IFWğ continuous mapping.

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