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$\tilde{g}_\alpha$-WEAKLY GENERALIZED CONTINUOUS FUNCTIONS

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ABSTRACT

In this paper we introduce and study of $\tilde{g}_\alpha$ - weakly generalized continuous functions and $\tilde{g}_\alpha$ - weakly generalized irresolute functions also obtain some properties of such functions.

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1. INTRODUCTION:

S. Jafari, M. lellis Thivagar and N. Rebecca Paul [19] introduced and studied $\tilde{g}_\alpha$ -closed sets. M. Maria Singam, G. Anitha [13] introduced the class $\tilde{g}_\alpha$ -Weakly generalized closed sets. By using such sets we introduce new forms of functions called $\tilde{g}_\alpha$ -Weakly generalized continuous functions and $\tilde{g}_\alpha$ -Weakly generalized irresolute functions. We obtain properties of such functions.

2. PRELIMINARIES:

Throughout this paper (X, τ) ,(Y, σ) and (Z, η) represent non empty topological space on which no separation axiom is defined unless otherwise mentioned. For a subset A of a space Cl(A) and Int(A) denote the closure and interior of A respectively.

Definition.1.1: A subset A of a space X is called
1 .a semi-open set [10] if A $\subseteq$ cl(int(A))
2. a pre-open set [15] if A $\subseteq$ int(cl(A))
3. an α -open set [17] if A $\subseteq$ int(cl(int(A)))
4. a regular open[20] if A = int(cl(A))
5. a semi-preopen set [1] if A $\subseteq$ cl(int(cl(A)))

The complement of a semi-open (pre open, α -open, regular open, semi-preopen) set is called a semi-closed (resp. pre-closed, α -closed, regular closed, semi-preclosed) set.

Definition 1.2: A subset A of a space X is called
1. a generalized closed set(g-closed)[9] if cl(A) $\subseteq$ U whenever A $\subseteq$ U,U is open in (X, τ).
2. a weakly generalized closed set(wg-closed)[16] if Cl(Int(A)) $\subseteq$ U whenever A $\subseteq$ U,U is open in (X, τ).
3. semi generalized closed set(sg-closed)[4] if scl(A) $\subseteq$ U, whenever A $\subseteq$ U,U is semi open in (X, τ).
4. a generalized semi-pre-closed set(gsp-closed)[7] if spcl(A) $\subseteq$ U whenever A $\subseteq$ U,U is open in (X, τ).
5 .a w-closed set [18]if cl(A) $\subseteq$ U, whenever A $\subseteq$ U and U is semi-open in (X, τ).
6. a generalized α -closed set (g α -closed) [11] if α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is α -open in (X, τ).
7. an α - generalized closed set (α g-closed) [12] if α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in (X, τ).
8. a * g-closed set[22]if cl(A) $\subseteq$ U, whenever A $\subseteq$ U and U is w-open in (X, τ).
9. a # g-semi closed set(# gs-closed)[23] if scl(A) $\subseteq$ U, whenever A $\subseteq$ U and U is * g -open in (X, τ).

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10. a $\tilde{g}_\alpha$-closed[19] if αcl(A) $\subseteq$ U, whenever A $\subseteq$ U and U is # gs-open in (X, τ).

11. a $\tilde{g}_\alpha$-Weakly generalized closed set($\tilde{g}_\alpha$ wg-closed) [13] if Cl(Int(A)) $\subseteq$ U, whenever A $\subseteq$ U,U is $\tilde{g}_\alpha$-open in (X, τ).

The complements of the above sets are called their respective open sets.

Definition 1.3: A function f : (X, τ) $\rightarrow (Y, \sigma)$ is called

1. α-continuous [14] if $f^{-1}(v)$ is α-closed in (X, τ) for every closed set V in (Y, σ).
2. semi continuous [10] if $f^{-1}(v)$ is semi closed in (X, τ) for every closed set V in (Y, σ).
3. g-continuous [3] if $f^{-1}(v)$ is g-closed in (X, τ) for every closed set V in (Y, σ).
4. sg-continuous [21] if $f^{-1}(v)$ is sg-closed in (X, τ) for every closed set V in (Y, σ).
5. αg-continuous [5] if $f^{-1}(v)$ is αg-closed in (X, τ) for every closed set V in (Y, σ).
6. gα-continuous [5] if $f^{-1}(v)$ is gα-closed in (X, τ) for every closed set V in (Y, σ).
7. gs-continuous [6] if $f^{-1}(v)$ is gs-closed in (X, τ) for every closed set V in (Y, σ).
8. gsp-continuous [7] if $f^{-1}(v)$ is gsp-closed in (X, τ) for every closed set V in (Y, σ).
9. completely-continuous [2] if $f^{-1}(v)$ is regular closed in (X, τ) for every closed set V in (Y, σ).
10. $\tilde{g}_\alpha$- continuous [8] if $f^{-1}(v)$ is $\tilde{g}_\alpha$-closed in (X, τ) for every closed set V in (Y, σ).
11. $\tilde{g}_\alpha$-irresolute [8] if $f^{-1}(v)$ is $\tilde{g}_\alpha$-closed in (X, τ) for every $\tilde{g}_\alpha$-closed set V in (Y, σ).

Proposition 1.4: If a subset A of a topological space (X, τ) is a regular closed, then it is $\tilde{g}_\alpha$wg-closed but not conversely.

Proof: Suppose a subset A of a topological space X is regular closed. Let G be a $\tilde{g}_\alpha$-open set containing A. Then G $\supseteq$ A = cl(int(A)),since A is regular closed. Hence A is $\tilde{g}_\alpha$wg-closed in (X, τ).

Converse of the above theorem need not be true as seen in the following example.

Example 1.5: Let X = {a, b, c) and τ = { ϕ,{a},{b, c},X}. In this topological space the subset {b} is $\tilde{g}_\alpha$wg-closed but it is not regular closed.

Proposition 1.6: If a subset A of a topological space (X, τ) is a gα- closed, then it is $\tilde{g}_\alpha$wg-closed but not conversely.

Proof: Suppose A is gα- closed subset X and let G be a α-open set containing A. Since every α-open set is $\tilde{g}_\alpha$-open. Hence G is $\tilde{g}_\alpha$-open set containing A.

G $\supseteq$ αcl(A)=cl(int(cl(A))) $\supseteq$ cl(int(A)).Thus A is $\tilde{g}_\alpha$wg-closed in (X, τ).

Converse of the above theorem need not be true as seen in the following example.

Example 1.7: Let X = {a, b, c) and τ = { ϕ,{a, c},X}. In this topological space the subset {a} is $\tilde{g}_\alpha$wg-closed but it is not gα closed.

Proposition 1.8: If a subset A of a topological space (X, τ) is a $\tilde{g}_\alpha$wg-closed, then it is gsp- closed but not conversely.

Proof: Let A be $\tilde{g}_\alpha$wg-closed subset X and G be an open set containing A in (X, τ). Then

G $\supseteq$cl(A) $\supseteq$cl(int(A)).Since every open set is $\tilde{g}_\alpha$-open. Hence G is $\tilde{g}_\alpha$-open set containing A.G$\supseteq$(int(cl(int(A))) which implies A $\cup$ G $\supseteq$ A $\cup$ int(cl(int(A)). That is G $\supseteq$ spcl(A). Thus A is gsp-closed in (X, τ).

Converse of the above theorem need not be true as seen in the following example.

Example.1.9: Let X = {a,b,c) and τ = { ϕ,{a},{c},{a, c},X}. In this topological space the subset {a} is gsp closed but not $\tilde{g}_\alpha$ wg-closed.

2. $\tilde{g}_\alpha$ wg - CONTINUOUS FUNCTIONS:

We have introduced the following definition

Definition 2.1: A function f : (X, τ) $\rightarrow (Y,\sigma)$ is said to be $\tilde{g}_\alpha$ wg-continuous if f^{-1}(V) is $\tilde{g}_\alpha$ wg-closed in (X, τ) for every closed set V of (Y, σ).

Example 2.2 : Let X = {a, b, c} = Y, τ = { ϕ,{a},{b, c},X} and σ = { ϕ,{a},Y}.Define a function f : (X, τ) $\rightarrow (Y,\sigma)$ by f(a) = b, f(b) = c, f(c) = a . Then f is $\tilde{g}_\alpha$ wg –continuous since inverse image of closed set {b, c} in (Y, σ) is {a, b}which is in $\tilde{g}_\alpha$ wg-closed in (X, τ).

Theorem 2.3: Every continuous map is $\tilde{g}_\alpha$ wg –continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is continuous, then f^{-1}(V) is closed in (X, τ).
By theorem 3.2 of [13], every closed set is $\tilde{g}_\alpha$ wg-closed. Then f^{-1}(V) is $\tilde{g}_\alpha$ wg-closed in (X, τ).

Hence f is $\tilde{g}_\alpha$ wg –continuous.

Example 2.4: Let X = {a, b, c} = Y, τ = { ϕ,{a, b},X} and σ ={ ϕ,{a},Y}.Define a function f: (X, τ) $\rightarrow (Y,\sigma)$ by f(a) = b, f(b) = a, f(c) = c. Then f is $\tilde{g}_\alpha$ wg –continuous but not continuous.

Theorem 2.5: Every $\tilde{g}_\alpha$-continuous function is $\tilde{g}_\alpha$ wg –continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is $\tilde{g}_\alpha$-continuous, then f^{-1}(V) is $\tilde{g}_\alpha$-closed in (X, τ).By theorem 3.7 of [13], every $\tilde{g}_\alpha$-closed set is $\tilde{g}_\alpha$ wg-closed. Then f^{-1}(V) is $\tilde{g}_\alpha$ wg-closed in (X, τ).Hence f is $\tilde{g}_\alpha$ wg –continuous.

Example 2.6: Let X = {a, b, c} = Y, τ = { ϕ,{a},X} and σ ={ ϕ,{a, c},Y}.Define a function f: (X, τ) $\rightarrow (Y,\sigma)$ by f(a) = c, f(b) = b, f(c) = a. Then f is $\tilde{g}_\alpha$ wg –continuous but not $\tilde{g}_\alpha$-continuous.

Theorem 2.7: Every α-continuous function is $\tilde{g}_\alpha$ wg –continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is α -continuous, then f^{-1}(V) is α -closed in (X, τ).By theorem 3.11 of [13], every α -closed set is $\tilde{g}_\alpha$ wg-closed. Then f^{-1}(V) is $\tilde{g}_\alpha$ wg-closed in (X, τ).Hence f is $\tilde{g}_\alpha$ wg –continuous.

Example 2.8: Let X = {a ,b, c} = Y, τ = { ϕ,{a, b},X} and σ ={ ϕ,{a, c},Y}.Define a function f: (X, τ) $\rightarrow (Y,\sigma)$ by f(a) = b, f(b) = c, f(c) = a. Then f is $\tilde{g}_\alpha$ wg –continuous but not α -continuous.

Theorem 2.9: Every gα-continuous function is $\tilde{g}_\alpha$ wg –continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is gα -continuous, then f^{-1}(V) is α -closed in (X, τ).By Proposition 1.6, every gα -closed set is $\tilde{g}_\alpha$ wg-closed. Then f^{-1}(V) is $\tilde{g}_\alpha$ wg-closed in (X, τ).Hence f is $\tilde{g}_\alpha$ wg –continuous.

Example 2.10: Let X = {a, b, c} = Y, τ = { ϕ,{a, b},X} and σ ={ ϕ,{a, c},Y}.Define a function f: (X, τ) $\rightarrow (Y,\sigma)$ by f(a) = b, f(b) = c, f(c) = a. Then f is $\tilde{g}_\alpha$ wg –continuous but not gα -continuous.

Theorem 2.11: Every completely continuous function is $\tilde{g}_\alpha$wg –continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is completely continuous function, then $f^{-1}(V)$ is regular closed in (X, τ).By Proposition 1.4, every regular closed set is $\tilde{g}_\alpha$wg-closed. Then
$f^{-1}(V)$ is $\tilde{g}_\alpha$wg-closed in (X, τ).Hence f is $\tilde{g}_\alpha$wg –continuous.

Example 2.12: Let X = {a, b, c} = Y, τ = {ϕ,{a},{b, c},X} and σ={ϕ,{a},Y}.Define a function f : (X, τ) $\to (Y,\sigma)$ by f(a) = b, f(b) = a, f(c) = c. Then f is $\tilde{g}_\alpha$wg –continuous but not regular continuous function.

Theorem 2.13: Every $\tilde{g}_\alpha$wg –continuous is gsp-continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is $\tilde{g}_\alpha$wg- continuous function, then $f^{-1}(V)$ is $\tilde{g}_\alpha$wg-closed in (X, τ). By Proposition 1.8, every $\tilde{g}_\alpha$wg-closed set is gsp closed. Then
$f^{-1}(V)$ is gsp closed in (X, τ).Hence f is gsp continuous.

Example 2.14: Let X = {a, b, c} = Y, τ = {ϕ,{a},{c},{a, c},X} and σ={ϕ,{b, c},Y}. Let f: (X, τ) $\to (Y,\sigma)$ be identity function. Then f is gsp continuous but not $\tilde{g}_\alpha$wg –continuous.

Theorem 2.15: Every $\tilde{g}_\alpha$wg –continuous is wg-continuous but not conversely.

Proof: Let V be a closed set in (Y, σ).Since f is $\tilde{g}_\alpha$wg- continuous function, then $f^{-1}(V)$ is $\tilde{g}_\alpha$wg-closed in (X, τ).By theorem 3.9 of [13], every $\tilde{g}_\alpha$wg-closed set is wg closed. Then $f^{-1}(V)$ is wg closed in (X, τ).Hence f is wg continuous.

Example 2.16: Let X = {a, b, c} = Y, τ = {ϕ, {b, c}, {c}}, X} and σ = {ϕ, {b}, Y}. Let f: (X, τ) $\to (Y,\sigma)$ be identity function. Then f is wg continuous but not $\tilde{g}_\alpha$wg –continuous.

Remark 2.17: The following examples show that semi continuous and $\tilde{g}_\alpha$wg –continuous functions are independent.

Example 2.18: Let X = {a, b, c} = Y, τ = {ϕ, {a}, {b, c}, X} and σ = {ϕ, {a}, Y} defined f: (X, τ) $\to (Y,\sigma)$ by f (a) = c, f (b) = a, f(c) = b. Then f is $\tilde{g}_\alpha$wg –continuous but not semi continuous.

Example 2.19: Let X = {a, b, c} = Y, τ = {ϕ,{a},{c},{a, c},X} and σ = {ϕ,{b, c},Y} defined f : (X, τ) $\to (Y,\sigma)$ be the identity function. Then f is semi continuous but not $\tilde{g}_\alpha$wg –continuous

Remark 2.20: The following examples show that g-continuous and $\tilde{g}_\alpha$wg –continuous functions are independent.

Example 2.21: Let X = {a, b, c} = Y, τ = {ϕ, {a, c}, X} and σ = {ϕ, {a, b}, Y} defined f: (X, τ) $\to (Y,\sigma)$ be the identity function. Then f is $\tilde{g}_\alpha$wg –continuous but not g-continuous.

Example 2.22: Let X = {a, b, c} = Y, τ = {ϕ, {b, c}, {c}, X} and σ = {ϕ, {b}, Y} defined f: (X, τ) $\to (Y,\sigma)$ be the identity function. Then f is g-continuous but not $\tilde{g}_\alpha$wg –continuous

Remark 2.23: The following examples show that sg-continuous and $\tilde{g}_\alpha$wg –continuous functions are independent.

Example 2.24: Let X = {a, b, c} = Y, τ = {ϕ,{a, c},X} and σ = {ϕ,{a},{b, c},Y} defined
f: (X, τ) $\to (Y,\sigma)$ by f(a) = c, f(b) = b, f(c) = a. Then f is $\tilde{g}_\alpha$wg –continuous but not sg-continuous.

Example 2.25: Let X = {a, b, c} = Y, τ = {ϕ,{a},{c},{a, c}},X} and σ = {ϕ,{a, b},Y} defined f: (X,τ) $\to (Y,\sigma)$ by f(a) = b, f(b) = a, f(c) = c. Then f is sg-continuous but not $\tilde{g}_\alpha$wg –continuous

Remark 2.26: The following examples show that αg-continuous and $\tilde{g}_\alpha$wg –continuous functions are independent.

Example 2.27: Let X = {a, b, c} = Y, τ = {ϕ,{a},{a, b},X} and σ = {ϕ,{b},Y} define f: (X,τ) $\to (Y,\sigma)$ be the identity function. Then f is αg-continuous function but not $\tilde{g}_\alpha$wg –continuous function;

Example 2.28: Let X = {a, b, c, d} = Y, τ = {ϕ,{b, c},{b, c, d},{a, b, c}},X} and σ = {ϕ,{a, c, d},Y} defined f : (X,τ) $\to (Y,\sigma)$ be the identity function . Then f is $\tilde{g}_\alpha$wg –continuous but not αg-continuous.

Remark 2.29: The following examples show that gs-continuous and $\tilde{g}_\alpha$wg –continuous functions are independent.

Example 2.30: Let X = {a, b, c} = Y, τ = {ϕ,{a},{c},{a, c}},X} and σ = {ϕ,{a},{b, c},Y} defined f : (X,τ) $\to (Y,\sigma)$ by f(a) = a, f(b) = c, f(c) = b. Then f is gs-continuous but not $\tilde{g}_\alpha$wg –continuous.

Example 2.31: Let X = {a, b, c, d} = Y, τ = {ϕ,{b, c},{b, c, d},{a, b, c}},X} and σ = {ϕ,{a, c, d},Y} defined f : (X,τ) $\to (Y,\sigma)$ be the identity function . Then f is $\tilde{g}_\alpha$wg –continuous but not gs-continuous.

Remark 2.32: The composition of two $\tilde{g}_\alpha$wg –continuous map need not be $\tilde{g}_\alpha$wg –continuous.

Example 2.33: Let X = Y = Z = {a, b, c}, τ = {ϕ,{a, b},X},σ = {ϕ,{a},{b, c},Y},η = {ϕ,{a},Z}.Define ϕ:(X,τ) $\to$(Y, σ) by ϕ(a) = c, ϕ(b) = a, ϕ(c) = b and Define ψ : (Y, σ) $\to$(Z, η) by ψ(a) = b, ψ(b) = a, ψ(c) = c. Then ϕ,ψ are $\tilde{g}_\alpha$wg –continuous. But $\phi \circ \psi$:(X,τ) $\to$ (Z, η) is not $\tilde{g}_\alpha$wg –continuous.

3. $\tilde{g}_\alpha$WG –IRRESOLUTE FUNCTIONS

Definition 3.1: A function f : (X,τ) $\to (Y,\sigma)$ is said to be $\tilde{g}_\alpha$wg- irresolute if f^{-1}(V) is $\tilde{g}_\alpha$wg-closed in (X,τ) for every $\tilde{g}_\alpha$wg-closed set V of (Y,σ).

Theorem 3.2: Every $\tilde{g}_\alpha$wg - irresolute map is $\tilde{g}_\alpha$wg – continuous.

Proof: Let f: (X,τ) $\to (Y,\sigma)$ be a $\tilde{g}_\alpha$wg- irresolute map and V be a closed set of (Y,σ).

Since every closed set is $\tilde{g}_\alpha$wg-closed set by theorem 3.2 of [13], V is $\tilde{g}_\alpha$wg-closed. Since f is a $\tilde{g}_\alpha$wg-irresolute, f^{-1}(V) is a $\tilde{g}_\alpha$wg-closed set of (X,τ). Hence f is $\tilde{g}_\alpha$wg-continuous.

Remark 3.3: $\tilde{g}_\alpha$wg-continuous map need not be $\tilde{g}_\alpha$wg-irresolute map.

Example 3.4: Let X = {a, b, c} = Y, τ = {ϕ,{a},{c},{a, c}},X} and σ = {ϕ,{a, c},Y} defined f : (X,τ) $\to (Y,\sigma)$ be the identity function . Then f is $\tilde{g}_\alpha$wg –continuous but not $\tilde{g}_\alpha$wg-irresolute map.

Theorem 3.5: Let f : (X,τ) $\to (Y,\sigma)$ be an $\tilde{g}_\alpha$- irresolute and closed map. Then f(A) is $\tilde{g}_\alpha$wg-closed of (Y,σ) for every $\tilde{g}_\alpha$wg-closed set A of (X,τ).

Proof: Let A be a $\tilde{g}_\alpha$wg-closed in (X,τ) .Let U be any $\tilde{g}_\alpha$-open set of (Y,σ) such that f(A)$\subseteq$U then A$\subseteq f^{-1}$(U).Since f is $\tilde{g}_\alpha$- irresolute then f^{-1}(U) is $\tilde{g}_\alpha$-open set of (X,τ).

By hypothesis, A is $\tilde{g}_\alpha$wg-closed and $f^{-1}(U)$ is $\tilde{g}_\alpha$-open set containing A,

then cl(int(A)) $\subseteq f^{-1}(U)$ which implies f(cl(int(A))) $\subseteq$ U.

Now, cl(int(f(A))) $\subseteq$ cl(int(f(cl(int(A))))) $\subseteq$ f(cl(int(A))) $\subseteq$ U

Hence cl(int(f(A))) $\subseteq$ U. Hence f(A) is $\tilde{g}_\alpha$wg-closed in (Y, σ).

Theorem 3.6: If a function f: (X, τ) $\rightarrow (Y,\sigma)$ is $\tilde{g}_\alpha$-irresolute and $\tilde{g}_\alpha$wg-closed and A is a $\tilde{g}_\alpha$wg-closed set of (X, τ),then $f_A : A \rightarrow Y$ is $\tilde{g}_\alpha$wg-closed.

Proof: Let F be closed subset of A. Then F is $\tilde{g}_\alpha$wg-closed. By theorem 3.5 f_A (F) = f(F) is $\tilde{g}_\alpha$wg-closed in (Y, σ). Hence $f_A : A \rightarrow Y$ is $\tilde{g}_\alpha$wg-closed function.

Theorem 3.7: Let f: (X, τ) $\rightarrow (Y,\sigma)$ and $g:(Y,\sigma) \rightarrow (z,\eta)$ $(Y,\sigma) \rightarrow (z,\eta)$ be such that $g \circ f$:(X, τ) $\rightarrow (z,\eta)$ is $\tilde{g}_\alpha$wg-closed function.

(i) If f is continuous and injective then g is $\tilde{g}_\alpha$wg-closed.

(ii) If g is $\tilde{g}_\alpha$wg-irresolute and injective then f is $\tilde{g}_\alpha$wg-closed.

Proof: Let F be closed set of (Y,σ). Since f is continuous, $f^{-1}(F)$ is closed in X. $g \circ f$ ($f^{-1}(F)$) is $\tilde{g}_\alpha$wg-closed in (z,η).Hence g(F) is $\tilde{g}_\alpha$wg-closed in (z,η).Thus g is $\tilde{g}_\alpha$wg-closed.

Proof of (ii) is similar to proof (i).

Theorem 3.8: Let f: (X, τ) $\rightarrow (Y,\sigma)$ be a bijection function such that the image of every $\tilde{g}_\alpha$-open in (X, τ) is $\tilde{g}_\alpha$ open in (Y,σ) and $\tilde{g}_\alpha$wg-continuous then f is $\tilde{g}_\alpha$wg-irresolute.

Proof: Let F be a $\tilde{g}_\alpha$wg-closed in (Y,σ). Let $f^{-1}(F) \subseteq$ U where U is $\tilde{g}_\alpha$ open set in (X, τ).
F $\subseteq$ f(U) and cl(int(F)) $\subseteq$ f(U) which implies f^{-1}(cl(int(F))) $\subseteq$ U. Since f is $\tilde{g}_\alpha$wg-continuous and cl(int(F)) is closed in (Y,σ) then f^{-1}(cl(int(F))) is $\tilde{g}_\alpha$wg closed in (X, τ). Since
f^{-1}(cl(int(F))) $\subseteq$ U and f^{-1}(cl(int(F))) is $\tilde{g}_\alpha$wg closed. We have cl(int(f^{-1}(cl(int(F))))) $\subseteq$ U and so cl(int(f^{-1}(F))) $\subseteq$ U. f^{-1}(F) is $\tilde{g}_\alpha$wg-closed set in (X, τ) hence f is $\tilde{g}_\alpha$wg-irresolute.

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