DOI : 10.15613/sijrs/2018/v5i1/188668
ISSN (Print): 2349-8919
SciеXplore: International Journal of Research in Science, *Vol 5(1), 11–18, January–June 2018*
ISSN (Online): 2350-0999

Distinct Concept of Edge Regular Intuitionistic Fuzzy M-Polargraphs

S. P. Geetha* and S. J. Praveena

Department of Mathematics, Vellalar College for Women (Autonomous), Erode; geetha_sams@rediffmail.com, sjpraveena60@gmail.com

Abstract

In this research paper, distinct concept of edge regular intuitionistic fuzzy m-polar graph are introduced. In that we describe some properties of edge regular, totally edge regular, regular, partially edge regular, full edge regular intuitionistic fuzzy m-polar graph respectively. We discuss the relationship between degree of a vertex and degree of an edge in intuitionistic fuzzy m-polar graph. Also dispute an application of intuitionistic fuzzy m-polar graph in a real life problem.

Keywords: Edge Regular, Partially Edge Regular and Full Edge Regular Intuitionistic Fuzzy m-Polar Graph, Regular, Totally Edge Regular

1. Introduction

In 1965 Zadeh[1] introduced the notion of fuzzy subset of a set. In 1994, Zhang[2] generalized the idea of a fuzzy set and gave the concept of bipolar fuzzy set on a given set X as a map which associates each element of X to a real number in the interval from -1, 1. In 2014, Chen[3] introduced the concept of bipolar fuzzy set map as an extension of bipolar fuzzy sets. In 1983 Attanassov[4] introduced the concept of Intuitionistic Fuzzy (IF) relations and Intuitionistic Fuzzy Graphs (IFGs). After that K. Sankar and D. Ezhilmaran[5], have studied bipolar intuitionistic fuzzy graph and some of its properties in 2015, it contains both membership and non-membership function by using the interval from -1, 1 and also introduced the concept on m-polar Intuitionistic Fuzzy Graph (IFG) in 2018. Akram, Dudek and Waseen[6] initiated the idea of regular, edge regular, totally edge regular, partially and full edge regular m-polar fuzzy graph. In this research paper, we introduced instinct concept of edge regular intuitionistic fuzzy m-polar graph. We describe some useful properties of edge regular, totally edge regular, regular, partially edge regular, full edge regular intuitionistic fuzzy m-polar graph.

2. Intuitionistic Fuzzy m-Polar Edge Regular Graph

Definition 2.1[7]: Anm-polar intuitionistic fuzzy set on a set X is a pair of mapping $\mu, \gamma : X \to [0,1]^m$, μ gives the membership values and γ gives a non-membership values for all $x \in X$.

Definition 2.2[7]: An m-polar intuitionistic fuzzy graph of a graph $G^* = [V, E]$ is an ordered triple $G = [V, A, B]$ where $A = [\mu_A, \gamma_A] \,\&\, B = [\mu_B, \gamma_B]$. μ_A, γ_A are m-polar membership and m-polar non-membership function from $V \to [0,1]^m$ and μ_B, γ_B are m-polar membership and m-polar non-membership function from $E \to [0,1]^m$ such that $\mu_B[x, y] \le \mu_A(x) \wedge \gamma_A(y)$ in the sense that $p_i \circ \mu_B(x, y) \le (p_i \circ \mu_A(x)) \wedge (p_i \circ \mu_A(y))$ and $\gamma_B(x, y) \ge \gamma_A(x) \vee \gamma_A(y)$ where $p_i \circ [0,1]^m \to [0,1]$ is the i^{th} projection mapping.

**Author for correspondence*

Definition 2.3: Consider $G = [N, \omega, \omega_1]$ be an intuitionistic fuzzy m-polar graph and let $na \in L$ be an edge in G. Then the degree of an edge $na \in L$ is defined as

$$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_\omega}(n), d_{\gamma_\omega}(n)\right] + \left[d_{\mu_\omega}(a), d_{\gamma_\omega}(a)\right] - 2\left[p_i \circ \mu_{\omega_1}(na),\ p_i \circ \gamma_{\omega_1}(na)\right]$$

If each edge in G has the same degree $[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ then G is called an Intuitionistic Fuzzy m-polar Edge Regular Graph.

Example 2.1: Consider a graph $G^* = (N, L)$ such that $N = [\gamma, \gamma_1, \Gamma, \Gamma_1]$, $L = [\gamma\gamma_1, \gamma\Gamma, \Gamma\Gamma_1, \Gamma_1\gamma]$

ω	γ	γ_1	Γ	Γ_1
$p_1 \circ \mu_\omega$	0.1	0.2	0.1	0.3
$p_2 \circ \mu_\omega$	0.3	0.3	0.3	0.5
$p_3 \circ \mu_\omega$	0.5	0.4	0.6	0.4
$p_1 \circ \gamma_\omega$	0.2	0.1	0.2	0.2
$p_2 \circ \gamma_\omega$	0.4	0.3	0.4	0.4
$p_3 \circ \gamma_\omega$	0.3	0.3	0.2	0.3

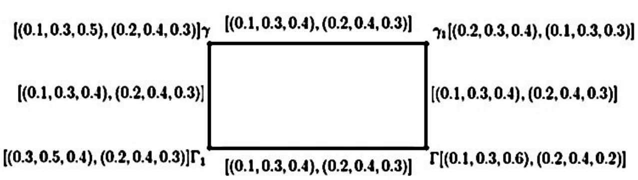

Figure 2.1. Intuitionistic Fuzzy 3-polar Edge Regular Graph.

ω_1	$\gamma\gamma_1$	$\gamma_1\Gamma$	$\Gamma\Gamma_1$	$\Gamma_1\gamma$
$p_1 \circ \mu_{\omega_1}$	0.1	0.1	0.1	0.1
$p_2 \circ \mu_{\omega_1}$	0.3	0.3	0.3	0.3
$p_3 \circ \mu_{\omega_1}$	0.4	0.4	0.4	0.4
$p_1 \circ \gamma_{\omega_1}$	0.2	0.2	0.2	0.2
$p_2 \circ \gamma_{\omega_1}$	0.4	0.4	0.4	0.4
$p_3 \circ \gamma_{\omega_1}$	0.3	0.3	0.3	0.3

By the Figure 2.1 using direct computations, we've

$$\left[d_{\mu_\omega}(\gamma), d_{\gamma_\omega}(\gamma)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

$$\left[d_{\mu_\omega}(\gamma_1), d_{\gamma_\omega}(\gamma_1)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

$$\left[d_{\mu_\omega}(\Gamma), d_{\gamma_\omega}(\Gamma)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]\left[d_{\mu_\omega}(\Gamma_1), d_{\gamma_\omega}(\Gamma_1)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

To find the degree of an each edge intuitionistic fuzzy

$$\left[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

$$\left[d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

$$\left[d_{\mu_{\omega_1}}(\Gamma\Gamma_1), d_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

$$\left[d_{\mu_{\omega_1}}(\Gamma_1\gamma), d_{\gamma_{\omega_1}}(\Gamma_1\gamma)\right] = [(0.2, 0.6, 0.8), (0.4, 0.8, 0.6)]$$

Hence, the degree of an each edge in $G = [\mu_{\omega_1}, \gamma_{\omega_1}]$ is same, therefore G is said to be an Intuitionistic Fuzzy m-polar Edge Regular Graph.

Definition 2.4: Let $G = [N, \omega, \omega_1]$ be an intuitionistic fuzzy m-polar graph and let $na \in L$ be an edge in G. Then the total degree of an edge $na \in L$ is defined as

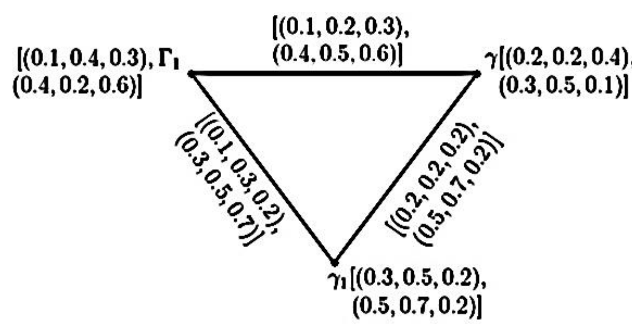

Figure 2.2. Intuitionistic Fuzzy 3-polar Totally Edge Regular Graph.

$$\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] + \left[p_i \circ \mu_{\omega_1}(na),\ p_i \circ \gamma_{\omega_1}(na)\right]$$

If each edge in G has the same degree $[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ then G is called an Intuitionistic Fuzzy m-polar Totally Edge Regular Graph.

Example 2.2: Consider an intuitionistic fuzzy 3-polar graph on $N = [\gamma, \gamma_1, \Gamma]$

By the Figure 2.2 using direct calculations, we've

$$\left[d_{\mu_\omega}(\gamma), d_{\gamma_\omega}(\gamma)\right] = [(0.2, 0.5, 0.5), (0.9, 1.2, 1.2)]\left[d_{\mu_\omega}(\gamma_1), d_{\gamma_\omega}(\gamma_1)\right] = [(0.3, 0.4, 0.5), (0.9, 1.2, 0.8)]\left[d_{\mu_\omega}(\Gamma), d_{\gamma_\omega}(\Gamma)\right] = [(0.3, 0.5, 0.4), (1.0, 1.4, 0.8)]$$

(i) To find a degree of an each edge inintuitionistic fuzzy 3-polar graph is,

$$\left[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] = [(0.3, 0.5, 0.4), (1.0, 1.4, 0.8)]\left[d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] = [(0.2, 0.5, 0.5), (0.9, 1.2, 1.2)]\left[d_{\mu_{\omega_1}}(\Gamma\Gamma_1), d_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right] = [(0.3, 0.4, 0.5), (0.9, 1.2, 0.8)]$$

Clearly,

$$\left[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] \neq \left[d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] \neq \left[d_{\mu_{\omega_1}}(\Gamma\Gamma_1), d_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right]$$

So G is not an Intuitionistic Fuzzy m-polar Edge Regular Graph.

(ii) To find a totally edge degree of an intuitionistic fuzzy m-polar graph is,

$$\left[td_{\mu_{\omega_1}}(\gamma\gamma_1), td_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] = [(0.4, 0.7, 0.7), (1.4, 1.9, 1.4)] \left[td_{\mu_{\omega_1}}(\gamma_1\Gamma), td_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right]$$
$$= [(0.4, 0.7, 0.7), (1.4, 1.9, 1.4)] \left[td_{\mu_{\omega_1}}(\Gamma\Gamma_1), td_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right] = [(0.4, 0.7, 0.7), (1.4, 1.9, 1.4)]$$

i.e.,

$$\left[td_{\mu_{\omega_1}}(\gamma\gamma_1), td_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] = \left[td_{\mu_{\omega_1}}(\gamma_1\Gamma), td_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] = \left[td_{\mu_{\omega_1}}(\Gamma\Gamma_1), td_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right].$$

Hence $G = [\mu_{\omega_1}, \gamma_{\omega_1}]$ is an Intuitionistic Fuzzy m-polar Totally Edge Regular Graph.

Definition 2.5: Let $G = [N, \omega, \omega_1]$ be an intuitionistic fuzzy m-polar graph is said to be $[(\gamma_1, \gamma_2, \dots, \gamma_m), (\Gamma_1, \Gamma_2, \dots, \Gamma_m)]$ regular if $[d_{\mu_\omega}(\mathrm{n}), \mathrm{d}_{\gamma_\omega}(\mathrm{n})] = [(\gamma_1, \gamma_2, \dots, \gamma_m), (\Gamma_1, \Gamma_2, \dots, \Gamma_m)] \forall n \in N$ then G is said to be an Intuitionistic Fuzzy m-polar Regular Graph.

By Figure 2.1, the degree of an each vertex is same by using direct computation. So G is said to be an Intuitionistic Fuzzy m-polar Regular Graph.

Definition 2.6: The size of an intuitionistic fuzzy m-polar graph

$$\Rightarrow S(G) = \left[\sum_{na \in L} p_i \circ \mu_{\omega_1}(na), \sum_{na \in L} p_i \circ \gamma_{\omega_1}(na)\right]$$

Definition 2.7: An intuitionistic fuzzy m-polar graph G of an edge regular crisp graph $G^* = \left[\mu^*{}_{\omega_1}, \gamma^*{}_{\omega_1}\right]$ is called an Intuitionistic Fuzzy m-polar Partially Edge Regular Graph.

Definition 2.8: An intuitionistic fuzzy m-polar graph $G = [\mu_{\omega_1}, \gamma_{\omega_1}]$, which is both edge regular and partially edge regular is called an Intuitionistic Fuzzy m-polar Full Edge Regular Graph.

Example 2.1: Consider an intuitionistic fuzzy 4-polar graph G on $N = [\gamma, \gamma_1, \Gamma, \Gamma_1]$.

By Figure 2.3 using direct computations, we've that $G = [N, \omega, \omega_1]$ is an intuitionistic fuzzy 4-polar full edge regular graph.

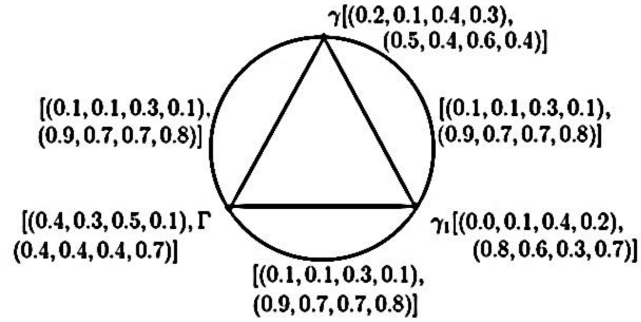

Figure 2.3. Intuitionistic Fuzzy 4-polar Full Edge Regular Graph.

Remark 2.1:

$(i) \delta_L(\mu_{\omega_1}, \gamma_{\omega_1}) = \Delta_L(\mu_{\omega_1}, \gamma_{\omega_1}) = (\delta, \Delta) = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$

if $G = [N, \omega, \omega_1]$ is an intuitionistic fuzzy m-polar graph.

$(ii)\ \delta_{tL}(\mu_{\omega_1}, \gamma_{\omega_1}) = \Delta_{tL}(\mu_{\omega_1}, \gamma_{\omega_1}) = (\sigma, \Sigma) = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$

iff $G = [N, \omega, \omega_1] G = [N, \omega, \omega_1]$ is an intuitionistic fuzzy m-polar graph.

Proposition 2.1: Let us take G be an intuitionistic fuzzy m-polargraph, then

$$\sum_{na \in L} \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = \sum_{na \in L} \left[d_{\mu^*{}_{\omega_1}}(na), d_{\gamma^*{}_{\omega_1}}(na)\right] [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$$

Where

$$\left[d_{\mu^*{}_{\omega_1}}(na), d_{\gamma^*{}_{\omega_1}}(na)\right] = \left[d_{\mu^*{}_{\omega_1}}(n), d_{\gamma^*{}_{\omega_1}}(n)\right] + \left[d_{\mu^*{}_{\omega_1}}(a), d_{\gamma^*{}_{\omega_1}}(a)\right] - 2 \ \forall n, a \in N$$

Proposition 2.2: Let us consider that G be an intuitionistic fuzzy m-polargraph. Then

$$\sum_{na \in L} \left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \sum_{na \in L} \left[d_{\mu^*{}_{\omega_1}}(na), d_{\gamma^*{}_{\omega_1}}(na)\right] [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] + S(G)$$

Proposition 2.3: Let G be an intuitionistic fuzzy m-polar totally edge regular graph of a (δ, Δ) i.e.,$[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ - edge regular graph G^*. Then the size of G is $\left[\left(\frac{n\delta_1}{\delta}, \frac{n\delta_2}{\delta}, \dots, \frac{n\delta_m}{\delta}\right), \left(\frac{n\Delta_1}{\Delta}, \frac{n\Delta_2}{\Delta}, \dots, \frac{n\Delta_m}{\Delta}\right)\right]$ where $|L| = n$.

Theorem 2.1: Let us take G be an $[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ intuitionistic fuzzy m-polar totally edge regular graph of a k-edge regular graph G^*, then the size of graph is $\left[\left(\frac{n\sigma_1}{K+1}, \frac{n\sigma_2}{k+1}, \dots, \frac{n\sigma_m}{k+1}\right), \left(\frac{n\Sigma_1}{k+1}, \frac{n\Sigma_2}{k+1}, \dots, \frac{n\Sigma_m}{k+1}\right)\right]$ where $|L| = n$.

Proof: Let us first consider, the size of an intuitionistic fuzzy m-polar graph

$$\Rightarrow S(G) = \left[\sum_{na \in L} p_i \circ \mu_{\omega_1}(na), \sum_{na \in L} p_i \circ \gamma_{\omega_1}(na)\right]$$

Assume that G be an $[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ intuitionistic fuzzy m-polar totally edge regular graph and G^* is a k-edge regular graph, that is $\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ and $\left[d_{\mu^*_{\omega_1}}(na), d_{\gamma^*_{\omega_1}}(na)\right] = k.$

$$\sum_{na \in L}\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \sum_{na \in L}\left[d_{\mu^*_{\omega_1}}(na), d_{\gamma^*_{\omega_1}}(na)\right][p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] + S(G)$$

$$\sum_{na \in L}[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$$

$$= KS(G) + S(G)$$

$$S(G) = \left[\left(\frac{nl_1}{K+1}, \frac{nl_2}{k+1}, \dots, \frac{nl_m}{k+1}\right), \left(\frac{nm_1}{K+1}, \frac{nm_2}{k+1}, \dots, \frac{nm_m}{k+1}\right)\right].$$

Theorem 2.2: Consider G be an $[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ edge regular and $[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ intuitionistic fuzzy m-polar totally edge regular graph $G^* = (N, L)$. Then the size of G is

$$n[(\sigma_1 - \delta_1, \sigma_2 - \delta_2, \dots, \sigma_m - \delta_m), (\Sigma_1 - \Delta_1, \Sigma_2 - \Delta_2, \dots, \Sigma_m - \Delta_m)]$$

where $|L| = n. |L| = n.$

Proof: Suppose that G is an $[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)] \& [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ intuitionistic fuzzy m-polar edge regular and totally edge regular graph i.e.,

$$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$$

and also

Now,

$$\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right]$$

$$\sum_{na \in L}\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \sum_{na \in L}\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$$

$$n[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$$
$$= n[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)] + S(G)$$
$$S(G) = n[(\sigma_1 - \delta_1, \sigma_2 - \delta_2, \dots, \sigma_m - \delta_m), (\Sigma_1 - \Delta_1, \Sigma_2 - \Delta_2, \dots, \Sigma_m - \Delta_m)].$$

Theorem 2.3: Let us take $G = [N, \omega, \omega_1]$ be an intuitionistic fuzzy m-polargraph then $\left[\mu_{\omega_1}, \gamma_{\omega_1}\right]$ is a constant function iff following statement are same.

(i) G is an intuitionistic fuzzy m-polar edge regular graph. (ii) G is an intuitionistic fuzzy m-polar totally edge regular graph.

Proof: Assume that $G = \left[\mu_{\omega_1}, \gamma_{\omega_1}\right]$ is a constant function i.e.,

$$[p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\varphi_1, \varphi_2, \dots, \varphi_m), (\Phi_1, \Phi_2, \dots, \Phi_m)] \; \forall \; na \in L$$

$(i) \Leftrightarrow (ii)$ Suppose that G is an $[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ intuitionistic fuzzy m-polar edge regular graph we've

$$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)], \forall \; na \in L.$$

And then,

$$\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)] + [(\varphi_1, \varphi_2, \dots, \varphi_m), (\Phi_1, \Phi_2, \dots, \Phi_m)] = [(\delta_1 + \varphi_1, \delta_2 + \varphi_2, \dots, \delta_m + \varphi_m), (\Delta_1 + \Phi_1, \Delta_2 + \Phi_2, \dots, \Delta_m + \Phi_m)]$$

is an intuitionistic fuzzy m-polar totally edge regular graph.

$(ii) \Leftrightarrow (i)$ Assume that G is an $[(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ intuitionistic fuzzy m-polar totally edge regular graph. So

$$\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)] \forall \; na \in L.$$

Thus,

$$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = \left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] - [p_i \circ$$

$$= [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)] - [(\varphi_1, \varphi_2, \dots, \varphi_m), (\Phi_1, \Phi_2, \dots, \Phi_m)] = [(\sigma_1 - \varphi_1, \sigma_2 - \varphi_2, \dots, \sigma_m - \varphi_m), (\Sigma_1 - \Phi_1, \Sigma_2 - \Phi_2, \dots, \Sigma_m - \Phi_m)]$$

Is an intuitionistic fuzzy m-polar edge regular graph.

Thus the statements $(i) \& (ii)$ are same.

Conversely, assume that $(i) \& (ii)$ are same. If $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is not a constant function, then

$$[p_i \circ \mu_{\omega_1}(na) \neq p_i \circ \mu_{\omega_1}(zz_1)] \& [p_i \circ \gamma_{\omega_1}(na) \neq p_i \circ \gamma_{\omega_1}(zz_1)]$$

for at least one pair of edges $na, zz_1 \in L$.

Consider now, $G = [\mu_{\omega_1}, \gamma_{\omega_1}]$ is an $[(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ intuitionistic fuzzy m-polar edge regular graph. Then,

$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right] = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)]$ $\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$ $\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = [(\delta_1, \delta_2, \dots, \delta_m), (\Delta_1, \Delta_2, \dots, \Delta_m)] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$

$$\therefore \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] \neq \left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right].$$

Hence G is not an intuitionistic fuzzy m-polar totally edge regular graph which is contradiction to our assumption, hence G is an intuitionistic fuzzy m-polar edge regular graph.

Finally, Let G is an intuitionistic fuzzy m-polar totally edge regular graph

$[td_{\mu_D}(na), td_{\gamma_D}(na)] = [td_{\mu_D}(zz_1), td_{\gamma_D}(zz_1)] = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)]$ $\left[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)\right] = \left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$ $\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)] - [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)]$

Similarly,

$\left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right] = [(\sigma_1, \sigma_2, \dots, \sigma_m), (\Sigma_1, \Sigma_2, \dots, \Sigma_m)] - [p_i \circ \mu_{\omega_1}(zz_1), p_i \circ \gamma_{\omega_1}(zz_1)]$

So,

$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] - \left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right] = [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] - [p_i \circ \mu_{\omega_1}(zz_1), p_i \circ \gamma_{\omega_1}(zz_1)].$

Since

$[p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] \neq [p_i \circ \mu_{\omega_1}(zz_1), p_i \circ \gamma_{\omega_1}(zz_1)],$

we have

$\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] - \left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right] \neq 0,$

i.e., $\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] \neq \left[d_{\mu_{\omega_1}}(zz_1), d_{\gamma_{\omega_1}}(zz_1)\right].$

Hence G is not an intuitionistic fuzzy m-polar edge regular graph, which is contradiction to our assumption that G is an intuitionistic fuzzy m-polar totally edge regular graph. Thus $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function.

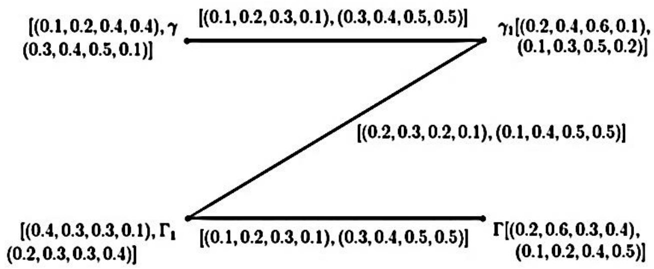

Figure 2.4 Intuitionistic Fuzzy 4-polar Graph.

Example 2.3: Consider an intuitionistic fuzzy 4-polar graph G on $N = [\gamma, \gamma_1, \Gamma, \Gamma_1]$.

By the Figure 2.4 using direct computations, we've

$$\begin{aligned}[d_{\mu_\omega}(\gamma), d_{\gamma_\omega}(\gamma)] &= [(0.3, 0.5, 0.5, 0.2), (0.4, 0.8, 1.0, 1.0)] [d_{\mu_\omega}(\gamma_1), d_{\gamma_\omega}(\gamma_1)] \\ &= [(0.3, 0.5, 0.5, 0.2), (0.4, 0.8, 1.0, 1.0)] [d_{\mu_\omega}(\Gamma), d_{\gamma_\omega}(\Gamma)] \\ &= [(0.3, 0.5, 0.5, 0.2), (0.4, 0.8, 1.0, 1.0)] [d_{\mu_\omega}(\Gamma_1), d_{\gamma_\omega}(\Gamma_1)] = [(0.1, 0.2, 0.3, 0.1), (0.3, 0.4, 0.5, 0.5)]\end{aligned}$$

To find the degree of an each edge in intuitionistic fuzzy 4-polar graph is,

$$\begin{aligned}\left[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] &= [(0.2, 0.3, 0.2, 0.1), (0.1, 0.4, 0.5, 0.5)] \left[d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] \\ &= [(0.0, 0.1, 0.4, 0.1), (0.5, 0.4, 0.5, 0.5)] \left[d_{\mu_{\omega_1}}(\Gamma\Gamma_1), d_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right] = [(0.2, 0.3, 0.2, 0.1), (0.1, 0.4, 0.5, 0.5)]\end{aligned}$$

i.e., $\left[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] \neq \left[d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right]$ is not an intuitionistic fuzzy 4-polar edge regular graph. Then

$$\begin{aligned}\left[td_{\mu_{\omega_1}}(\gamma\gamma_1), td_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] &= [(0.3,0.5,0.5,0.2), (0.4,0.8,1.0,1.0)] \left[td_{\mu_{\omega_1}}(\gamma_1\Gamma), td_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right] \\ &= [(0.2,0.4,0.6,0.2), (0.6,0.8,1.0,1.0)] \left[td_{\mu_{\omega_1}}(\Gamma\Gamma_1), td_{\gamma_{\omega_1}}(\Gamma\Gamma_1)\right] = [(0.3,0.5,0.5,0.2), (0.4,0.8,1.0,1.0)].\end{aligned}$$

i.e.,

$$\left[td_{\mu_{\omega_1}}(\gamma\gamma_1), td_{\gamma_{\omega_1}}(\gamma\gamma_1)\right] \neq \left[td_{\mu_{\omega_1}}(\gamma_1\Gamma), td_{\gamma_{\omega_1}}(\gamma_1\Gamma)\right]$$

is not an intuitionistic fuzzy 4-polar totally edge regular graph.

Theorem 2.4: Let $G = [N, \omega, \omega_1]$ be an intuitionistic fuzzy m-polar graph, where $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function. If G is an intuitionistic fuzzy m-polar regular graph. Then G is an intuitionistic fuzzy m-polar edge regular graph.

Proof: Given that $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function i.e.,

$[p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\varphi_1, \varphi_2, \dots, \varphi_m), (\Phi_1, \Phi_2, \dots, \Phi_m)] \forall\, na \in L.$

Suppose that G is an intuitionistic fuzzy m-polar graph, in that $[d_{\mu_\omega}(\mathrm{n}), d_{\gamma_\omega}(\mathrm{n})] = [(\gamma_1, \gamma_2, \dots, \gamma_m), (\Gamma_1, \Gamma_2, \dots, \Gamma_m)], \forall n \in N$. Now,

$$\begin{aligned}\left[d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)\right] &= [d_{\mu_\omega}(n), d_{\gamma_\omega}(n)] + [d_{\mu_\omega}(\mathrm{a}), d_{\gamma_\omega}(\mathrm{a})] - 2[p_i \circ \mu_{\omega_1}(na), \\ & p_i \circ \gamma_{\omega_1}(na)] = 2\{(\gamma_1 - \varphi_1, \gamma_2 - \varphi_2, \dots, \gamma_m - \varphi_m), (\Gamma_1 - \Phi_1, \Gamma_2 - \Phi_2, \dots, \Gamma_m - \Phi_m)\}\end{aligned}$$

Hence G is an intuitionistic fuzzy m-polar totally edge regular graph.

Theorem 2.5: Let $G = [N, \omega, \omega_1]$ bean intuitionistic fuzzy m-polar graph, where $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function. If G is an intuitionistic fuzzy m-polar regular graph. Then G is an intuitionistic fuzzy m-polar totally edge regular graph.

Proof: Given that $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function i.e.,

$$[p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)]$$

$\forall\, na \in L$. Suppose that G is an intuitionistic fuzzy m-polar regular graph

$$[d_{\mu_{\omega_1}}(\mathrm{n}), d_{\gamma_{\omega_1}}(\mathrm{n})] = [(\gamma_1, \gamma_2, \ldots, \gamma_m), (\Gamma_1, \Gamma_2, \ldots, \Gamma_m)] \forall n \in N.$$

Then G is an intuitionistic fuzzy m-polar regular graph.

$$[td_{\mu_{\omega_1}}(na), td_{\gamma_{\omega_1}}(na)] = [d_{\mu_{\omega_1}}(na), d_{\gamma_{\omega_1}}(na)] + [p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\delta_1, \delta_2, \ldots, \delta_m), (\Delta_1, \Delta_2, \ldots, \Delta_m)] + [(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)] = [(\delta_1 - \varphi_1, \delta_2 - \varphi_2, \ldots, \delta_m - \varphi_m), (\Gamma_1 - b_1, \Gamma_2 - b_2, \ldots, \Gamma_m - b_m)]$$

Hence G is an intuitionistic fuzzy m-polar totally edge regular graph.

Theorem 2.6: Let $G = [N, \omega, \omega_1]$ bean intuitionistic fuzzy m-polar regular graph, then $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function iff G is an intuitionistic fuzzy m-polar edge regular graph.

Proof: Consider that $G = [N, \omega, \omega_1]$ is an $[(\gamma_1, \gamma_2, \ldots, \gamma_m), (\Gamma_1, \Gamma_2, \ldots, \Gamma_m)]$ intuitionistic fuzzy m-polar regular graph i.e.,

$$[d_{\mu_\omega}(n), d_{\gamma_\omega}(n)] = [(\gamma_1, \gamma_2, \ldots, \gamma_m), (\Gamma_1, \Gamma_2, \ldots, \Gamma_m)] \; \forall n \in N.$$

And let $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function i.e., we've

$$[p_i \circ \mu_{\omega_1}(na), \; p_i \circ \gamma_{\omega_1}(na)] = [(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)] \forall\, na \in L.$$

$$[d_{\mu_{\omega_1}}(\mathrm{na}), d_{\gamma_{\omega_1}}(\mathrm{na})] = [d_{\mu_\omega}(\mathrm{n}), d_{\gamma_\omega}(\mathrm{n})] + [d_{\mu_\omega}(\mathrm{a}), d_{\gamma_\omega}(\mathrm{a})] - 2[p_i \circ \mu_{\omega_1}(na), \; p_i \circ \gamma_{\omega_1}(na)] = 2[(\delta_1, \delta_2, \ldots, \delta_m), \; (\Delta_1, \Delta_2, \ldots, \Delta_m)] - 2[(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)]$$

Therefore, G is an intuitionistic fuzzy m-polar edge regular graph.

Conversely, Suppose that G is an intuitionistic fuzzy m-polar edge regular graph, then we have

$$[d_{\mu_{\omega_1}}(\mathrm{na}), d_{\gamma_{\omega_1}}(\mathrm{na})] = [(\delta_1, \delta_2, \ldots, \delta_m), \; (\Delta_1, \Delta_2, \ldots, \Delta_m)].$$

Now,

$$[d_{\mu_{\omega_1}}(\mathrm{na}), d_{\gamma_{\omega_1}}(\mathrm{na})] = [d_{\mu_\omega}(\mathrm{n}), d_{\gamma_\omega}(\mathrm{n})] + [d_{\mu_\omega}(\mathrm{a}), d_{\gamma_\omega}(\mathrm{a})] - 2[p_i \circ \mu_{\omega_1}(na), \; p_i \circ \gamma_{\omega_1}(na)] 2[p_i \circ \mu_{\omega_1}(na), \; p_i \circ \gamma_{\omega_1}(na)] = [(\delta_1, \delta_2, \ldots, \delta_m), (\Delta_1, \Delta_2, \ldots, \Delta_m)] - 2[(\gamma_1, \gamma_2, \ldots, \gamma_m), (\Gamma_1, \Gamma_2, \ldots, \Gamma_m)][p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = \frac{[(\delta_1, \delta_2, \ldots, \delta_m), (\Delta_1, \Delta_2, \ldots, \Delta_m)] - [(2\gamma_1, 2\gamma_2, \ldots, 2\gamma_m), (2\Gamma_1, 2\Gamma_2, \ldots, 2\Gamma_m)]}{2} \forall\, na \in L.$$

Hence $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function.

Example 2.5: Consider an intuitionistic fuzzy 2-polar graph $G = [N, \omega, \omega_1]$ of a graph G^*, where $N = [\gamma, \gamma_1, \Gamma, \Gamma_1]$, $L = [\gamma\gamma_1, \gamma_1\Gamma, \Gamma\Gamma_1, \Gamma_1\gamma]$.

By the Figure 2.5 using direct calculations, we've

$$[d_{\mu_\omega}(\gamma), d_{\gamma_\omega}(\gamma)] = [(0.4, 0.2), (1.4, 1.2)] \; [d_{\mu_\omega}(\gamma_1), d_{\gamma_\omega}(\gamma_1)] = [(0.4, 0.2), (1.4, 1.2)][d_{\mu_\omega}(\Gamma), d_{\gamma_\omega}(\Gamma)] = [(0.6, 0.3), (2.1, 1.8)][d_{\mu_\omega}(\Gamma_1), d_{\gamma_\omega}(\Gamma_1)] = [(0.2, 0.1), (0.7, 0.6)]$$

To find the degree of an each edge in intuitionistic fuzzy 2-polar graph is,

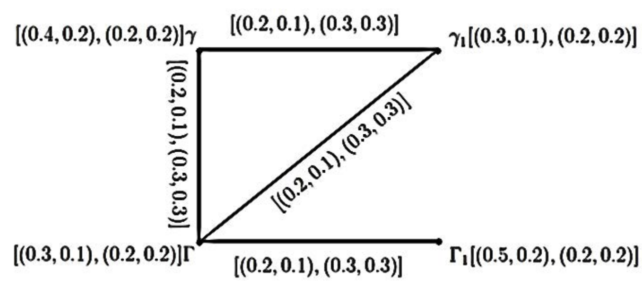

Figure 2.5. Intuitionistic Fuzzy 2-polar Graph.

$$[d_{\mu_{\omega_1}}(\gamma\gamma_1), d_{\gamma_{\omega_1}}(\gamma\gamma_1)] = [(0.4, 0.2), (1.4, 1.2)] \; [d_{\mu_{\omega_1}}(\gamma_1\Gamma), d_{\gamma_{\omega_1}}(\gamma_1\Gamma)] = [(0.6, 0.3), (2.1, 1.8)]$$

$$[d_{\mu_{\omega_1}}(\Gamma\Gamma_1), d_{\gamma_{\omega_1}}(\Gamma\Gamma_1)] = [(0.4, 0.2), (1.4, 1.2)]$$

To find an intuitionistic fuzzy 3-polar totally edge regular graph is

$$[td_{\mu_{\omega_1}}(\gamma\gamma_1), td_{\gamma_{\omega_1}}(\gamma\gamma_1)] = [(0.6, 0.3), (0.9, 0.9)] \; [td_{\mu_{\omega_1}}(\gamma_1\Gamma), td_{\gamma_{\omega_1}}(\gamma_1\Gamma)] = [(0.8, 0.4), (1.1, 1.1)] \; [td_{\mu_{\omega_1}}(\Gamma\Gamma_1), td_{\gamma_{\omega_1}}(\Gamma\Gamma_1)] = [(0.6, 0.3), (0.9, 0.9)] \; [td_{\mu_{\omega_1}}(\Gamma_1\gamma), td_{\gamma_{\omega_1}}(\Gamma_1\gamma)] = ([(0.8, 0.4), (1.1, 1.1)]$$

The above solution that $G = [\mu_{\omega_1}, \gamma_{\omega_1}]$ is neither edge regular nor an intuitionistic fuzzy m-polar totally edge regular graph.

Theorem 2.7: Allow G be an intuitionistic fuzzy m-polar graph of a graph G^*, where $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function. If G is an intuitionistic fuzzy m-polar full edge regular graph.

Proof: Given that $[\mu_{\omega_1}, \gamma_{\omega_1}]$ is a constant function i.e.,

$$[p_i \circ \mu_{\omega_1}(na), p_i \circ \gamma_{\omega_1}(na)] = [(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)], \forall\, na \in L,$$

were $[(\varphi_1, \varphi_2, \ldots, \varphi_m), (\Phi_1, \Phi_2, \ldots, \Phi_m)]$ are constant.

Let G be an intuitionistic fuzzy m-polar fulledge regular graph. Then $[d_{\mu_\omega}(\mathrm{n}), d_{\gamma_\omega}(\mathrm{n})] = [(\gamma_1, \gamma_2, \ldots, \gamma_m), (\Gamma_1, \Gamma_2, \ldots, \Gamma_m)]$, and $[d_{\mu^*_\omega}(n), d_{\gamma^*_\omega}(n)] = (\gamma, \Gamma)\ \forall\, n \in N$

$$[d_{\mu^*_{\omega_1}}(na), d_{\gamma^*_{\omega_1}}(na)] = [d_{\mu^*_\omega}(n),\ d_{\gamma^*_\omega}(n)] + [d_{\mu^*_\omega}(a), d_{\gamma^*_\omega}(a)] - 2 = 2(\gamma,\ \Gamma) - 2$$

where γ & Γ are fixed one. Now, which is constant. Thus G^* is edge regular graph and also $\forall\, na \in L$ we've

$$[d_{\mu_{\omega_1}}(\mathrm{na}), d_{\gamma_{\omega_1}}(\mathrm{na})] = [d_{\mu_\omega}(\mathrm{n}), d_{\gamma_\omega}(\mathrm{n})] + [d_{\mu_\omega}(\mathrm{a}), d_{\gamma_\omega}(\mathrm{a})] - 2[p_i \circ \mu_{\omega_1}(na),\ p_i \circ \gamma_{\omega_1}(na)] = [2(\gamma_1 - \varphi_1,\ \gamma_2 - \varphi_2, \ldots, \gamma_m - \varphi_m), 2(\Gamma_1 - \Phi_1,\ \Gamma_2 - \Phi_2, \ldots, \Gamma_m - \Phi_m)]$$

which is constant.

Hence, G is an intuitionistic fuzzy m-polar edge regular graph from this we have, G is also intuitionistic fuzzy m-polar fulledge regular graph.

3. Application

Intuitionistic Fuzzy Graphs have become an important segment of mathematics with a number of applications in physics, biology, social networks and transportation networks. In that it takes a vital role in flight system. The airline crew aim to assist the progress of their passengers with extreme quality of service. Air traffic investigators have to make sure that crew planes must appear and leave at right time. This mission is possible by planning economic routes for the planes. Suppose we want to travel between difference cities through the flight system. Consider an example through an airline network in which vertices represent the cities and edge represent the flights. Figure 1 shows an airline network between cities which is represented as an intuitionistic fuzzy 4-polar set of cities where $G = [N, \omega, \omega_1]$ where ω is an Intuitionistic Fuzzy 4-polar Set at which distance, worth and flying time to be calculated, and ω_1 Intuitionistic Fuzzy 4-polar Set of flights between the two cities. The membership and non-membership degrees of an edges can be calculated by using the relations

$$p_i \circ \gamma_{\omega_1}(na) \le [p_i \circ \gamma_\omega(na), p_i \circ \gamma_\omega(na)]$$

To find the reasonable route as well as expensive route between the cities such that distance, expense and flying time. Let us consider the routes from Amritsar to Chandigarh.

- $[\mu_{\omega_{1_1}}, \gamma_{\omega_{1_1}}]$: Amritsar → Chandigarh.
- $[\mu_{\omega_{1_2}}, \gamma_{\omega_{1_2}}]$: Amritsar → Shimla → Chandigarh.
- $[\mu_{\omega_{1_3}}, \gamma_{\omega_{1_3}}]$: Amritsar→ Jalandhar → Chandigarh.
- $[\mu_{\omega_{1_4}}, \gamma_{\omega_{1_4}}]$: Amritsar → Jalandhar → Shimla → Chandigarh.
- $[\mu_{\omega_{1_5}}, \gamma_{\omega_{1_5}}]$: Amritsar → Jalandhar → Patiala → Chandigarh.
- $[\mu_{\omega_{1_6}}, \gamma_{\omega_{1_6}}]$: Amritsar → Jalandhar → Ludhiana → Chandigarh.
- $[\mu_{\omega_{1_7}}, \gamma_{\omega_{1_7}}]$: Amritsar → Jalandhar → Ludhiana → Patiala → Chandigarh.

Now we computing the lengths of all the given routes we obtain,

$$l[\mu_{\omega_{1_1}}, \gamma_{\omega_{1_1}}] = [(0.4, 0.2, 0.2, 0.1), (0.5, 0.7, 0.7, 0.8)],$$

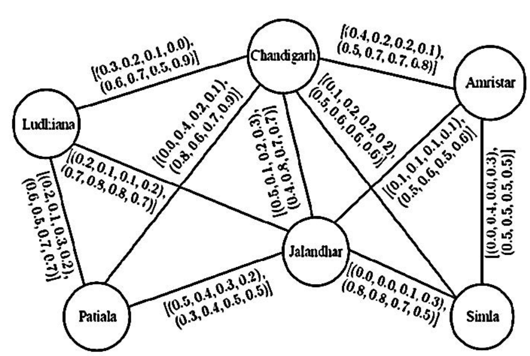

Figure 1. Intuitionistic Fuzzy 5-polar Graph.

$$l\left[\mu_{\omega_{1_2}},\gamma_{\omega_{1_2}}\right] = [(0.1,0.6,0.2,0.5),(1.0,1.1,1.1,1.1)],$$

$$l\left[\mu_{\omega_{1_3}},\gamma_{\omega_{1_3}}\right] = [(0.6,0.2,0.3,0.4),(0.9,1.4,1.2,1.3)],$$

$$l\left[\mu_{\omega_{1_4}},\gamma_{\omega_{1_4}}\right] = [(0.2,0.3,0.4,0.6),(1.8,2.0,1.8,1.9)],$$

$$l\left[\mu_{\omega_{1_5}},\gamma_{\omega_{1_5}}\right] = [(0.6,0.9,0.6,0.4),(1.6,1.6,1.7,2.0)],$$

$$l\left[\mu_{\omega_{1_6}},\gamma_{\omega_{1_6}}\right] = [(0.6,0.4,0.3,0.3),(1.2,2.1,1.8,2.2)],$$

$$l\left[\mu_{\omega_{1_7}},\gamma_{\omega_{1_7}}\right] = [(0.5,0.7,0.7,0.6),(2.6,2.5,2.7,2.9)].$$

After computations we noticed that reasonable route is Amritsar → Chandigarh and also the expensive route is Amritsar → Jalandhar → Ludhiana → Patiala → Chandigarh.

Here we present our technique as an algorithm that is used in our application.

Algorithm

- Input: $[\mu_\omega,\gamma_\omega]$ intuitionistic fuzzy m-polar set of vertices, $[\mu_{\omega_1},\gamma_{\omega_1}]$ = intuitionistic fuzzy m-polar set of edges,
- Calculate the intuitionistic fuzzy m-polar graph $G = [N,\omega,\omega_1]$,
- Calculate all possible routes $\left[\mu_{\omega_{1_j}},\gamma_{\omega_{1_j}}\right]$ between cities
- Calculate the length of all routes $\left[\mu_{\omega_{1_j}},\gamma_{\omega_{1_j}}\right]$ using formula

$$l_i\left[\mu_{\omega_{1_j}},\gamma_{\omega_{1_j}}\right] = \sum_{j=1}^{n-1}\frac{1}{[p_i\circ\mu_{\omega_1}(n_i a_{j+1}),[p_i\circ\mu_{\omega_1}(n_i a_{j+1})]}$$

- Find the route with minimum and maximum length.

4. Conclusion

IFG theory has variety of applications in many disciplines, including control theory, expert system and management sciences. An intuitionistic fuzzy m-polar model is a generalization of the fuzzy model which gives more accurate, adjustability and fit with a system when compared with an intuitionistic fuzzy model. Also discussed an application problem by using intuitionistic fuzzy m-polar graph procedure. Based on the situation that is observed to exist the economic and expensive route to be calculated.

5. Reference

1. Zadeh LA. Fuzzy Sets, Information and Control. 1965; 8:338-53. https://doi.org/10.1016/S0019-9958(65)90241-X
2. Zhang WR. Bipolar Fuzzy Sets and Relations: a computational frame work for cognitive modeling and multiagent decision analysis. Proceedings of the IEEE Conference. 1994; p. 305-9.
3. Chen J, Li SG, Ma S and Xang X. m-polar fuzzy sets. The Scientific World Journal. 2014(2014):416530.
4. Atanassov KT. Intuitionistic Fuzzy Sets: Theory and Applications, Studies in Fuzziness and Soft Computing. Physica-Verlag, Heidelberg, New York. 1999.
5. Sankar K and Ezhilmaran D. Bipolar Intuitionistic Fuzzy Graph with Applications. International Journal of Research and Scientific Innovation (IJRSI). 2016 December; III(XII).
6. Akram M, Waseem N and Dudek WA. Certain types of edge m-polar fuzzy graph. Iranian Journal of Fuzzy System. 2017; 14(4).
7. Sankar K and Ezhilmaran D. On m-polar intuitionistic fuzzy graphs. International Journal of Pune and Applied Mathematics. 2018; 119(14):892-8.
8. Karunanbigai MG, Palanivel K and Sivasankar S. Edge Regular Intuitionistic Fuzzzy Graph, 2015 Puspa Publishing House, Allahabad India. 2015; 20(1). ISSN:0973-421X.
9. Karunambigai MG and Parvathi R. Intuitionistic Fuzzy Graphs. Journal of Computational Intelligence: Theory and Applications. 2006; 20:139-50.
10. Akram M, Dudek WA. Regular Intuitionistic Fuzzy Graphs. Neural Computing and Apllication. 1007-S00521-0772-6.
11. Karunambigai MG, Sivasankar S and Palanivel K. Some properties of Regular Intuitionistic Fuzzy graph. International Journal of Mathematics and Computaion. 2015; 26(4).
12. Akram M. Bipolar fuzzy graphs. Information Sciences. 2011; 181:5548-64. https://doi.org/10.1016/j.ins.2011.07.037
13. Naggor Gani A and Shajitha Begum. Degree, Order and Size in Intuitionistic Fuzzy Graphs. International Journal of Algorithm, Computing and Mathematics. 2010; 3(3).