Intern. J. Fuzzy Mathematical Archive
Vol. 14, No. 1, 2017, 91-99
ISSN: 2320 –3242 (P), 2320 –3250 (online)
Published on 11 December 2017
www.researchmathsci.org
DOI: http://dx.doi.org/10.22457/ijfma.v14n1a11

International Journal of
Fuzzy Mathematical Archive

Perfect Domination in Constant Intuitionistic Fuzzy Graph of Degree (k_i,k_j)

***S.Revathi*[1], *C.V.R. Harinarayanan*[2] and *R.Muthuraj*[3]**

[1]Department of Mathematics, Saranathan College of Engineering
Trichy – 620 012, Tamilnadu, India. E- mail: revathi.soundar@gmail.com
[2]Department of Mathematics, Government Arts College
Paramakudi – 637 001, Tamilnadu, India. E-mail:CVRHNS@yahoo.com
[3]PG & Research Department of Mathematics, H.H. The Rajah's College
Pudukkottai – 622 001, Tamilnadu, India. E-mail: rmr1973@yahoo.co.in

Received 5 November 2017; accepted 7 December 2017

Abstract. In this paper, the new kind of parameter perfect dominating set in constant intuitionistic fuzzy graph is defined and established the parametric conditions. Another new kind of parameter totally constant intuitionistic fuzzy graph is defined and established the parametric conditions. Some properties of Perfect dominating set in constant IFG and totally constant IFG with suitable examples are also discussed.

Keywords: Dominating set, perfect dominating set in constant intuitionistic fuzzy graph.

AMS Mathematics Subject Classification (2010): 03E72, 03F55, 05C69, 05C72

1.Introduction

Atanassov [1] initiated the concept of intuitionistic fuzzy relations and intuitionistic fuzzy graphs (IFGS). Karunambigai [2] gave a definition of IFG as a special case of Intuitionistic Fuzzy Graphs(IFG) defined by Atanassov and Shannon [1]. Nagoor Gani, and Begum[4] gave the definition of order, degree and size in IFG. Parvathi and Thamizhendhi [5] was introduced dominating set, domination number, domination number in Intuitionistic fuzzy graphs and also Karunambigai and Buvaneswari [3] was introduced the constant intuitionistic fuzzy graph. Revathi et al., was introduced the perfect domination in fuzzy graph [7], Perfect Domination in Intuitionistic Fuzzy graphs [8]. In this paper, we study the perfect dominating set in constant intuitionistic fuzzy graph, the perfect domination number and its properties.

2. Preliminaries

Definition 2.1. [1] Let G = (V, E) be an **intuitionistic fuzzy graph (IFG)** where V={v_1,v_2,…,v_n}. Then,

i. $\mu_1 : V \to [0, 1]$ and $\gamma_1 : V \to [0, 1]$ respectively denote the degree of membership and non-membership of the element $v_i \in V$ and $0 \le \mu_1(v_i) + \gamma_1(v_i) \le 1$ for every $v_i \in V$.

ii. E $\subset$ V $\times$ V where μ_2:V $\times$ V $\to$ [0,1] and γ_2:V $\times$ V $\to$ [0,1] are such that $\mu_2(v_i,v_j) \le \min\{\mu_1(v_i),\mu_1(v_j)\}$, $\gamma_2(v_i,v_j) \le \max\{\gamma_1(v_i),\gamma_1(v_j)\}$ and $0 \le \mu_2(v_i,v_j) + \gamma_2(v_i,v_j) \le 1$ for every $(v_i,v_j) \in$ E.

Definition 2.2. [5] If $v_i, v_j \in V \subseteq G$, the μ-strength of connectedness between v_i and v_j is $\mu_2^\infty(v_i,v_j) = \sup\{\mu_2^k(v_i,v_j) / k = 1,2,\ldots.n\}$ and γ-strength of connectedness between v_i and v_j is $\gamma_2^\infty(v_i,v_j) = \inf\{\gamma_2^k(v_i,v_j) / k = 1,2,\ldots.n\}$

Definition 2.3. [5] An arc (u,v) is said to be a **strong arc,** if $\mu_2(u,v) \ge \mu_2^\infty(u,v)$ and $\gamma_2(u,v) \ge \gamma_2^\infty(u,v)$

Definition 2.4. [5] Let u be a vertex in an IFG G= (V,E), then N(u) = {v: v∈V and (u,v) is a strong arc} is called neighborhood of u.

Definition 2.5. [5] A vertex u∈V of an IFG G = (V,E) is said to be an isolated vertex if $\mu_2(u,v)$ =0 and $\gamma_2(u,v)$=0 for all v∈V.

Definition 2.6. [4] Let G = (V, E) be an IFG. Then the **cardinality of G** is defined to be

$$|G| = \left| \sum_{V_i \in V} \left[\frac{(1 + \mu_1(v_i) - \gamma_1(v_i))}{2} \right] + \sum_{v_i,v_j \in E} \left[\frac{(1 + \mu_2(v_i,v_j) - \gamma_2(v_i,v_j))}{2} \right] \right|$$

Definition 2.7. [4] The **fuzzy vertex cardinality** of G is defined by

$$p = |V| = \left| \sum_{V_i \in V} \left[\frac{(1 + \mu_1(v_i) - \gamma_1(v_i))}{2} \right] \right| \text{ for all } v_i \in V.$$

Definition 2.8. [4] Let G = (V,E) be an IFG. Then the **order** of G is defined to be O(G) = $(O_\mu(G), O_\gamma(G))$ where $O_\mu(G) = \sum_{v_i \in V} \mu_1(v_i)$ and $O_\gamma(G) = \sum_{v_i \in V} \gamma_1(v_i)$

Definition 2.9. [4] The **fuzzy edge cardinality** of G is defined by

$$q = |E| = \left| \sum_{v_i,v_j \in E} \left[\frac{(1 + \mu_2(v_i,v_j) - \gamma_2(v_i,v_j))}{2} \right] \right| \text{ for all } (v_i, v_j) \in E.$$

Definition 2.10. [4] The **Size** of G is defined to be S(G) = $(S_\mu(G), S_\gamma(G))$ where $S_\mu(G) = \sum_{i \ne j} \mu_2(v_i,v_j)$ and $S_\gamma(G) = \sum_{i \ne j} \gamma_2(v_i,v_j)$

Definition 2.11. [4] Let G =(V, E) be an IFG. The μ-degree of a vertex v_i is $d\mu(v_i) = \sum_{(v_i,v_j)\in E} \mu_2(v_i, v_j)$. The γ-degree of a vertex v_i is $d\gamma(v_i) = \sum_{(v_i,v_j)\in E} \gamma_2(v_i, v_j)$.

The **degree of a vertex** is $d(v_i) = [\sum_{(v_i,v_j)\in E} \mu_2(v_i, v_j), \sum_{(v_i,v_j)\in E} \gamma_2(v_i, v_j)]$ and $\mu_2(v_i, v_j) = \gamma_2(v_i, v_j) = 0$ for $v_iv_j \notin E$.
The **minimum degree** of G is $\delta(G) = \{\min(d\mu(v_i)), \min(d_\gamma(v_i)) | v_i \in V\}$.
The **maximum degree** of G is $\Delta(G) = \{\max(d\mu(v_i)), \max(d_\gamma(v_i)) | v_i \in V\}$

Definition 2.12. [3] The **degree of a vertex** v in an IFG G = (V, E) is defined to be sum of the membership values of the strong arcs incident at v. It is denoted by W(G).

Definition 2.13. [3] Let G : $[(\mu_1(v_i), \gamma_1(v_i)), (\mu_2(v_i, v_j), \gamma_2(v_i, v_j))]$ be an IFG on G^*: (V,E). If $d\mu(v_i) = k_i$ and $d_\gamma(v_j) = k_j$ for all v_i, $v_j \in V$ i.e the graph is called as **(k_i, k_j)-IFG** (or) c**onstant IFG of degree (k_i, k_j)**.

Definition 2.10. [3] Let G be an IFG. The total degree of a vertex v $\in$ V is defined as

$$td(v) = \left[\sum_{v_1v_2\in E} d_{\mu_2}(v_i) + \mu_1(v_i),\ \sum_{v_1v_2\in E} d_{\gamma_2}(v_i) + \gamma_1(v_i) \right]$$

If each vertex of G has the same total degree (r_1, r_2), then G is said to be an **IFG of total degree (r_1, r_2)** or a **(r_1, r_2)-totally constant IFG.**

Definition 2.15. [5]Let G = (V,E) be an IFG on V. Let u, v $\in$ V, we say that **u dominates v** in G if there exists a strong arc between them. A subset S of V is called a **dominating set** in G if for every v$\in$ V-S, there exists u$\in$ S such that u dominates v.

Definition 2.16. [5] A dominating set S of an IFG is said to be **minimal dominating set** if no proper subset of S is a dominating set.

Definition 2.17. [7] A dominating set P is an IFG G = (V,E) is called **Perfect dominating set** (PDS) in IFG if for every vertex v$\in$ V-P, is dominated by exactly one vertex of P.

Definition 2.18. [7] A perfect dominating set P is an IFG G = (V,E) is said to be **minimal perfect dominating set** if for each u$\in$ P, P-{u} is not a perfect dominating set in IFG.

Definition 2.19. [7] Minimum fuzzy cardinality among all minimal perfect dominating set in an IFG is called the **perfect domination number** of an IFG, and is denoted by $\gamma_{pif}(G)$ or simply γ_{pif} .

Definition 2.20. [7] A perfect dominating set P with minimum fuzzy cardinality equal to $\gamma_{pif}(G)$ is called the **minimum perfect dominating set** and is denoted by γ_{pif}-set in intuitionistic fuzzy graph.

3. Dominating set in constant intuitionistic fuzzy graph

In this section, the new concept of dominating set in constant intuitionistic fuzzy graph(IFG) of degree (k_i , k_j) are introduced.

Definition 3.1. Let G = (V, E) be a constant intuitionistic fuzzy graph of degree (k_i , k_j) on V. Let $u,v \in V$, we say that u dominates v in G if there exists a strong arc between them.

Definition 3.2. A subset D of V is said to be a dominating set in G if for every $v \in V-D$, there exists $u \in D$ such that u dominates v.

Definition 3.3. A dominating set D of a constant intuitionistic fuzzy graph of degree (k_i , k_j) is said to be **minimal dominating set** if no proper subset of D is a dominating set.

Definition 3.4. Minimum fuzzy cardinality among all minimal dominating set in a constant intuitionistic fuzzy graph of degree (k_i , k_j) is called the **domination number** of a constant intuitionistic fuzzy graph of degree (k_i , k_j), and is denoted by $\gamma_{dcif}(G)$ or simply γ_{dcif} .

Example 3.5. Let G be a constant intuitionistic fuzzy graph of degree (k_i , k_j).

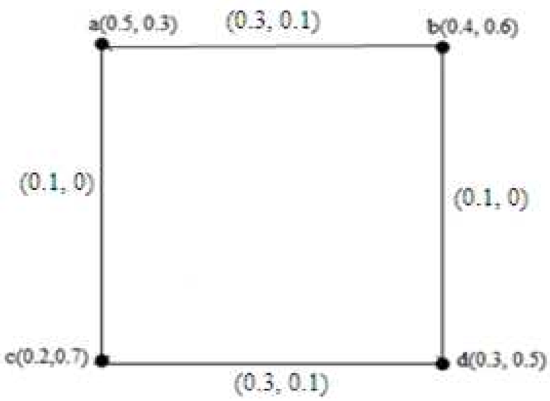

Figure 1:

Here, minimal dominating sets are {a, c}, {a, d}, {b, c}, {b, d}
Minimum dominating set = {b, c}
Domination number = 0.65.

4. Perfect dominating set in constant intuitionistic fuzzy graph

Perfect Domination in Constant Intuitionistic Fuzzy Graph of Degree (k_i,k_j)

In this section, the new concept of perfect dominating set in constant intuitionistic fuzzy graph(IFG) of degree (k_i, k_j) are introduced. Let G=(V,E) with $p \leq q$ be considered throughout this section.

Definition 4.1. Let G = (V,E) be a constant intuitionistic fuzzy graph of degree (k_i , k_j). A dominating set P of G is called **Perfect dominating set** (PDS) in G if for every vertex $v \in V-P$ is dominated by exactly one vertex of P.

Definition 4.2. Let G = (V,E) be a constant intuitionistic fuzzy graph of degree (k_i , k_j).
A Perfect dominating set P of G is said to be **minimal perfect dominating set** if for each $u \in P$, P-{u} is not a perfect dominating set in constant IFG of degree (k_i, k_j).

Definition 4.3. Minimum fuzzy cardinality among all minimal perfect dominating set in Constant IFG of degree (k_i , k_j) is called the **perfect domination number** of constant IFG, and is denoted by $\gamma_{pcif}(G)$ or simply γ_{pcif} .

Definition 4.4. A perfect dominating set P with minimum cardinality equal to $\gamma_{pcif}(G)$ is called the **minimum perfect dominating set** and is denoted by γ_{pcif} −set in constant intuitionistic fuzzy graph of degree (k_i, k_j).

Example 4.5. Let G be a constant intuitionistic fuzzy graph of degree (k_i, k_j).

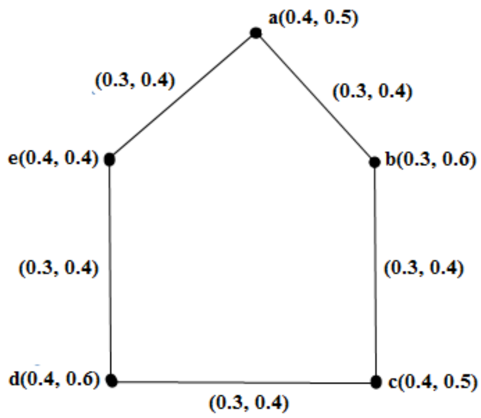

Figure 2:

Here perfect dominating sets are exists.
Perfect dominating sets are {a, b, c}, {b, c, d}, {c, d, e}, {a, d, e}.
Minimal perfect dominating set = {b, c, d}.
Perfect domination number $\gamma_{pcif}(G)$ = 1.2.

Theorem 4.6. Let G= (V, E) be a constant intuitionistic fuzzy graph of degree (k_i, k_j) without isolated vertices and P is a minimal perfect dominating set. Then V-P is a dominating set of G.

Proof: Let P be a minimal perfect dominating set of G. Consider v be any vertex of P. There is a vertex d∈N(v), v must be dominated by exactly one vertex in P-{v} which is also a dominating set, since G has no isolated vertices. Thus every vertex in P is dominated by atleast one vertex in V-P, and V-P is a dominating set.

Theorem 4.7. Let G= (V,E) be a constant intuitionistic fuzzy graph of degree (k_i, k_j) where crisp graph G^* is an odd cycle. If (μ_2, γ_2) is a constant function then perfect dominating set P exists for constant intuitionistic fuzzy graph of degree (k_i, k_j)

Proof: Assume that G is an intuitionistic fuzzy graph where crisp graph G^* is an odd cycle (that is, Let $e_1, e_2 \ldots\ldots e_{2n+1}$ be the edges of even cycle G^* respectively we have $\mu_2(e_i) = \begin{cases} c_1 & if\ i\ is\ odd \\ k_1 - c_1 & if\ i\ is\ even \end{cases}$ similarly, $\mu_2(e_i) = \begin{cases} c_2 & if\ i\ is\ odd \\ k_2 - c_2 & if\ i\ is\ even \end{cases}$)

Consider (μ_2, γ_2) is a constant function say μ_2 = membership value = c_1 and γ_2 = non membership value = c_2 for all $(v_i v_j)$∈E, then $d_\mu(v_i)$ = twice the membership values and $d_\gamma(v_i)$ = twice the non-membership values for all v_i∈V.(Since, if e_1 and e_{2n+1} incident at a vertex v_1 then $d(e_1)+d(e_{2n+1})= c_1+ c_1=2c_1$). So G is a constant intuitionistic fuzzy graph of degree (k_i, k_j). Here, every arc is a strong arc in this constant intuitionistic fuzzy graph of degree (k_i, k_j), since, (μ_2, γ_2) is a constant function. Also if for every vertex v∈ V-P is dominated by exactly one vertex of P. That is, perfect dominating set P exists for constant intuitionistic fuzzy graph of degree (k_i, k_j).

Theorem 4.8. Let G be an intuitionistic fuzzy graph where crisp graph G^* is an even cycle. Then G is a constant intuitionistic fuzzy graph of degree (k_i, k_j) if either (μ_2, γ_2) is a constant function or alternate edges have same membership values and non-membership values then P is a perfect dominating set of G.

Proof: Assume that G is an intuitionistic fuzzy graph where crisp graph G^* is an even cycle (that is, Let $e_1, e_2 \ldots\ldots e_{2n}$ be the edges of even cycle G^* respectively we have $\mu_2(e_i) = \begin{cases} c_1 & if\ i\ is\ odd \\ k_1 - c_1 & if\ i\ is\ even \end{cases}$ similarly, $\mu_2(e_i) = \begin{cases} c_2 & if\ i\ is\ odd \\ k_2 - c_2 & if\ i\ is\ even \end{cases}$)

and consider (μ_2, γ_2) is a constant function say $\mu_2 = c_1$ and $\gamma_2 = c_2$ for all $(v_i v_j)$∈E, then $d_\mu(v_i) = 2c_1$ and $d_\gamma(v_i) = 2c_2$ for all v_i∈V. So, G is a constant intuitionistic fuzzy graph of degree (k_i, k_j). Here, every arc is a strong arc in this constant intuitionistic fuzzy graph of degree (k_i, k_j), since, (μ_2, γ_2) is a constant function. Also if for every vertex v∈ V-P is dominated by exactly one vertex of P. That is, perfect dominating set P exists for constant intuitionistic fuzzy graph of degree (k_i, k_j) . Therefore, If $(\mu_2, \gamma_2)$is a constant function then P is a perfect dominating set of a constant intuitionistic fuzzy graph of degree (k_i, k_j).

If (μ_2, γ_2) are alternate edges have same membership values and non-membership values ($c_1 \neq k_1-c_1$) and let G be a constant intuitionistic fuzzy graph of degree (k_i, k_j) . It is clear that, every arc is a strong arc in G. So, perfect dominating set P exists for constant intuitionistic fuzzy graph of degree (k_i, k_j) .

Theorem 4.9. For a constant IFG of degree (k_i, k_j), then $\gamma_{pcif}(G) \leq$ p $\leq$ q.

Proof: Let p is the sum of vertex fuzzy cardinality of a constant IFG but need not be a minimum of a perfect domination number of a constant IFG. $\gamma_{pcif}(G)$ is a perfect domination number of a constant IFG is less than or equal to sum of vertex cardinality of a perfect dominating constant IFG. That is, $\gamma_{pcif}(G) \leq$ p, q is a sum of edge fuzzy cardinality of a perfect domination in constant IFG but need not be a minimum of sum of vertex fuzzy cardinality of a perfect domination of a constant IFG then sum of vertex cardinality is less than or equal to sum of edge fuzzy cardinality of a perfect domination of a constant IFG. That is p $\leq$ q. Hence, $\gamma_{pcif}(G) \leq$ p $\leq$ q.

Theorem 4.10. For a constant IFG of degree (k_i, k_j), then W(G) $\leq$ O(G)$\leq$S(G).

Proof: Let O(G) is the order of fuzzy cardinality of a constant IFG but need not be a minimum of a weighted perfect domination number of a constant IFG. W(G) is a weighted perfect domination number of a constant IFG is less than or equal to the order of fuzzy cardinality of a perfect dominating constant IFG. That is, W(G) $\leq$ O(G) and S(G) is the size of fuzzy cardinality of a perfect domination in constant IFG but need not be a minimum of order of fuzzy cardinality of a perfect domination of a constant IFG, then order of fuzzy cardinality is less than or equal to size of fuzzy cardinality of a perfect domination of a constant IFG. That is O(G)$\leq$ S(G). Hence, W(G) $\leq$ O(G)$\leq$ S(G).

Theorem 4.11. For a constant IFG of degree (k_i, k_j), then $|O_\gamma - s_\gamma| \leq \gamma_{pcif}(G) \leq |O_\mu - s_\mu|$.

Proof: Let $\gamma_{pcif}(G)$ is a perfect domination number of a constant IFG but need not be $|O_\gamma - s_\gamma|$ of a constant IFG. $|O_\gamma - s_\gamma|$is less than or equal to the perfect domination number $\gamma_{pcif}(G)$ of a constant IFG. That is, $|O_\gamma - s_\gamma| \leq \gamma_{pcif}(G)$ and $|O_\mu - s_\mu|$ is a constant IFG but need not be a perfect domination number $\gamma_{pcif}(G)$ of a constant IFG, then $\gamma_{pcif}(G)$ is a perfect domination number $\gamma_{pcif}(G)$ less than or equal to $|O_\mu - s_\mu|$a constant IFG. That is $\gamma_{pcif}(G) \leq |O_\mu - s_\mu|$. Hence, $|O_\gamma - s_\gamma| \leq \gamma_{pcif}(G) \leq |O_\mu - s_\mu|$.

Theorem 4.12. For a constant IFG of degree (k_i, k_j), then $\gamma_{pcif}(G) \leq \frac{p}{2}$.

Proof: Let $\frac{p}{2}$ is the fuzzy vertices of a constant IFG but need not be a perfect domination number $\gamma_{pcif}(G)$ of a constant IFG. Perfect domination number $\gamma_{pcif}(G)$ of a constant IFG is less than or equal to the $\frac{p}{2}$ is the fuzzy vertices of a constant IFG. That is, $\gamma_{pcif}(G) \leq \frac{p}{2}$.

Theorem 4.13. For a constant IFG of degree (k_i, k_j), then $\left(\frac{p-\Delta_\mu}{2}\right) \leq \gamma_{pcif}(G) \leq 3(q - \Delta_\mu)$.

Proof: Let $\gamma_{pcif}(G)$ is the perfect domination number of a constant IFG but need not be a$\left(\frac{p-\Delta_\mu}{2}\right)$ a fuzzy vertices of a constant IFG. $\left(\frac{p-\Delta_\mu}{2}\right)$is the fuzzy vertices of a constant IFG is less than or equal to the perfect domination number $\gamma_{pcif}(G)$ of a constant IFG. That is, $\left(\frac{p-\Delta_\mu}{2}\right) \leq \gamma_{pcif}(G)$ and $3(q-\Delta_\mu)$ is the fuzzy vertices of a constant IFG but need not be a perfect domination number $\gamma_{pcif}(G)$ of a constant IFG , then $\gamma_{pcif}(G)$ is the perfect domination number of a constant IFG is less than or equal to $3(q-\Delta_\mu)$ is the fuzzy vertices of a constant IFG. That is, $\gamma_{pcif}(G) \leq 3(q-\Delta_\mu)$. Hence, $\left(\frac{p-\Delta_\mu}{2}\right) \leq \gamma_{pcif}(G)$ $\leq 3(q-\Delta_\mu)$.

Theorem 4.14. For a constant IFG of degree (k_i, k_j), then$|O_\mu - \Delta_\mu| \leq \gamma_{pcif}(G) \leq |O_\gamma - \Delta_\mu|$.

Proof: Let $\gamma_{pcif}(G)$ is a perfect domination number of a constant IFG but need not be $|O_\mu - \Delta_\mu|$of a constant IFG. $|O_\mu - \Delta_\mu|$is less than or equal to the perfect domination number $\gamma_{pcif}(G)$ of a constant IFG. That is, $|O_\mu - \Delta_\mu| \leq \gamma_{pcif}(G)$ and $|O_\gamma - \Delta_\mu|$is a constant IFG but need not be a perfect domination number $\gamma_{pcif}(G)$ of a constant IFG, then $\gamma_{pcif}(G)$ is a perfect domination number $\gamma_{pcif}(G)$ less than or equal to$|O_\gamma - \Delta_\mu|$a constant IFG. That is $\gamma_{pcif}(G) \leq |O_\gamma - \Delta_\mu|$. Hence, $|O_\mu - \Delta_\mu| \leq \gamma_{pcif}(G) \leq |O_\gamma - \Delta_\mu|$.

Example 4.15. Let G be constant IFG of degree (k_i, k_j).

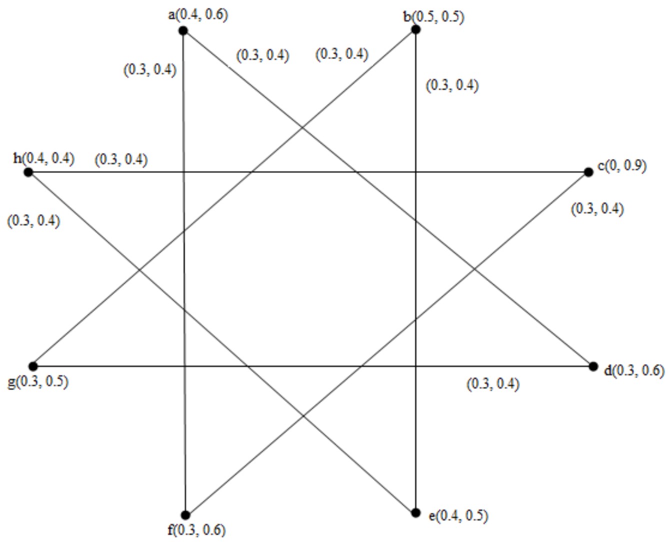

Figure 3:

Perfect dominating set of a constant IFG of degree (k_i, k_j).

Perfect domination number $\gamma_{pcif}(G)$ = 1.3; p = 3 ; q = 3.6 ; $\gamma_{pcif}(G) \le$ p $\le$ q

W(G) = (1, 2.4); O(G) = (2.5, 4.5); S(G) = (4.8, 5.6) ; W(G) $\le$ O(G)$\le$S(G)

$\left|O_\gamma - s_\gamma\right|$= 1.1; $\gamma_{pcif}(G)$ = 1.3; $\left|O_\mu - s_\mu\right|$= 2.3; $\left|O_\gamma - s_\gamma\right| \le \gamma_{pcif}(G) \le \left|O_\mu - s_\mu\right|$

$\gamma_{pcif}(G)$ = 1.3; $\frac{p}{2}$ = 1.5; $\gamma_{pcif}(G) \le \frac{p}{2}$

$\left(\frac{p-\Delta_\mu}{2}\right) = 0.03$; $\gamma_{pcif}(G)$ = 1.3 ; 3($q - \Delta_\mu$) = 3(1.2) = 3.6;

$\left(\frac{p-\Delta_\mu}{2}\right) \le \gamma_{pcif}(G) \le 3(\ q - \Delta_\mu)$

$\left|O_\mu - \Delta_\mu\right|$ = 0.1; $\gamma_{pcif}(G)$=1.3; $\left|O_\gamma - \Delta_\mu\right| = 2.1$; $\left|O_\mu - \Delta_\mu\right| \le \gamma_{pcif}(G) \le \left|O_\gamma - \Delta_\mu\right|$

5. Conclusion

In this paper, we have introduced the concept of dominating set, domination number, perfect dominating set and perfect domination number for constant intuitionistic fuzzy graph and some interesting properties of these new concepts are proved.

Acknowledgement. The authors of highly grateful to the referees for their valuable comments and suggestions for improving this paper.

REFERENCES

1. K.T.Atanassov and A.Shannon, On a generalization of intuitionistic fuzzy graphs, *NIFS*, 12(1) (2006) 24-29.
2. M.G.Karunambigai and R.Buvaneswari, Degrees in intuitionistic fuzzy graphs, *Annals of Fuzzy Mathematics and Informatics*, 10 (2016) 1-10.
3. M.G.Karumabigai and R.Buvaneswari, Constant intuitionistic fuzzy graphs, *NIFS*, 17 (2011) 37-47.
4. A. Nagoor Gani and S. Shajitha Begum, Degree, order and size in intuitionistic fuzzy grphs, *International Journal of Algorithm, Computing and Mathematics*, 3 (2010) 11-16.
5. R. Parvathi and G. Tamizhendhi, Domination in intuitionistic fuzzy graphs, *NIFS*, 16(2) (2010)15-16.
6. S.Revathi, C.V.R. Harinarayanan, and P.J.Jayalakshmi, Perfect dominating sets in fuzzy graphs, *IOSR Journal of Mathematics*, 8(3) (2013) 43-47.
7. S.Revathi, C.V.R.Harinarayanan and R.Muthuraj, Perfect domination in intuitionistic fuzzy graphs, *IOSR Journal of Mathematics*, 12(5) (2016) 37-41.
8. S.Sahoo and M.Pal, Different types of products on intuitionistic fuzzy graphs, *Pacific Science Review A; Natural Science and Engineering*, 17(3) (2015) 87-96.
9. S.Sahoo and M.Pal, Intuitionistic fuzzy competition graphs, *J. Appl. Math. Comput.*, 52(1) (2016) 37–57.
10. S.Sahoo and M.Pal, Product of intuitionistic fuzzy graphs and their degree, *Journal of Intelligent and Fuzzy Systems*, 32(1) (2017) 1059-1067.
11. S.Sahoo and M.Pal, Intuitionistic fuzzy tolerance graphs with application, *J. Appl. Math. Comput.*, 55 (2017) 495–511.