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SOMEWHAT FUZZY γ-IRRESOLUTE CONTINUOUS MAPPINGS

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Abstract. We define and characterize a somewhat fuzzy γ-irresolute continuous mapping and a somewhat fuzzy irresolute γ-open mapping on a fuzzy topological space.

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1. Introduction

The concept of fuzzy γ-continuous mappings on a fuzzy topological space was introduced and studied by I. M. Hanafy in [2]. Also, the concept of fuzzy γ-irresolute continuous mappings on a fuzzy topological space were introduced and studied by Y. B. Im et al. in [8] and fuzzy irresolute γ-open mappings on a fuzzy topological space was introduced and studied by Y. B. Im in [3].

Recently, somewhat fuzzy γ-continuous mappings on a fuzzy topological space were introduced and studied by G. Thangaraj and V. Seenivasan in [9].

In this paper, we define and characterize a somewhat fuzzy γ-irresolute continuous mapping and a somewhat fuzzy irresolute γ-open mapping which are stronger than a somewhat fuzzy γ-continuous mapping and a somewhat fuzzy γ-open mapping respectively. Besides, some interesting properties of those mappings are also given.

2. Preliminaries

A fuzzy set μ on a fuzzy topological space X is called *fuzzy γ-open* if $\mu \leq \mathrm{ClInt}\mu \vee \mathrm{IntCl}\mu$ and μ is called *fuzzy γ-closed* if μ^c is a fuzzy γ-open set on X.

A mapping $f : X \to Y$ is called *fuzzy γ-continuous* if $f^{-1}(\nu)$ is a fuzzy γ-open set on X for any fuzzy open set ν on Y and a mapping $f : X \to Y$ is

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called *fuzzy γ-open* if $f(\mu)$ is a fuzzy γ-open set on Y for any fuzzy open set μ on X. It is clear that every fuzzy continuous mapping is a fuzzy γ-continuous mapping. And every fuzzy open mapping is a fuzzy γ-open mapping from the above definitions. But the converses are not true in general [2].

A mapping $f : X \to Y$ is called *fuzzy γ-irresolute continuous* if $f^{-1}(\nu)$ is a fuzzy γ-open set on X for any fuzzy γ-open set ν on Y and a mapping $f : X \to Y$ is called *fuzzy irresolute γ-open* if $f(\mu)$ is a fuzzy γ-open set on Y for any fuzzy γ-open set μ on X. It is clear that every fuzzy γ-irresolute continuous mapping is a fuzzy γ-continuous mapping. And every fuzzy irresolute γ-open mapping is a fuzzy open mapping from the above definitions. But the converses are not true in general [8] and [3].

A mapping $f : X \to Y$ is called *somewhat fuzzy γ-continuous* if there exists a fuzzy γ-open set $\mu \neq 0_X$ on X such that $\mu \leq f^{-1}(\nu) \neq 0_X$ for any fuzzy open set ν on Y. It is clear that every fuzzy γ-continuous mapping is a somewhat fuzzy γ-continuous mapping. But the converse is not true in general.

A mapping $f : X \to Y$ is called *somewhat fuzzy γ-open* if there exists a fuzzy γ-open set $\nu \neq 0_Y$ on Y such that $\nu \leq f(\mu) \neq 0_Y$ for any fuzzy open set μ on X. Every fuzzy open mapping is a somewhat fuzzy γ-open mapping but the converse is not true in general [9].

3. Somewhat fuzzy γ-irresolute continuous mappings

In this section, we introduce a somewhat fuzzy γ-irresolute continuous mapping and a somewhat fuzzy irresolute γ-open mapping which are stronger than a somewhat fuzzy γ-continuous mapping and a somewhat fuzzy γ-open mapping respectively. And we characterize a somewhat fuzzy γ-irresolute continuous mapping and a somewhat fuzzy irresolute γ-open mapping.

Definition 3.1. A mapping $f : X \to Y$ is called somewhat fuzzy γ-irresolute continuous if there exists a fuzzy γ-open set $\mu \neq 0_X$ on X such that $\mu \leq f^{-1}(\nu)$ for any fuzzy γ-open set $\nu \neq 0_Y$ on Y.

It is clear that every fuzzy γ-irresolute continuous mapping is a somewhat fuzzy γ-irresolute continuous mapping. And every somewhat fuzzy γ-irresolute continuous mapping is a fuzzy γ-continuous mapping from the above definitions. But the converses are not true in general as the following examples show.

Example 3.2. Let μ_1, μ_2 and μ_3 be fuzzy sets on $X = \{a, b, c\}$ and let ν_1, ν_2 and ν_3 be fuzzy sets on $Y = \{x, y, z\}$ with

$$\mu_1(a) = 0.1, \mu_1(b) = 0.1, \mu_1(c) = 0.1,$$
$$\mu_2(a) = 0.2, \mu_2(b) = 0.2, \mu_2(c) = 0.2,$$
$$\mu_3(a) = 0.5, \mu_3(b) = 0.5, \mu_3(c) = 0.5 \text{ and}$$
$$\nu_1(x) = 0.3, \nu_1(y) = 0.2, \nu_1(z) = 0.3,$$
$$\nu_2(x) = 0.5, \nu_2(y) = 0.5, \nu_2(z) = 0.5,$$
$$\nu_3(x) = 0.5, \nu_3(y) = 0.2, \nu_3(z) = 0.5.$$

Let $\tau = \{0_X, \mu_1, \mu_1^c, \mu_2^c, 1_X\}$ be fuzzy topologies on X and let $\tau^* = \{0_Y, \nu_1, \nu_2, 1_Y\}$ be fuzzy topologies on Y. Consider the mapping $f : (X, \tau) \to (Y, \tau^*)$ defined by $f(a) = y$, $f(b) = y$ and $f(c) = y$. Then we have $\mu_1 \leq f^{-1}(\nu_1) = \mu_2$, $f^{-1}(\nu_2) = \mu_3$ and $\mu_1 \leq f^{-1}(\nu_3) = \mu_2$. Since μ_1 is a fuzzy γ-open set on (X, τ), f is somewhat fuzzy γ-irresolute continuous. But $f^{-1}(\nu_1) = \mu_2$ and $f^{-1}(\nu_3) = \mu_2$ are not fuzzy γ-open sets on (X, τ). Hence f is not a fuzzy γ-irresolute continuous mapping. $\square$

Example 3.3. Let μ_1, μ_2 and μ_3 be fuzzy sets on $X = \{a, b, c\}$ and let ν_1, ν_2 and ν_3 be fuzzy sets on $Y = \{x, y, z\}$ with

$$\begin{aligned}
&\mu_1(a) = 0.2, \mu_1(b) = 0.2, \mu_1(c) = 0.2,\\
&\mu_2(a) = 0.5, \mu_2(b) = 0.5, \mu_2(c) = 0.5, \text{ and}\\
&\nu_1(x) = 0.3, \nu_1(y) = 0.2, \nu_1(z) = 0.3,\\
&\nu_2(x) = 0.5, \nu_2(y) = 0.5, \nu_2(z) = 0.5.
\end{aligned}$$

Let $\tau = \{0_X, \mu_1^c, 1_X\}$ be fuzzy topologies on X and let $\tau^* = \{0_Y, \nu_2, 1_Y\}$ be fuzzy topologies on Y. Consider the mapping $f : (X, \tau) \to (Y, \tau^*)$ defined by $f(a) = y$, $f(b) = y$ and $f(c) = y$. Since $f^{-1}(\nu_2) = \mu_2$ is fuzzy γ-open sets on (X, τ), f is fuzzy γ-continuous. But the inverse images $0_X \leq f^{-1}(\nu_1) = \mu_1$ of a fuzzy γ-open set ν_1 on (Y, τ^*) is not fuzzy γ-open on (X, τ). Hence f is not a fuzzy somewhat γ-irresolute continuous mapping. $\square$

Definition 3.4 ([9])**.** A fuzzy set μ on a fuzzy topological space X is called fuzzy γ-dense if there exists no fuzzy γ-closed set ν such that $\mu < \nu < 1$.

Theorem 3.5. *Let $f : X \to Y$ be a mapping. Then the following are equivalent:*

(1) f is somewhat fuzzy γ-irresolute continuous.

(2) If ν is a fuzzy γ-closed set of Y such that $f^{-1}(\nu) \neq 1_X$, then there exists a fuzzy γ-closed set $\mu \neq 1_X$ of X such that $f^{-1}(\nu) \leq \mu$.

(3) If μ is a fuzzy γ-dense set on X, then $f(\mu)$ is a fuzzy γ-dense set on Y.

Proof. (1) implies (2): Let ν be a fuzzy γ-closed set on Y such that $f^{-1}(\nu) \neq 1_X$. Then ν^c is a fuzzy γ-open set on Y and $f^{-1}(\nu^c) = (f^{-1}(\nu))^c \neq 0_X$. Since f is somewhat fuzzy γ-irresolute continuous, there exists a fuzzy γ-open set $\lambda \neq 0_X$ on X such that $\lambda \leq f^{-1}(\nu^c)$. Let $\mu = \lambda^c$. Then $\mu \neq 1_X$ is fuzzy γ-closed such that $f^{-1}(\nu) = 1 - f^{-1}(\nu^c) \leq 1 - \lambda = \lambda^c = \mu$.

(2) implies (3): Let μ be a fuzzy γ-dense set on X and suppose $f(\mu)$ is not fuzzy γ-dense on Y. Then there exists a fuzzy γ-closed set ν on Y such that $f(\mu) < \nu < 1$. Since $\nu < 1$ and $f^{-1}(\nu) \neq 1_X$, there exists a fuzzy γ-closed set $\delta \neq 1_X$ such that $\mu \leq f^{-1}(f(\mu)) < f^{-1}(\nu) \leq \delta$. This contradicts to the assumption that μ is a fuzzy γ-dense set on X. Hence $f(\mu)$ is a fuzzy γ-dense set on Y.

(3) implies (1): Let $\nu \neq 0_Y$ be a fuzzy γ-open set on Y and $f^{-1}(\nu) \neq 0_X$. Suppose there exists no fuzzy γ-open $\mu \neq 0_X$ on X such that $\mu \leq f^{-1}(\nu)$. Then $(f^{-1}(\nu))^c$ is a fuzzy set on X such that there is no fuzzy γ-closed set δ on X

with $(f^{-1}(\nu))^c < \delta < 1$. In fact, if there exists a fuzzy γ-open set δ^c such that $\delta^c \leq f^{-1}(\nu)$, then it is a contradiction. So $(f^{-1}(\nu))^c$ is a fuzzy γ-dense set on X. Then $f((f^{-1}(\nu))^c)$ is a fuzzy γ-dense set on Y. But $f((f^{-1}(\nu))^c) = f(f^{-1}(\nu^c)) \neq \nu^c < 1$. This is a contradiction to the fact that $f((f^{-1}(\nu))^c)$ is fuzzy γ-dense on Y. Hence there exists a γ-open set $\mu \neq 0_X$ on X such that $\mu \leq f^{-1}(\nu)$. Consequently, f is somewhat fuzzy γ-irresolute continuous. $\square$

A fuzzy topological space X is *product related* to a fuzzy topological space Y if for fuzzy sets μ on X and ν on Y whenever $\gamma^c \not\geq \mu$ and $\delta^c \not\geq \nu$ (in which case $(\gamma^c \times 1) \vee (1 \times \delta^c) \geq (\mu \times \nu))$ where γ is a fuzzy open set on X and δ is a fuzzy open set on Y, there exists a fuzzy open set γ_1 on X and a fuzzy open set δ_1 on Y such that $\gamma_1^c \geq \mu$ or $\delta_1^c \geq \nu$ and $(\gamma_1^c \times 1) \vee (1 \times \delta_1^c) = (\gamma^c \times 1) \vee (1 \times \delta^c)$ [1].

Theorem 3.6. *Let X_1 be product related to X_2 and Y_1 be product related to Y_2. Then the product $f_1 \times f_2 : X_1 \times X_2 \to Y_1 \times Y_2$ of somewhat fuzzy γ-irresolute continuous mappings $f_1 : X_1 \to Y_1$ and $f_2 : X_2 \to Y_2$ is also somewhat fuzzy γ-irresolute continuous.*

Proof. Let $\lambda = \bigvee_{i,j}(\mu_i \times \nu_j)$ be a fuzzy γ-open set on $Y_1 \times Y_2$ where $\mu_i \neq 0_{Y_1}$ and $\nu_j \neq 0_{Y_2}$ are fuzzy γ-open sets on Y_1 and Y_2 respectively. Then $(f_1 \times f_2)^{-1}(\lambda) = \bigvee_{i,j}(f_1^{-1}(\mu_i) \times f_2^{-1}(\nu_j))$. Since f_1 is somewhat fuzzy γ-irresolute continuous, there exists a fuzzy γ-open set $\delta_i \neq 0_{X_1}$ such that $\delta_i \leq f_1^{-1}(\mu_i) \neq 0_{X_1}$. And, since f_2 is somewhat fuzzy γ-irresolute continuous, there exists a fuzzy γ-open set $\eta_j \neq 0_{X_2}$ such that $\eta_j \leq f_2^{-1}(\nu_j) \neq 0_{X_2}$. Now $\delta_i \times \eta_j \leq f_1^{-1}(\mu_i) \times f_2^{-1}(\nu_j) = (f_1 \times f_2)^{-1}(\mu_i \times \nu_j)$ and $\delta_i \times \eta_j \neq 0_{X_1 \times X_2}$ is a fuzzy γ-open set on $X_1 \times X_2$. Hence $\bigvee_{i,j}(\delta_i \times \eta_j) \neq 0_{X_1 \times X_2}$ is a fuzzy γ-open set on $X_1 \times X_2$ such that $\bigvee_{i,j}(\delta_i \times \eta_j) \leq \bigvee_{i,j}(f_1^{-1}(\mu_i) \times f_2^{-1}(\nu_j)) = (f_1 \times f_2)^{-1}(\bigvee_{i,j}(\mu_i \times \nu_j)) = (f_1 \times f_2)^{-1}(\lambda) \neq 0_{X_1 \times X_2}$. Therefore, $f_1 \times f_2$ is somewhat fuzzy γ-irresolute continuous. $\square$

Theorem 3.7. *Let $f : X \to Y$ be a mapping. If the graph $g : X \to X \times Y$ of f is a somewhat fuzzy γ-irresolute continuous mapping, then f is also somewhat fuzzy γ-irresolute continuous.*

Proof. Let ν be a fuzzy γ-open set on Y. Then $f^{-1}(\nu) = 1 \wedge f^{-1}(\nu) = g^{-1}(1 \times \nu)$. Since g is somewhat fuzzy γ-irresolute continuous and $1 \times \nu$ is a fuzzy γ-open set on $X \times Y$, there exists a fuzzy γ-open set $\mu \neq 0_X$ on X such that $\mu \leq g^{-1}(1 \times \nu) = f^{-1}(\nu) \neq 0_X$. Therefore, f is somewhat fuzzy γ-irresolute continuous. $\square$

Definition 3.8. A mapping $f : X \to Y$ is called somewhat fuzzy irresolute γ-open if there exists a fuzzy γ-open set $\nu \neq 0_Y$ on Y such that $\nu \leq f(\mu)$ for any fuzzy γ-open set $\mu \neq 0_X$ on X.

It is clear that every fuzzy irresolute γ-open mapping is a somewhat fuzzy irresolute γ-open mapping. And every somewhat fuzzy irresolute γ-open mapping is a fuzzy γ-open mapping. Also, every fuzzy γ-open mapping is a somewhat fuzzy γ-open mapping from the above definitions. But the converses are not true in general as the following examples show.

Example 3.9. Let μ_1 and μ_2 be fuzzy sets on $X = \{a, b, c\}$ and let ν_1 and ν_2 be fuzzy sets on $Y = \{x, y, z\}$ with

$$\mu_1(a) = 0.1, \mu_1(b) = 0.1, \mu_1(c) = 0.1,$$
$$\mu_2(a) = 0.2, \mu_2(b) = 0.2, \mu_2(c) = 0.2 \text{ and}$$
$$\nu_1(x) = 0.0, \nu_1(y) = 0.1, \nu_1(z) = 0.0,$$
$$\nu_2(x) = 0.0, \nu_2(y) = 0.2, \nu_2(z) = 0.0,$$
$$\nu_3(x) = 0.0, \nu_3(y) = 0.8, \nu_3(z) = 0.0,$$
$$\nu_4(x) = 0.0, \nu_4(y) = 0.9, \nu_4(z) = 0.0.$$

Let $\tau = \{0_X, \mu_2, 1_X\}$ be fuzzy topologies on X and let $\tau^* = \{0_Y, \nu_1, \nu_1^c, \nu_2^c, 1_Y\}$ be fuzzy topologies on Y. Consider the mapping $f : (X, \tau) \to (Y, \tau^*)$ defined by $f(a) = y$, $f(b) = y$ and $f(c) = y$. Since $f(\mu_1) = \nu_1$, $\nu_1 \leq f(\mu_2) = \nu_2$, $f(\mu_1^c) = \nu_3$ and $f(\mu_2^c) = \nu_4$, f is somewhat fuzzy irresolute γ-open. But $f(\mu_2) = \nu_2$ is not a fuzzy γ-open set on (Y, τ^*). Hence f is not a fuzzy irresolute γ-open mapping. □

Example 3.10. Let μ_1, μ_2 and μ_3 be fuzzy sets on $X = \{a, b, c\}$ and let ν_1 and ν_2 be fuzzy sets on $Y = \{x, y, z\}$ with

$$\mu_1(a) = 0.4, \mu_1(b) = 0.1, \mu_1(c) = 0.4,$$
$$\mu_2(a) = 0.5, \mu_2(b) = 0.5, \mu_2(c) = 0.5,$$
$$\mu_3(a) = 0.1, \mu_3(b) = 0.0, \mu_3(c) = 0.1 \text{ and}$$
$$\nu_1(x) = 0.0, \nu_1(y) = 0.1, \nu_1(z) = 0.0,$$
$$\nu_2(x) = 0.0, \nu_2(y) = 0.5, \nu_2(z) = 0.0.$$

Let $\tau = \{0_X, \mu_1, \mu_2, 1_X\}$ be fuzzy topologies on X and let $\tau^* = \{0_Y, \nu_2, 1_Y\}$ be fuzzy topologies on Y. Consider the mapping $f : (X, \tau) \to (Y, \tau^*)$ defined by $f(a) = y$, $f(b) = y$ and $f(c) = y$. Since $f(\mu_1) = \nu_1$ and $f(\mu_2) = \nu_2$ are fuzzy γ-open sets on (Y, τ^*), f is fuzzy γ-open. But $\mu_3 \neq 0_X$ is a fuzzy γ-open set on (X, τ) and $f(\mu_3) = 0_Y$. Hence f is not a fuzzy somewhat irresolute γ-open mapping. □

Example 3.11. Let μ_1, μ_2 and μ_3 be fuzzy sets on $X = \{a, b, c\}$ with

$$\mu_1(a) = 0.1, \mu_1(b) = 0.1, \mu_1(c) = 0.1,$$
$$\mu_2(a) = 0.2, \mu_2(b) = 0.2, \mu_2(c) = 0.2 \text{ and}$$
$$\mu_3(a) = 0.3, \mu_3(b) = 0.3, \mu_3(c) = 0.3.$$

Let $\tau = \{0_X, \mu_2^c, 1_X\}$ and $\tau^* = \{0_X, \mu_1, \mu_3, 1_X\}$be fuzzy topologies on X. Consider the identity mapping $i_X : (X, \tau) \to (X, \tau^*)$. We have $\mu_3 \leq i_X(\mu_2^c) = \mu_2^c$. Since μ_3 is a fuzzy γ-open set on (X, τ), i_X is somewhat fuzzy γ-open. But $i_X(\mu_2^c) = \mu_2^c$ is not a fuzzy γ-open set on (X, τ^*). Hence i_X is not a fuzzy γ-open mapping. □

Theorem 3.12. *Let $f : X \to Y$ be a bijection. Then the following are equivalent:*

(1) f is somewhat fuzzy irresolute γ-open.

(2) If μ is a fuzzy γ-closed set on X such that $f(\mu) \neq 1_Y$, then there exists a fuzzy γ-closed set $\nu \neq 1_Y$ on Y such that $f(\mu) < \nu$.

Proof. (1) implies (2): Let μ be a fuzzy γ-closed set on X such that $f(\mu) \neq 1_Y$. Since f is bijective and μ^c is a fuzzy γ-open set on X, $f(\mu^c) = (f(\mu))^c \neq 0_Y$. And, since f is somewhat fuzzy irresolute γ-open, there exists a γ-open set $\delta \neq 0_Y$ on Y such that $\delta < f(\mu^c) = (f(\mu))^c$. Consequently, $f(\mu) < \delta^c = \nu \neq 1_Y$ and ν is a fuzzy γ-closed set on Y.

(2) implies (1): Let μ be a fuzzy γ-open set on X such that $f(\mu) \neq 0_Y$. Then μ^c is a fuzzy γ-closed set on X and $f(\mu^c) \neq 1_Y$. Hence there exists a fuzzy γ-closed set $\nu \neq 1_Y$ on Y such that $f(\mu^c) < \nu$. Since f is bijective, $f(\mu^c) = (f(\mu))^c < \nu$. Hence $\nu^c < f(\mu)$ and $\nu^c \neq 0_X$ is a fuzzy γ-open set on Y. Therefore, f is somewhat fuzzy irresolute γ-open. □

Theorem 3.13. *Let $f : X \to Y$ be a surjection. Then the following are equivalent:*

(1) f is somewhat fuzzy irresolute γ-open.

(2) If ν is a fuzzy γ-dense set on Y, then $f^{-1}(\nu)$ is a fuzzy γ-dense set on X.

Proof. (1) implies (2): Let ν be a fuzzy γ-dense set on Y. Suppose $f^{-1}(\nu)$ is not fuzzy γ-dense on X. Then there exists a fuzzy γ-closed set μ on X such that $f^{-1}(\nu) < \mu < 1$. Since f is somewhat fuzzy irresolute γ-open and μ^c is a fuzzy γ-open set on X, there exists a fuzzy γ-open set $\delta \neq 0_Y$ on Y such that $\delta \leq f(\mathrm{Int}\mu^c) \leq f(\mu^c)$. Since f is surjective, $\delta \leq f(\mu^c) < f(f^{-1}(\nu^c)) = \nu^c$. Thus there exists a γ-closed set δ^c on Y such that $\nu < \delta^c < 1$. This is a contradiction. Hence $f^{-1}(\nu)$ is fuzzy γ-dense on X.

(2) implies (1): Let μ be a fuzzy open set on X and $f(\mu) \neq 0_Y$. Suppose there exists no fuzzy γ-open $\nu \neq 0_Y$ on Y such that $\nu \leq f(\mu)$. Then $(f(\mu))^c$ is a fuzzy set on Y such that there exists no fuzzy γ-closed set δ on Y with $(f(\mu))^c < \delta < 1$. This means that $(f(\mu))^c$ is fuzzy γ-dense on Y. Thus $f^{-1}((f(\mu))^c)$ is fuzzy γ-dense on X. But $f^{-1}((f(\mu))^c) = (f^{-1}(f(\mu)))^c \leq \mu^c < 1$. This is a contradiction to the fact that $f^{-1}((f(\nu))^c$ is fuzzy γ-dense on X. Hence there exists a γ-open set $\nu \neq 0_Y$ on Y such that $\nu \leq f(\mu)$. Therefore, f is somewhat fuzzy irresolute γ-open. □

References

1. K. K. Azad, *On fuzzy semicontinuity, fuzzy almost continuity and fuzzy weakly continuity*, J. Math. Anal. Appl. **82** (1981), 14-32.
2. I. M. Hanafy, *γ-open sets and fuzzy γ-continuity*, J. Fuzzy Math. **7** (1999), 419-430.
3. Y. B. Im, *Fuzzy γ-open sets and γ-irresolute open mappings*, Far East J. Math. Sci. **21** (2006), 259-267.

4. Y. B. Im, J. S. Lee and Y. D. Cho, *Somewhat fuzzy precontinuous mappings*, J. Appl. Math. & Informatics **30** (2012), 685-691.
5. Y. B. Im, J. S. Lee and Y. D. Cho, *Somewhat fuzzy pre-irresolute continuous mappings*, J. Appl. Math. & Informatics. **30** (2012), 1077-1084.
6. Y. B. Im, J. S. Lee and Y. D. Cho, *Somewhat fuzzy irresolute continuous mappings*, Int. J. Fuzzy Logic and Intelligent Systems, **12** (2012), 319-323.
7. Y. B. Im, J. S. Lee and Y. D. Cho, *Somewhat fuzzy α-irresolute continuous mappings*, Far East J. Math. Sci. **70** (2012), 145-155.
8. Y. B. Im, E. P. Lee and S. W. Park *Fuzzy γ-irresolute mappings on fuzzy topological spaces*, J. Fuzzy Math. **14** (2006), 605-612.
9. G. Thangaraj and V. Seenivasan, *On somewhat fuzzy γ-continuous functions*, J. Fuzzy Math. **19** (2011), 341-352.
10. G. Thangaraj and V. Seenivasan, *On somewhat fuzzy continuous functions*, J. Fuzzy Math. **11** (2003), 725-736.
11. G. Thangaraj and V. Seenivasan, *On somewhat fuzzy semicontinuous functions*, Kybernetika **137** (2001), 165-170.

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