International J.Math. Combin. Vol.4(2021), 65-74

On Support Regular Interval-Valued Fuzzy Graphs

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Abstract: In this paper, support regular interval-valued fuzzy graphs and support totally regular interval-valued fuzzy graphs are defined. Comparative study between support regular interval-valued fuzzy graph and support totally regular interval-valued fuzzy graph is done. A necessary and sufficient condition under which they are equivalent is provided. Characterization of support regular interval-valued fuzzy graph in which underlying crisp graph is a cycle is investigated. Also, whether the results hold for support totally regular interval-valued fuzzy graphs is examined.

Key Words: Support(2-degree) of a vertex in fuzzy graph, interval-valued fuzzy graph.

AMS(2010): 05C12, 03E72, 05C72.

§1. Introduction

In this paper, we consider only finite, simple, connected graphs. We denote the vertex set and the edge set of a graph G by V (G) and E(G) respectively. The degree of a vertex v is the number of edges incident at v, and it is denoted by d(v). A graph G is regular if all its vertices have the same degree. The notion of fuzzy sets was introduced by Zadeh as a way of representing uncertainity and vagueness [29]. The first definition of fuzzy graph was introduced by Haufmann in 1973. In 1975, A. Rosenfeld introduced the concept of fuzzy graphs [9]. The theory of graph is an extremely useful tool for solving combinatorial problems in different areas. Irregular fuzzy graphs play a central role in combinatorics and theoretical computer science.In 1975, Zadeh introduced the notion of interval-valued fuzzy sets as an extension of fuzzy set [30] in which the values of the membership degree are intervals of numbers instead of the numbers. In 2011, Akram and Dudek [1] defined interval-valued fuzzy graphs and give some operations on them.

§2. Review of Literatures

Nagoorgani and Radha introduced the concept of degree, total degree, regular fuzzy graphs in 2008 [6]. Nagoorgani and Latha introduced the concept of irregular fuzzy graphs, neighbourly

[1]Received October 25, 2021, Accepted December 18, 2021.

irregular fuzzy graphs and highly irregular fuzzy graphs in 2012 [7]. N.R.Santhi Maheswari and C.Sekar introduced $(2, k)$-regular fuzzy graphs and totally $(2, k)$-regular fuzzy graphs, $(r, 2, k)$-regular fuzzy graphs, (m, k)-regular fuzzy graphs and (r, m, k)-regular fuzzy graphs [10, 14, 15, 16]. N.R.Santhi Maheswari and C. Sekar introduced 2-neighbourly irregular fuzzy graphs and m-neighbourly irregular fuzzy graphs [21, 13]. N.R.Santhi Maheswari and C.Sekar introduced an edge irregular fuzzy graphs, neighbourly edge irregular fuzzy graphs and strongly edge irregular fuzzy graph [17, 11, 18]. D.S.Cao, introduced 2-degree of vertex v is the the sum of the degrees of the vertices adjacent to v and it is denoted by t(v) [3]. A.Yu, M.Lu and F.Tian, introduced pseudo degree (average degree) of a vertex v is $(t(v))/d(v)$, where $d(v)$ is the number of edges incident at the vertex v [2]. N.R.Santhi Maheswari and C.Sekar introduced 2-degree of a vertex in fuzzy graphs , pseudo degree of a vertex in fuzzy graph and pseudo regular fuzzy graphs [12]. N.R Santhi Maheswari and M.Sutha introduced concept of pseudo irregular fuzzy graphs and highly pseudo irregular fuzzy graphs [19]. N.R.Santhi Maheswari and M.Rajeswari introduced the concept of strongly pseudo irregular fuzzy graphs [20]. N.R.Santhi Maheswari and V.Jeyapratha introduced the concept of neighbourly pseudo irregular fuzzy graphs [22]. N.R.Santhi Maheswari and K.Amutha introduced support neighbourly edge irregular graphs and 1-neighbourly edge irregular graphs, Pseudo Edge Regular and Pseudo Neighbourly edge irregular graphs [23, 24, 25]. J.Krishnaveni and N.R.Santhi Maheswari introduced support and total support of a vertex in fuzzy graphs, support neighbourly irregular fuzzy graphs and support neighbourly totally irregular fuzzy graphs []4. N.R.Santhi Maheswari and K.Priyadharshini introduced support highly irregular fuzzy graphs [26]. These motivate us to introduce support regular interval-valued fuzzy graphs and support totally regular interval-valued fuzzy graphs and discussed some of its properties.

§3. Preliminaries

We present some known definitions and results for ready reference to go through the work presented in this paper. By graph, we mean a pair $G^* = (V, E)$, where V is the set and E is a relation on V. The elements of V are vertices of G^* and the elements of E are edges of G^*.

Definition 3.1([3]) *The 2-degree (support) of v is defined as the sum of the degrees of the vertices adjacent to v and it is denoted by $t(v)$.*

Definition 3.2([2]) *The average (pseudo) degree of v is defined as $t(v))/(d(v)$, where $t(v)$ is the 2-degree of v and $d(v)$ is the degree of v and it is denoted by $da(v)$.*

Definition 3.3([2]) *A graph is called pseudo-regular if every vertex of G has equal (pseudo) average-degree.*

Definition 3.4([6]) *A fuzzy graph $G : (\sigma, \mu)$ is a pair of functions (σ, μ), where $\sigma : V \to [0, 1]$ is a fuzzy subset of a non-empty set V and $\mu : VXV \to [0, 1]$ is a symmetric fuzzy relation on σ such that for all u, v in V, the relation $\sigma(uv) \leq \sigma(u)\Lambda\sigma(v)$ is satisfied. A fuzzy graph G is called complete fuzzy graph if the relation $\sigma(uv) = \sigma(u)\Lambda\sigma(v)$ is satisfied.*

Definition 3.5([6]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. The degree of a vertex u in G is denoted by $d(u)$ and is defined as $d(u) = \sum \mu(uv)$, for all $uv \in E$.*

Definition 3.6([6]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. The total degree of a vertex u in G is denoted by $td(u)$ and is defined as $td(u) = d(u) + \sigma(u)$, for all $u \in V$.*

Definition 3.7([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be an irregular fuzzy graph, if there is a vertex which is adjacent to the vertices with distinct degrees.*

Definition 3.8([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a totally irregular fuzzy graph if there is a vertex which is adjacent to the vertices with distinct total degrees.*

Definition 3.9([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a neighbourly irregular fuzzy graph if every two adjacent vertices of G have distinct degrees.*

Definition 3.10([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a neighbourly totally irregular fuzzy graph if every two adjacent vertices have distinct total degrees.*

Definition 3.11([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a highly irregular fuzzy graph if every vertex of G is adjacent to vertices with distinct degrees.*

Definition 3.12([7]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a highly totally irregular fuzzy graph if every vertex of G is adjacent to vertices with distinct total degrees.*

Definition 3.13([6]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a regular fuzzy graph if all the vertices of G have same degree.*

Definition 3.14([6]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. Then G is said to be a totally regular fuzzy graph if all the vertices of G have same total degree.*

Definition 3.15([4]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^* : (V, E)$. The support (2-degree) of a vertex v in G is defined as the sum of degrees of the vertices adjacent to v and is denoted by $s(v)$. That is, $s(v) = \sum dG(u)$, where $dG(u)$ is the degree of the vertex u which is adjacent with the vertex v.*

Definition 3.16([4]) *Let $G : (\sigma, \mu)$ be a fuzzy graph on $G^*(V, E)$. The total support of a vertex v in G is denoted by $ts(v)$ and is defined as $ts(v) = s(v) + \sigma(v)$, for all $v \in V$.*

Definition 3.17([4]) *A graph G is said to be a support neighbourly irregular fuzzy graph if every two adjacent vertices of G have distinct supports.*

Definition 3.18([4]) *A graph G is said to be a support neighbourly totally irregular graph if every two adjacent vertices of G have distinct total supports.*

Definition 3.19([4]) *A graph G is said to be a support highly irregular fuzzy graph if every vertex of G is adjacent to the vertices having distinct supports.*

Definition 3.20([26]) *A graph G is said to be a support highly totally irregular graph if every vertex of G is adjacent to the vertices having distinct total supports.*

Definition 3.21 *An interval-valued fuzzy graph with an underlying set V is defined to be the pair (A, B), where $A = (\mu_A^-, \mu_A^+)$ is an interval-valued fuzzy set on V such that $\mu_A^-(x) \leq \mu_A^+(x)$, for all $x \in V$ and $B = (\mu_B^-, \mu_B^+)$ is an interval-valued fuzzy set on E such that $\mu_B^-(x, y) \leq min((\mu_A^-(x), \mu_A^-(y)))$ and $\mu_B^+(x, y) \leq min((\mu_A^+(x), \mu_A^+(y)))$, for all edge $xy \in E$. Hence A is called an interval-valued fuzzy vertex set on V and B is called an interval-valued fuzzy edge set on E.*

Definition 3.22 *Let $G : (A, B)$ be an interval-valued fuzzy graph. The negative degree of a vertex $u \in G$ is defined as $d_G^-(u) = \sum \mu_B^-(u, v)$, for $uv \in E$. The positive degree of a vertex $u \in G$ is defined as $d_G^+(u) = \sum \mu_B^+(u, v)$, for $uv \in E$ and $\mu_B^+(uv) = \mu_B^-(uv) = 0$ if uv not in E. The degree of a vertex u is defined as $d_G(u) = (d_G^-(u), d_G^+(u))$.*

Definition 3.23 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$. The total degree of a vertex $u \in V$ is denoted by $td_G(u)$ and is defined as $td_G(u) = (td_G^-(u), td_G^+(u))$, where $td_G^-(u) = \sum \mu_B^-(u, v) + (\mu_A^-(u))$ and $td_G^+(u) = \sum \mu_B^+(u, v) + (\mu_A^+(u))$.*

Definition 3.24 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$, where $A = (\mu_A^-, \mu_A^+)$ and $B = (\mu_B^-, \mu_B^+)$ be two interval-valued fuzzy sets on a non-empty set V and $E \subseteq V \times V$ respectively. Then G is said to be regular interval-valued fuzzy graph if all the vertices of G has same degree (c_1, c_2).*

Definition 3.25 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$, then G is said to be totally regular interval-valued fuzzy graph if all the vertices of G has same total degree (c_1, c_2).*

§4. Support Regular Interval-Valued Fuzzy Graphs and the Totally Support Regular Interval-Valued Fuzzy Graphs

In this section, we define support regular interval-valued fuzzy graph and totally support regular interval-valued fuzzy graph and discussed about its properties.

Definition 4.1 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^* : (V, E)$. The support of a vertex a in G is denoted by $s_G(a)$ and is defined as $s_G(a) = (s_G^-(a), s_G^+(a))$, where $s_G^-(a) = \sum_{u \in N(a)} d_G^-(a)$ and $s_G^+(a) = \sum_{u \in N(a)} d_G^+(a)$, for all $a \in V$.*

Definition 4.2 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^* : (V, E)$. If $s_G(v) = (k_1, k_2)$, for all v in V; then G is called (k_1, k_2) - support regular interval-valued fuzzy graph.*

Example 4.3 Consider a fuzzy graph on graph on $G^*(V, E)$ following.

Figure 1

Here, $d_G(a) = (0.3, 0.6) = d_G(b) = d_G(c) = d_G(d)$. And, $s_G(a) = s_G(b) = s_G(c) = s_G(d) = (0.9, 1.8)$, for all $a \in V$. Hence G is $(0.9, 1.8)$- support regular interval-valued fuzzy graph.

Definition 4.3 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V,E)$. The total support of a vertex a in G is denoted by $ts_G(a)$ and is defined as $ts_G(a) = (ts_G^-(a), ts_G^+(a)) = (s_G^-(a) + \mu_A^-(a), s_G^+(a) + \mu_A^+(a))$ for all $a \in V$.*

Definition 4.4 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V,E)$. If all the vertices of G have the same total support (k_1, k_2), then G is said to be a (k_1, k_2)- support totally regular interval-valued fuzzy graph.*

Example 4.6 Consider an interval-valued fuzzy graph $G : (A, B)$ on graph on $G^*(V, E)$ following.

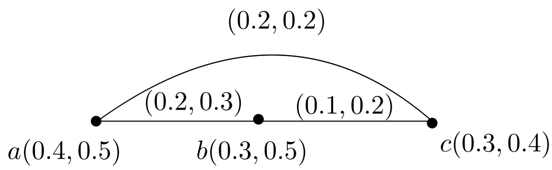

Figure 2

Here, $ts_G(a) = ts_G(b) = ts_G(c) = (1, 1.4)$. Hence G is a $(1, 1.4)$- totally support regular interval-valued fuzzy graph.

Remark 4.7 *A support regular interval-valued fuzzy graph need not be totally support regular interval-valued fuzzy graph.*

Example 4.8 Consider an interval-valued fuzzy graph $G : (A, B)$ on a crisp graph $G^*(V, E)$.

Notice that in Figure 1, $s_G(a) = s_G(b) = s_G(c) = s_G(d) = (0.9, 1.8)$. But $ts_G(a) = (1.3, 2.3), ts_G(b) = (1.1, 2.4), ts_G(c) = (1.2, 2.2), ts_G(d) = (1.2, 2.3)$. Hence support regular interval-valued fuzzy graph need not be totally support regular interval-valued fuzzy graph.

Remark 4.9 *A totally support regular interval-valued fuzzy need not be a support regular interval-valued fuzzy graph.*

Example 4.10 Consider an interval-valued fuzzy graph $G : (A, B)$ on graph $G^*(V, E)$.

Notice that in Figure 2, $s_G(a) = (0.6, 0.9), s_G(b) = (0.7, 0.9), s_G(c) = (0.7, 1)$. But $ts_G(a) = ts_G(b) = ts_G(c) = (1, 1.4)$. Hence totally support regular interval-valued fuzzy graph need not be support regular interval-valued fuzzy graph.

Example 4.11 A graph which is both support regular interval-valued fuzzy graph and support totally regular interval-valued fuzzy graph is given below.

Consider an interval-valued fuzzy graph $G : (A, B)$ on graph $G^*(V, E)$ following.

Figure 3

Here, the graph is $(0.6, 1.2)$- support regular interval-valued fuzzy graph and $(1, 1.7)$-totally support regular interval-valued fuzzy graph.

Theorem 4.12 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G * (V, E)$. Then $A(u) = (\mu_A^-(u), \mu_A^+(u))$, for all $u \in V$ is a constant function if and only if the following are equivalent:*

(i) G is a support regular interval-valued fuzzy graph;

(ii) G is a support totally regular interval-valued fuzzy graph.

Proof Assume that $A(u) = (\mu_A^-(u), \mu_A^+(u)) = (c_1, c_2)$, for all $u \in V$, where c_1 and c_2 are constant. Suppose G is a support regular interval-valued fuzzy graph. Then $s_G(u) = (k_1, k_2)$, for all $u \in V$. Now, $ts_G(u) = s_G(u) + (\mu_A^-(u), \mu_A^+(u)) = (k_1, k_2) + (c_1, c_2) = (k_1 + c_1, k_2 + c_2)$, for all $u \in V$. Hence G is a support totally regular fuzzy graph. Thus $(i) \Rightarrow (ii)$ is proved. Suppose G is a support totally regular fuzzy graph. Then $ts_G(u) = (k_1, k_2)$ for all $u \in V$ $\Rightarrow\ s_G(u) + (\mu_A^-(u), \mu_A^+(u)) = (k_1, k_2)$, for all $u \in V \Rightarrow\ s_G(u) + (c_1, c_2) = (k_1, k_2)$, for all $u \in V$ $\Rightarrow s_G(u) = (k_1 - c_1, k_2 - c_2)$, for all $u \in V$. Hence G is a support regular fuzzy graph. Thus $(ii) \Rightarrow\ (i)$ is proved. Hence (i) and (ii) are equivalent.

Conversely, suppose (i) and (ii) are equivalent. Let G be a support regular interval-valued fuzzy graph and a support totally regular interval-valued fuzzy graph. Then $s_G(u) = (k_1, k_2)$ and $ts_G(u) = (c_1, c_2)$, for all $u \in V$. Now $ts_G(u) = (c_1, c_2)$ for all $u \in V \Rightarrow s_G(u) + (\mu_A^-(u), \mu_A^+(u)) = (c_1, c_2)$, for all $u \in V \Rightarrow (k_1, k_2) + (\mu_A^-(u), \mu_A^+(u)) = (c_1, c_2)$, for all $u \in V \Rightarrow (\mu_A^-(u), \mu_A^+(u)) = (c_1, c_2) - (k_1, k_2) = (c_1 - k_1, c_2 - k_2)$, for all $u \in V$. Hence $A = (\mu_A^-(u), \mu_A^+(u))$ is a constant function. □

Theorem 4.13 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$. If G is both support regular and support totally regular interval-valued fuzzy graph then $A(u) = (\mu_A^-(u), \mu_A^+(u))$, for all $u \in V$ is a constant function.*

Proof Assume that G is both support regular and support totally regular interval-valued fuzzy graph. Then $s_G(u) = (c_1, c_2)$ and $ts_G(u) = (k_1, k_2)$, for all $u \in V$. Now,

$$\begin{aligned} ts_G(u) = (k_1, k_2) &\Rightarrow s_G(u) + (\mu_A^-(u), \mu_A^+(u)) = (k_1, k_2) \\ &\Rightarrow (c_1, c_2) + (\mu_A^-(u), \mu_A^+(u)) = (k_1, k_2) \\ &\Rightarrow (\mu_A^-(u), \mu_A^+(u)) = (k_1, k_2) - (c_1, c_2) = (k_1 - c_1, k_2 - c_2) = \text{constant}. \end{aligned}$$

Hence, $(\mu_A^-(u), \mu_A^+(u))$ is a constant function. □

Remark 4.14 The converse of the theorem 4.13 need not be true.

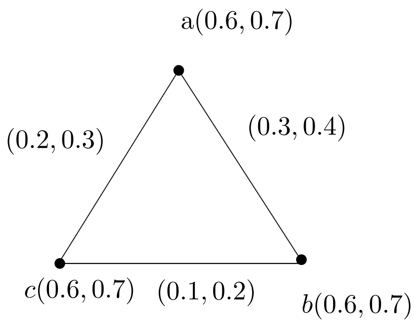

Figure 4

Here, $s_G(a) = (0.7, 1.1), s_G(b) = (0.8, 1.2), s_G(c) = (0.9, 1.3)$, $ts_G(a) = (1.3, 1.8), ts_G(b) = (1.4, 1.9), ts_G(c) = (1.5, 2)$ and $A = (\mu_A^-(u), \mu_A^+(u))$, for all $u \in V$ is a constant function. But G is neither support regular interval-valued fuzzy graph nor a support totally regular interval-valued fuzzy graph.

Theorem 4.15 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$, a cycle of length n. If $B = (\mu_B^-(uv), \mu_B^+(uv))$, for all $uv \in E$, is a constant function, then G is a support regular interval-valued fuzzy graph.*

Proof If $B = (\mu_B^-(uv), \mu_B^+(uv))$,for all $uv \in E$, is a constant function say $(\mu_B^-(uv), \mu_B^+(uv)) = (c_1, c_2)$; for all $uv \in E$. Then $s_G(u) = 4(c_1, c_2)$, for all $u \in V$: Hence G is $4(c_1, c_2)$- support regular interval-valued fuzzy graph. □

Remark 4.16 *The converse of Theorem* 4.15 *needs not be true.*

Example 4.17 Consider an interval-valued fuzzy graph $G : (A, B)$ on $G^* : (V, E)$ following.

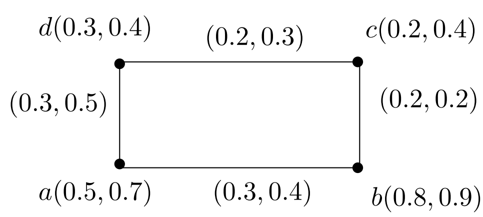

Figure 5

Here, B is not constant. But $s_G(a) = s_G(b) = s_G(c) = s_G(d) = (1, 1.4)$, for all $u \in V$. Therefore the graph is $(1, 1.4)$- support regular interval-valued fuzzy graph.

Theorem 4.18 *Let $G : (A, B)$ be an interval-valued fuzzy graph on $G^*(V, E)$, an even cycle of length n. If the alternate edges have same membership values, then G is a support regular interval-valued fuzzy graph.*

Proof If the alternate edges have the same membership values, then

$$\mu(ei) = \begin{cases} (c_1, c_2), & \text{if } i \text{ is odd;} \\ (k_1, k_2), & \text{if } i \text{ is even.} \end{cases}$$

Now, if $(c_1, c_2) = (k_1, k_2)$, then B is a constant function. So, by above theorem G is a support regular fuzzy graph. If $(c_1, c_2) \neq (k_1, k_2)$; then $dG(v) = (c_1, c_2)+(k_1, k_2) = (c_1+k_1, c_2+k_2)$ for all $v \in V$. So, $s(v) = 2(c_1, c_2) + 2(k_1, k_2)$. Hence, G is a $2(c_1 + k_1, c_2 + k_2)$-support regular interval-valued fuzzy graph. □

Remark 4.19 *The above theorem does not hold for a support totally regular interval-valued fuzzy graph.*

Example 4.20 Consider an interval-valued fuzzy graph on $G^*(V, E)$ following.

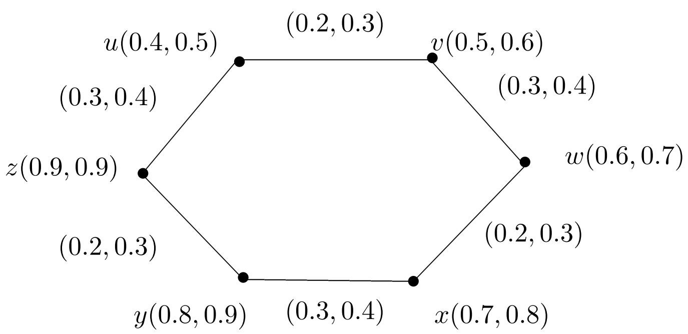

Figure 6

Here, $s_G(u) = (1, 1.4)$ for all $u \in V$, $ts_G(u) = (1.4, 1.9) \neq (1.5, 2) = ts_G(v)$ and the alternate edges have the same membership values, but G is not a support totally regular fuzzy graph.

Proposition 4.21 *If v is a pendant vertex, then support of a vertex v is the degree of the vertex which is adjacent with v. (or) If v is a pendant vertex then $s_G(v) = dG(u)$, where u is the vertex adjacent with v.*

Theorem 4.22 *If G is a (k_1, k_2)-regular interval-valued fuzzy graph on $G^*(V, E)$, an r-regular graph then $s_G(v) = rd_G(v)$, for all $v \in G$.*

Proof Let G be a (k_1, k_2) - regular interval valued fuzzy graph on $G^*(V, E)$, an r-regular graph. Then $d_G(v) = (k_1, k_2)$, for all $v \in G$ and $dG^*(v) = r$, for all $v \in G$. So, $s_G(v) =$

$\sum d_G(v_i)$, where each v_i (for $i = 1, 2, \cdots, r$) is adjacent with vertex $v \Rightarrow s_G(v) = \sum d_G(vi) = r(k_1, k_2) = rd_G(v)$. $\square$

Theorem 4.23 *Let G be an interval-valued fuzzy graph on $G^*(V, E)$, an r-regular graph. Then G is support regular interval-valued fuzzy graph if G is a regular interval-valued fuzzy graph.*

Proof Let G be a (k_1, k_2) - regular interval-valued fuzzy graph on $G^*(V, E)$, an r-regular graph. Then,

$\Rightarrow s_G(v) = rdG(v)$, for all $v \in G$

$\Rightarrow s(v) = r(k_1, k_2)$, for all $v \in G$

$\Rightarrow$ all the vertices have same support $r(k_1, k_2)$.

Hence G is an $r(k_1, k_2)$ - support regular interval-valued fuzzy graph. $\square$

References

[1] Akram, M. and W.A.Dudek, Interval-valued fuzzy graphs, *Computers Math Appl.,* 61(2011), 289-299.

[2] A.Yu, M.Lu and F.Tian, On the spectral radius of graphs, *Linear Algebra and Its Applications*, 387 (2004), 41-49.

[3] Dasong Cao, Bounds on eigen values and chromatic numbers, *Linear algebra and its Applications*,270(1998), 1-13.

[4] J.Krishnaveni and N.R.Santhi Maheswari, Support neighbourly Irregular fuzzy Graphs,*International Journal of Advanced Research in Engineering and Technology*, Vol.11, 1(2020), 147-154.

[5] R.Muneeswari and N.R.Santhi Maheswari,vSupport Edge Regular Fuzzy Graphs,*International Journal of Advanced Research in Engineering and Technology*, Vol.11, 1(2020), 184-193.

[6] A.Nagoor Gani and K.Radha, On regular fuzzy graphs, *Journal of Physical Sciences*, 12 (2008) 33-40.

[7] A.Nagoor Gani and S.R.Latha, On Irregular Fuzzy graphs, *Applied Mathematical Sciences*, 6 (2012) 517-523.

[8] K.Priyadharshini and N.R.Santhi Maheswari, A study on support regular graphs containing a given graph and its complement, *International Journal of Advanced Research in Engineering and Technology*, Vol.11, 2(2020), 369-378.

[9] A.Rosenfeld, Fuzzy graphs, In: L.A.Zadeh,K.S.Fu, M.Shimura, eds., *Fuzzy sets and Their Applications*, Academic Press (1975), 77-95.

[10] N.R.Santhi Maheswari and C.Sekar, On (2, k)- regular fuzzy graph and totally $(2, k)$-regular fuzzy graph, *International Journal of Mathematics and Soft Computing*, 4(2)(2014), 59-69.

[11] N.R.Santhi Maheswari and C.Sekar, On neighbourly edge irregular fuzzy graphs, *International Journal of Mathematical Archive*, 6(10)(2015), 224-231.

[12] N.R.Santhi Maheswari and C.Sekar, On pseudo regular fuzzy graphs, *Annals of Pure and Applied Mathematics*, 11(1)(2016), 105-113.

[13] N.R.Santhi Maheswari and C.Sekar, On m-neighbourly Irregular fuzzy graphs, *International Journal of Mathematics and Soft Computing*, 5(2)(2015), 145-153.

[14] N. R. Santhi Maheswari and C. Sekar, On $(r, 2, k)$- regular fuzzy graphs, *Journal of Combinatorial Mathematics and Combinatorial Computing*, 97(2016), 11-21.

[15] N. R. Santhi Maheswari and C. Sekar, On (m, k) -Regular fuzzy graphs, *International Journal of Mathematical Archieve*, 7(1)(2016), 1-7.

[16] N. R. Santhi Maheswari and C. Sekar, On (r, m, k) - Regular Fuzzy Graphs, *International J.Math.Combin.*, Vol.1(2016), 18-26.

[17] N. R. Santhi Maheswari and C. Sekar, On Edge Irregular Fuzzy Graphs ,*International Journal of Mathematics and Soft Computing*, Vol.6, 2(2016), 131 - 143.

[18] N. R. Santhi Maheswari and C. Sekar, On Strongly Edge Irregular fuzzy graphs, *Kragujevac Journal of Mathematics*, Vol.40, 1(2016), 125-135.

[19] N. R. Santhi Maheswari and M.Sudha, Pseudo irregular fuzzy graphs and highly pseudo irregular fuzzy graphs, *International Journal of Mathematical Archieve*, 7(4)(2016), 99-106.

[20] N.R.Santhi Maheswari and M.Rajeswari, On Strongly pseudo irregular fuzzy graphs, *International Journal of Mathemaical Archive*, 7(6)(2016), 145-151.

[21] N.R.Santhi Maheswari and C.Sekar, On 2-neighbourly irregular fuzzy graphs, *Utilitas Mathematica*, June 2018.

[22] N.R.Santhi Maheswari and V.Jeyapratha, On neighbourly pseudo irregular fuzzy graphs, *International Journal of Mathematical Combinatorics*, Vol.4(2018), 45-52.

[23] N. R. Santhi Maheswari and K. Amutha, Support neighbourly edge irregular graphs, *International Journal of Recent Technology and Engineering*, Vol 8, 3(2019), 5329-5332.

[24] N.R.Santhi Maheswari and K.Amutha, 1- Neighbourly edge irregular graphs, *Advances in Mathematics: Scientific Journal*, Special issue 3(2019), 200-207.

[25] N.R.Santhi Maheswari and K.Amutha, Pseudo edge regular and neighbourly pseudo edge irregular graphs, *Advances and Applications in Mathematical Sciences*(Communicated).

[26] N.R.Santhi Maheswari and K.Priyadharshini, Support highly irregular fuzzy graphs, *Advances and Applications in Mathematical Sciences* (Communicated).

[27] S.Sivabala and N.R.Santhi Maheswari, Support edge regular fuzzy graphs, *International Journal of Advanced Research in Engineering and Technology*, Vol.11, 1(2020), 172-183.

[28] D.Subburaj and N.R.Santhi Maheswari, Support edge regular fuzzy graphs,*International Journal of Advanced Research in Engineering and Technology*, Vol.11, 1(2020), 163-171.

[29] L.A. Zadeh, Fuzzy Sets, *Information and Control*, 8 (1965), 338-353.

[30] L.A. Zadeh, The concept of a linguistic and application to approximate reasoning, *Information Science*, 8 (1975), 199-249.