THE JOIN PRODUCT AND DUAL STRONG DOMINATION IN MIXED SPLIT INTUITIONISTIC FUZZY GRAPH

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Abstract

In this paper, we introduce the notion of mixed split intuitionistic fuzzy graph, strong mixed split intuitionistic fuzzy graph, complete mixed split intuitionistic fuzzy graph, join product of two mixed split intuitionistic fuzzy graphs and establish some of their properties. Also we discuss dual strong domination regarding the concept.

Keywords:

Mixed split intuitionistic fuzzy graph, Strong mixed split intuitionistic fuzzy graph, Complete mixed split intuitionistic fuzzy graph, Join product of two mixed split intuitionistic fuzzy graphs .

1.Introduction

In 1965 Lotfi. A. Zadeh introduced fuzzy sets as a generalization of crisp set and later in 1983 Krassimir T. The fuzzy relations between fuzzy sets were also considered by Rosenfield, he developed the structure of fuzzy graphs and obtained analogues of several graphs theoretical concepts. Atanassov introduced the notion on intuitionistic fuzzy set. The concept of fuzzy graph was introduced by Rosenfield in 1975 and then K. T. Atanassov extended it to intuitionistic fuzzy graph in 1999. Research in intuitionistic fuzzy graph and its application have been increased considerably in recent years. Different types of intuitionistic fuzzy graphs and their applications can be found in several papers. Parvathi and Thamizhendhi (2010) introduced the concept of domination number in intuitionistic fuzzy graphs.

In this paper, we develop the concept of mixed split intuitionistic fuzzy graph, strong mixed split intuitionistic fuzzy graph, complete mixed split intuitionistic fuzzy graph and join product of two mixed split intuitionistic fuzzy graphs are defined, and many interesting results involving these concepts are investigated. Moreover, we discuss dual strong domination number and investigated their many interesting results.

2.Preliminaries

Definition 2.1

An intuitionistic fuzzy graph (IFG) is of the form $G:(V,E)$ where

(i) $V=\{v_1,v_2,...,v_n\}$ such that $\mu_V:V\to[0,1]$ and $\gamma_V:V\to[0,1]$ denote the degree of membership and non membership of the element $v_i\in V$ respectively and $0\le\mu_V(v_i)+\gamma_V(v_i)\le 1$ for every $v_i\in V(i=1,2,....,n)$

(ii) $E\subseteq V\times V$ where $\mu_E:V\times V\to[0,1]$ and $\gamma_E:V\times V\to[0,1]$ are such that

$$\mu_E(v_i,v_j)\le\min(\mu_V(v_i),\mu_V(v_j))$$

$$\gamma_E(v_i,v_j)\le\max(\gamma_V(v_i),\gamma_V(v_j))$$

and $0\le\mu_E(v_i,v_j)+\gamma_E(v_i,v_j)\le 1$ for every $(v_i,v_j)\in E,(i,j=1,2,...,n)$

Definition 2.2

An IFG $G:(V,E)$ is said to be strong IFG if $\mu_E(v_i,v_j)=\min(\mu_V(v_i),\mu_V(v_j))$ and

$\gamma_E(v_i,v_j)=\max(\gamma_V(v_i),\gamma_V(v_j))$ for every $v_i,v_j\in E$.

Definition 2.3

An IFG $G:(V,E)$ is said to be complete IFG if $\mu_E(v_i,v_j)=\min(\mu_V(v_i),\mu_V(v_j))$ and

$\gamma_E(v_i,v_j)=\max(\gamma_V(v_i),\gamma_V(v_j))$ for every $v_i,v_j\in V$.

3.MIXED SPLIT INTUITIONISTIC FUZZY GRAPH (MSIFG)

Definition 3.1

An mixed split intuitionistic fuzzy graph (MSIFG) is of the form $G:(V,E)$ where

(i) the vertex set $V=\{v_1,v_2,...,v_n\}$ such that $\mu_V:V\rightarrow[0,1]$ and $\gamma_V:V\rightarrow[0,1]$ denote the degree of membership and non membership of the element $v_i\in V$ respectively and $0\leq\frac{\mu_V(v_i)\times\gamma_V(v_i)}{2}\leq 1$(where "×" represent ordinary multiplication) for every $v_i\in V(i=1,2,....,n)$

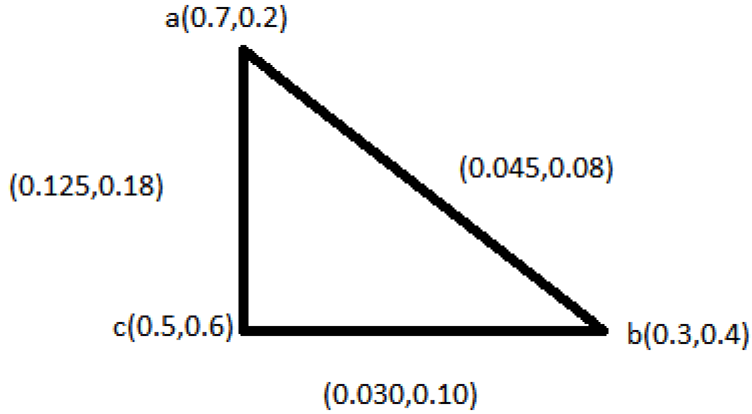
(ii) $E\subseteq V\times V$ where $\mu_E:V\times V\rightarrow[0,1]$ and $\gamma_E:V\times V\rightarrow[0,1]$ are such that

$$\mu_E(v_i,v_j)\leq\min\left(\frac{\mu_V(v_i)\times\mu_V(v_i)}{2},\frac{\mu_V(v_j)\times\mu_V(v_j)}{2}\right)$$

$$\gamma_E(v_i,v_j)\leq\max\left(\frac{\gamma_V(v_i)\times\gamma_V(v_i)}{2},\frac{\gamma_V(v_j)\times\gamma_V(v_j)}{2}\right)$$

and $0\leq\frac{\mu_E(v_i,v_j)\times\gamma_E(v_i,v_j)}{2}\leq 1$ for every $(v_i,v_j)\in E,(i,j=1,2,...,n)$.

Example:



Definition 3.2

A mixed split intuitionistic fuzzy graph $G:(V,E)$ is said to be strong if

$$\mu_E(v_i,v_j)=\min\left(\frac{\mu_V(v_i)\times\mu_V(v_i)}{2},\frac{\mu_V(v_j)\times\mu_V(v_j)}{2}\right)$$

$$\gamma_E(v_i,v_j)=\max\left(\frac{\gamma_V(v_i)\times\gamma_V(v_i)}{2},\frac{\gamma_V(v_j)\times\gamma_V(v_j)}{2}\right)$$

for all $(v_i,v_j)\in E$.

Definition 3.3

A mixed split intuitionistic fuzzy graph $G:(V,E)$ is said to be complete if

$$\mu_E(v_i,v_j)=\min\left(\frac{\mu_V(v_i)\times\mu_V(v_i)}{2},\frac{\mu_V(v_j)\times\mu_V(v_j)}{2}\right)$$

$$\gamma_E(v_i,v_j)=\max\left(\frac{\gamma_V(v_i)\times\gamma_V(v_i)}{2},\frac{\gamma_V(v_j)\times\gamma_V(v_j)}{2}\right)$$

for all $(v_i,v_j)\in V$.

3.1. THE JOIN PRODUCT OF TWO MIXED SPLIT INTUITIONISTIC FUZZY GRAPHS

Definition 3.1.1

The join product of two MSIFG $G_1=(V_1,E_1)$ and $G_2=(V_2,E_2)$ denoted by

$$G_1+G_2=\left[V_1\cup V_2,E_1\cup E_2\cup E^N\right]$$

where E^N is the new edge joining $V_1 \& V_2$, its membership and non membership are defined as follows

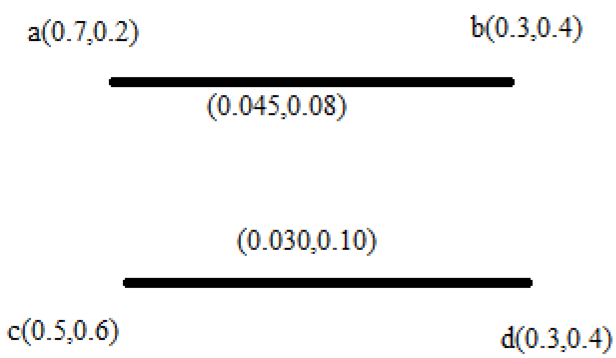
$$\left(\mu_{V_1}+\mu_{V_2}\right)(u)=\begin{cases}\mu_{V_1}(u)\ if\ u\in V_1\\ \mu_{V_2}(u)\ if\ u\in V_2\end{cases}$$

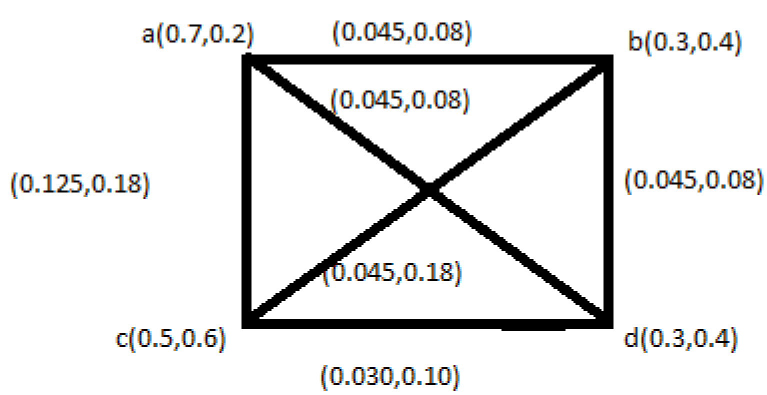
$$\left(\gamma_{V_1}+\gamma_{V_2}\right)(u)=\begin{cases}\gamma_{V_1}(u)\ if\ u\in V_1\\ \gamma_{V_2}(u)\ if\ u\in V_2\end{cases}$$

$$(\mu_{E_1} + \mu_{E_2})(uv) = \begin{cases} \mu_{E_1}(uv) \ if \ uv \in E_1 \\ \mu_{E_2}(uv) \ if \ uv \in E_2 \\ \min\left\{ \frac{\mu_{V_1}(u) \times \mu_{V_1}(u)}{2}, \frac{\mu_{V_2}(v) \times \mu_{V_2}(v)}{2} \right\} if \ uv \in E^N \end{cases}$$

$$(\gamma_{E_1} + \gamma_{E_2})(uv) = \begin{cases} \gamma_{E_1}(uv) \ if \ uv \in E_1 \\ \gamma_{E_2}(uv) \ if \ uv \in E_2 \\ \max\left\{ \frac{\gamma_{V_1}(u) \times \gamma_{V_1}(u)}{2}, \frac{\gamma_{V_2}(v) \times \gamma_{V_2}(v)}{2} \right\} if \ uv \in E^N \end{cases}$$

Example:





Theorem 3.1.1

The join of two MSIFG is again an MSIFG

Proof:

Let $G_1 = [V_1, E_1]$ and $G_2 = [V_2, E_2]$ be MSIFG, we have to prove that the join of $G_1 \& G_2$ denoted by $G_1 + G_2 = \left[V_1 \cup V_2, E_1 \cup E_2 \cup E^N\right]$ where E^N is the new edge joining V_1 & V_2 is an MSIFG.

By definition, we have if

$x \in V_1$ then $\left(\mu_{V_1} + \mu_{V_2}\right)(x) = \mu_{V_1}(x)$ &

$$\left(\gamma_{V_1} + \gamma_{V_2}\right)(x) = \gamma_{V_1}(x)$$

therefore $0 \le \dfrac{\left(\mu_{V_1} + \mu_{V_2}\right)(x) \times \left(\gamma_{V_1} + \gamma_{V_2}\right)(x)}{2} \le 1$

Similarly if $x \in V_2$ then $\left(\mu_{V_1} + \mu_{V_2}\right)(x) = \mu_{V_2}(x)$ &

$$\left(\gamma_{V_1} + \gamma_{V_2}\right)(x) = \gamma_{V_2}(x)$$

therefore $0 \le \dfrac{\left(\mu_{V_1} + \mu_{V_2}\right)(x) \times \left(\gamma_{V_1} + \gamma_{V_2}\right)(x)}{2} \le 1$

and if $xy \in E_1$ then

$$\left(\mu_{E_1} + \mu_{E_2}\right)(x, y) = \mu_{E_1}(xy)$$

$$\left(\mu_{E_1} + \mu_{E_2}\right)(x, y) \le \min\left(\frac{\mu_{V_1}(x) \times \mu_{V_1}(x)}{2}, \frac{\mu_{V_1}(y) \times \mu_{V_1}(y)}{2}\right)$$

$$\le \min\left(\frac{(\mu_{V_1} + \mu_{V_2})(x) \times (\mu_{V_1} + \mu_{V_2})(x)}{2}, \frac{(\mu_{V_1} + \mu_{V_2})(y) \times (\mu_{V_1} + \mu_{V_2})(y)}{2}\right)$$

and $\left(\gamma_{E_1} + \gamma_{E_2}\right)(x, y) = \gamma_{E_1}(xy)$

$$\left(\gamma_{E_1} + \gamma_{E_2}\right)(x, y) \le \max\left(\frac{\gamma_{V_1}(x) \times \gamma_{V_1}(x)}{2}, \frac{\gamma_{V_1}(y) \times \gamma_{V_1}(y)}{2}\right)$$

$$\leq \max\left(\frac{(\gamma_{V_1}+\gamma_{V_2})(x)\times(\gamma_{V_1}+\gamma_{V_2})(x)}{2},\frac{(\gamma_{V_1}+\gamma_{V_2})(y)\times(\gamma_{V_1}+\gamma_{V_2})(y)}{2}\right)$$

Similarly if $xy \in E_2$

$$(\mu_{E_1}+\mu_{E_2})(x,y)\leq \min\left(\frac{(\mu_{V_1}+\mu_{V_2})(x)\times(\mu_{V_1}+\mu_{V_2})(x)}{2},\frac{(\mu_{V_1}+\mu_{V_2})(y)\times(\mu_{V_1}+\mu_{V_2})(y)}{2}\right)$$

and

$$(\gamma_{E_1}+\gamma_{E_2})(x,y)\leq \max\left(\frac{(\gamma_{V_1}+\gamma_{V_2})(x)\times(\gamma_{V_1}+\gamma_{V_2})(x)}{2},\frac{(\gamma_{V_1}+\gamma_{V_2})(y)\times(\gamma_{V_1}+\gamma_{V_2})(y)}{2}\right)$$

If $xy \in E^N$,

$$(\mu_{E_1}+\mu_{E_2})(x,y) = \min\left(\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2},\frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right)$$

$$= \min\left(\frac{(\mu_{V_1}+\mu_{V_2})(x)\times(\mu_{V_1}+\mu_{V_2})(x)}{2},\frac{(\mu_{V_1}+\mu_{V_2})(y)\times(\mu_{V_1}+\mu_{V_2})(y)}{2}\right)$$

$$(\gamma_{E_1}+\gamma_{E_2})(x,y) = \max\left(\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2},\frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right)$$

$$= \max\left(\frac{(\gamma_{V_1}+\gamma_{V_2})(x)\times(\gamma_{V_1}+\gamma_{V_2})(x)}{2},\frac{(\gamma_{V_1}+\gamma_{V_2})(y)\times(\gamma_{V_1}+\gamma_{V_2})(y)}{2}\right)$$

Therefore G_1+G_2 is also an MSIFG.

Theorem 3.1.2

If G_1 and G_2 are strong MSIFG, then their join denoted by G_1+G_2 is again strong MSIFG.

Proof:

Since G_1 and G_2 are strong MSIFG

$$\mu_{E_1}(x,y) = \min\left(\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2},\frac{\mu_{V_1}(y)\times\mu_{V_1}(y)}{2}\right) \text{ and}$$

$$\gamma_{E_1}(x,y)=\max\left(\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2},\frac{\gamma_{V_1}(y)\times\gamma_{V_1}(y)}{2}\right)\ \forall\ x,y\in E_1$$

and $\mu_{E_2}(x,y)=\min\left(\frac{\mu_{V_2}(x)\times\mu_{V_2}(x)}{2},\frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right)$ and

$$\gamma_{E_2}(x,y)=\max\left(\frac{\gamma_{V_2}(x)\times\gamma_{V_2}(x)}{2},\frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right)\ \forall\ x,y\in E_2$$

$$(\mu_{E_1}+\mu_{E_2})(x,y)=\begin{cases}\mu_{E_1}(x,y)\ if\ xy\in E_1\\ \mu_{E_2}(x,y)\ if\ xy\in E_2\end{cases}$$

$$=\left\{\begin{array}{l}\min\left\{\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2},\frac{\mu_{V_1}(y)\times\mu_{V_1}(y)}{2}\right\}\\ \min\left\{\frac{\mu_{V_2}(x)\times\mu_{V_2}(x)}{2},\frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right\}\end{array}\right\}$$

$$(\gamma_{E_1}+\gamma_{E_2})(x,y)=\begin{cases}\gamma_{E_1}(x,y)\ if\ xy\in E_1\\ \gamma_{E_2}(x,y)\ if\ xy\in E_2\end{cases}$$

$$=\left\{\begin{array}{l}\max\left\{\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2},\frac{\gamma_{V_1}(y)\times\gamma_{V_1}(y)}{2}\right\}\\ \max\left\{\frac{\gamma_{V_2}(x)\times\gamma_{V_2}(x)}{2},\frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right\}\end{array}\right\}$$

and if $x,y\in E^N$

$$(\mu_{E_1}+\mu_{E_2})(x,y)=\min\left(\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2},\frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right)$$

$$(\gamma_{E_1}+\gamma_{E_2})(x,y)=\max\left(\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2},\frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right)$$

Therefore G_1+G_2 is strong MSIFG.

Theorem 3.1.3

If G_1 and G_2 are complete MSIFG, then their join product denoted by $G_1 + G_2$ is again complete MSIFG.

Proof:

Since G_1 and G_2 are complete MSIFG

$$\mu_{E_1}(x,y) = \min\left(\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2}, \frac{\mu_{V_1}(y)\times\mu_{V_1}(y)}{2}\right) \text{ and}$$

$$\gamma_{E_1}(x,y) = \max\left(\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2}, \frac{\gamma_{V_1}(y)\times\gamma_{V_1}(y)}{2}\right) \ \forall\ x,y\in V_1$$

and $$\mu_{E_2}(x,y) = \min\left(\frac{\mu_{V_2}(x)\times\mu_{V_2}(x)}{2}, \frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right) \text{ and}$$

$$\gamma_{E_2}(x,y) = \max\left(\frac{\gamma_{V_2}(x)\times\gamma_{V_2}(x)}{2}, \frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right) \ \forall\ x,y\in V_2$$

$$(\mu_{E_1}+\mu_{E_2})(x,y) = \begin{cases}\mu_{E_1}(x,y)\ if\ xy\in E_1\\ \mu_{E_2}(x,y)\ if\ xy\in E_2\end{cases}$$

$$= \begin{cases}\min\left\{\frac{\mu_{V_1}(x)\times\mu_{V_1}(x)}{2}, \frac{\mu_{V_1}(y)\times\mu_{V_1}(y)}{2}\right\}\\ \min\left\{\frac{\mu_{V_2}(x)\times\mu_{V_2}(x)}{2}, \frac{\mu_{V_2}(y)\times\mu_{V_2}(y)}{2}\right\}\end{cases} \ \forall\ x,y\in V_1$$

$$(\gamma_{E_1}+\gamma_{E_2})(x,y) = \begin{cases}\gamma_{E_1}(x,y)\ if\ xy\in E_1\\ \gamma_{E_2}(x,y)\ if\ xy\in E_2\end{cases}$$

$$= \begin{cases}\max\left\{\frac{\gamma_{V_1}(x)\times\gamma_{V_1}(x)}{2}, \frac{\gamma_{V_1}(y)\times\gamma_{V_1}(y)}{2}\right\}\\ \max\left\{\frac{\gamma_{V_2}(x)\times\gamma_{V_2}(x)}{2}, \frac{\gamma_{V_2}(y)\times\gamma_{V_2}(y)}{2}\right\}\end{cases} \ \forall\ x,y\in V_2$$

and if $x, y \in E^N$

$$\left(\mu_{E_1} + \mu_{E_2}\right)(x, y) = \min\left(\frac{\mu_{V_1}(x) \times \mu_{V_1}(x)}{2}, \frac{\mu_{V_2}(y) \times \mu_{V_2}(y)}{2}\right) \forall\ x, y \in V_1$$

$$\left(\gamma_{E_1} + \gamma_{E_2}\right)(x, y) = \max\left(\frac{\gamma_{V_1}(x) \times \gamma_{V_1}(x)}{2}, \frac{\gamma_{V_2}(y) \times \gamma_{V_2}(y)}{2}\right) \forall\ x, y \in V_2$$

Therefore $G_1 + G_2$ is complete MSIFG.

4. DUAL STRONG DOMINATION IN MIXED SPLIT INTUITIONISTIC FUZZY GRAPH

Definition 4.1

A path P is called strong path if P contains only strong arcs. If $\mu(u,v) > 0$, then u and v are called neighbors. The set of all neighbors of u is denoted by $N(u)$. Also v is called strong neighbors of u if arc (u,v) is strong.

Definition 4.2

A set D of nodes of MSIFG G is a dual strong dominating set of MSIFG G if every node of $V(G) - D$ is a strong neighbor of two node in D.

Definition 4.3

A minimum dual strong dominating set as a dual strong dominating set of minimum scalar cardinality. The scalar cardinality of a minimum dual strong dominating set is called the dual strong domination number of MSIFG G.

Definition 4.4

The weight of a dual strong dominating set D of MSIFG is defined as $W(D) = \sum_{v_i \in D}\left[\frac{1 + \left|\mu_2(v_i, v_j) - \gamma_2(v_i, v_j)\right|}{2}\right]$, where $\left|\mu_2(v_i, v_j) - \gamma_2(v_i, v_j)\right|$ is the membership values and non membership values of the strong arcs incident on v_i. The dual strong domination number of a MSIFG G is defined as the minimum weight of dual strong dominating sets of MSIFG G and it is denoted by $\gamma_{DMS}(G)$ or simply γ_{DMS}. A minimum dual strong dominating set in a MSIFG G is a dual strong dominating set of minimum weight.

Definition 4.5

The dual strong domination number of a MSIFG G is defined as the minimum weight of dual strong dominating sets of MSIFG G and it is denoted by $\gamma_{DMS}(G)$ or simply γ_{DMS}. A minimum dual strong dominating set in a MSIFG G is a dual strong dominating set of minimum weight.

Theorem 4.1

Let G be an MSIFG and if G having atleast two strong arcs, then G contains dual strong dominating set.

Proof:

Let G be an MSIFG. If G having atleast two strong arcs, then G contains dual strong dominating set.

Conversely, suppose that G contains dual strong dominating set . To prove that G having atleast two strong arcs. If possible G contains only one strong arc, then G does not contain a dual strong dominating set. Which is a contradiction. Hence G having atleast two strong arcs.

Remark 4.1

Let G be an MSIFG and if G having only one strong arcs, then G does not have a dual strong dominating set.

Remark 4.2

If G_1+G_2 contains dual strong domination number then G_1 and G_2 need not be strong MSIFG.

References

[1] K.T. Atanassov, Intuitionistic fuzzy sets: Theory, applications, Studies in fuzziness and soft computing, Heidelberg, New York, Physica – Verl., 1999.

[2] K.T. Atanassov, Intuitionistic fuzzy sets, Fuzzy Sets and Systems 20 (1986) 87-96.

[3] Begum Syed Siddiqua, Srinivasan R.,(2017), Some Properties of Intuitionistic Fuzzy Sets of Third type, Advances in Fuzzy Mathematics, Vol 12, pp. 189-195.

[4] S.K. De, R. Biswas, A.R. Roy, An application of intuitionistic fuzzy sets in medical diagnosis, Fuzzy Sets and Systems 117 (2001) 209-213.

[5] Dhavudh Sheik. S, Srinivasan R. 2017, Intuitionistic Fuzzy Graphs of Second Type, Advances in Fuzzy mathematics, Vol. 12, pp. 197-204, Research India Publications.

[6] Josna James, Shiny Jose, Intuitionistic Fuzzy Graph of Third Type, International journal of Scientific Research in Mathematical and Statistical Sciences, Vol. 6, Issue.1, pp.220-224, February(2019).

[7] K. Kalaiarasi, L. Mahalakshmi, An Introduction to Fuzzy strong graphs, Fuzzy soft graps, complement of fuzzy strong and soft graphs, Global Journal of Pure and Applied Mathematics, ISSN: 0973-1768, Volume 13, Number 6 (2017), pp. 2235-2254 .

[8] K. Kalaiarasi, L. Mahalakshmi, Coloring of Regular and Strong Arcs Fuzzy Graphs, International journal of Fuzzy Mathematical Archive, ISSN : 2320-3242(P), 2320-3250(online), Volume 14, Number 1 (2017), pp. 59-69.

[9] K. Kalaiarasi, L. Mahalakshmi, On Co-normal product of Two Intuitionistic Fuzzy Graphs, International Journal of Pure and Applied Mathematics, ISSN : 1314-3395, Volume: 120, No:5, sep 2018, pp: 1321-1335.

[10] M.G.Karunambigai, S.Sivasankar , K.Palanivel, Different types of Domination in Intuitionistic Fuzzy Graph, Annals of Pure and Applied Mathematics, ISSN : 2279-087X(P),2279-0888(online), Volume: 14, No:1, 2017, pp: 87-101.

[11] O. T. Manjusha . M. S. Sunitha , Strong domination in Fuzzy graphs, Fuzzy Information and Engineering. (2015) 7:369-377.

[12] R.Parvathi, M.G. Karunambigai, K.T. Atanassov, Operations on intuitionistic fuzzy graphs, Fuzzy Systems, 2009. FUZZ-IEEE 2009. IEEE International Conference, 1396-1401.

[13] A.Rosenfield, in: LA. Zadeh, K.S. Fu, M. Shimura(Eds.), Fuzzy Graphs, Fuzzy Sets and Their Application, Academic Press, New York, 1975, pp. 77-95.

[14] Sankar Sahoo, Madhumangal Pal, Different types of product on intuitionistic fuzzy graphs, Pacific Science Review A: Natural Science and Engineering, 17(2015) 87-96.

[15] L.A.Zadeh, Fuzzy stes, Information Control 8 (1965) 338-353.