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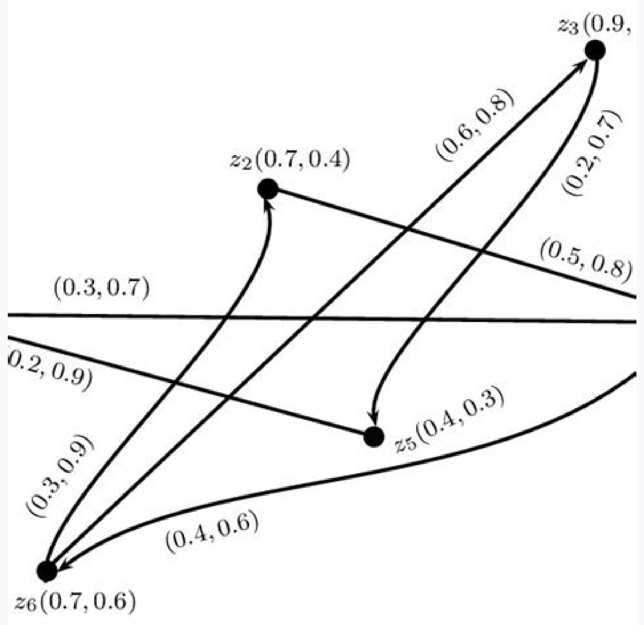
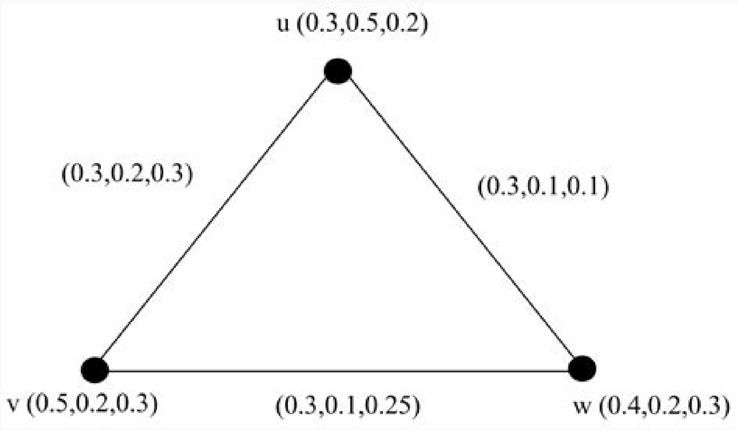
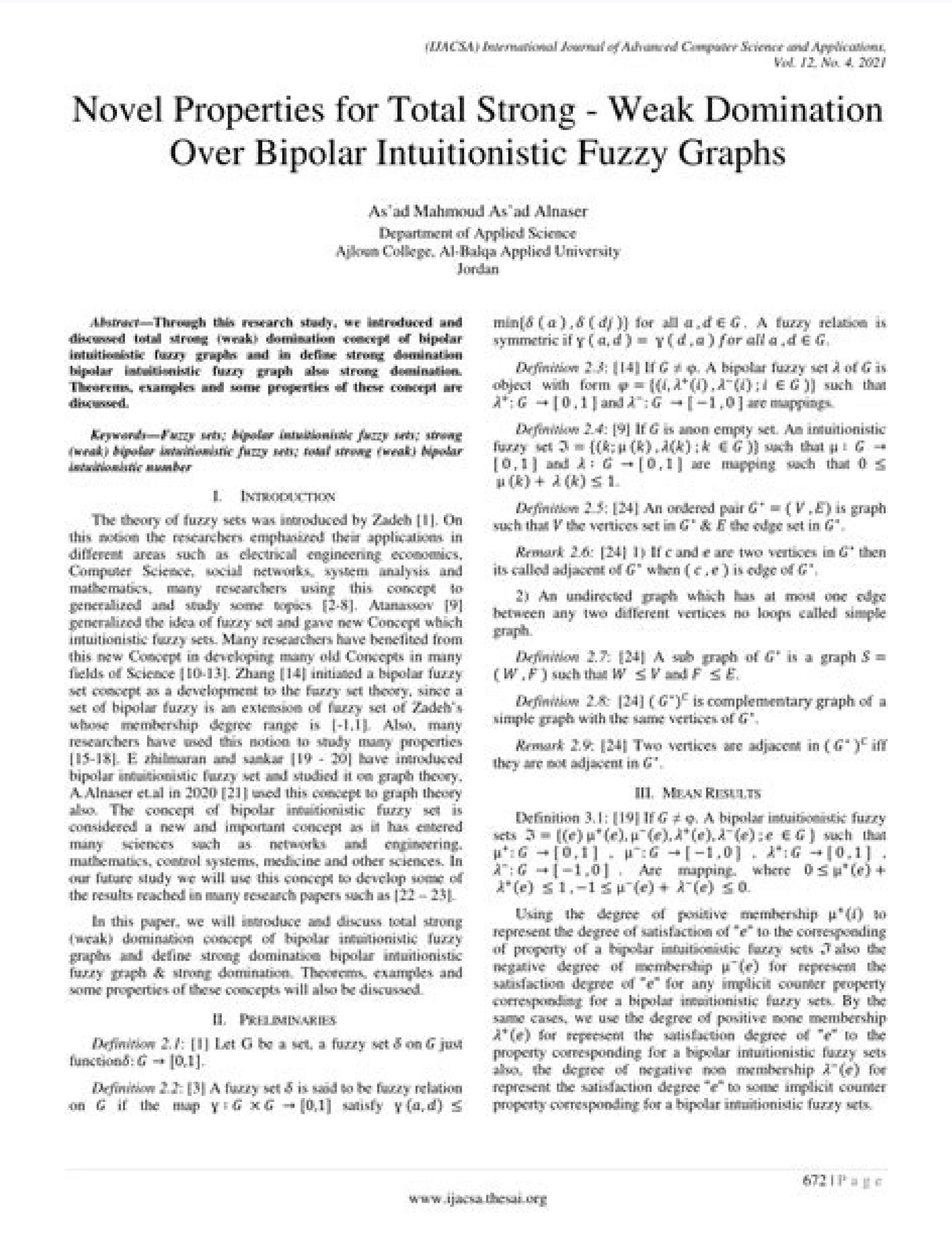
Intuitionistic fuzzy graph pdf full length







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Novel Properties for Total Strong - Weak Domination Over Bipolar Intuitionistic Fuzzy Graphs

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***Abstract*—Through this research study, we introduced and discussed total strong (weak) domination concept of bipolar intuitionistic fuzzy graphs and in define strong domination bipolar intuitionistic fuzzy graph also strong domination. Theorems, examples and some properties of these concept are discussed.**

***Keywords*—Fuzzy sets; bipolar intuitionistic fuzzy sets; strong (weak) bipolar intuitionistic fuzzy sets; total strong (weak) bipolar intuitionistic number**

I. Introduction

The theory of fuzzy sets was introduced by Zadeh [1]. On this notion the researchers emphasized their applications in different areas such as electrical engineering economics, Computer Science, social networks, system analysis and mathematics, many researchers using this concept to generalized and study some topics [2-8]. Atanassov [9] generalized the idea of fuzzy set and gave new Concept which intuitionistic fuzzy sets. Many researchers have benefited from this new Concept in developing many old Concepts in many fields of Science [10-13]. Zhang [14] initiated a bipolar fuzzy set concept as a development to the fuzzy set theory, since a set of bipolar fuzzy is an extension of fuzzy set of Zadeh's whose membership degree range is [-1,1]. Also, many researchers have used this notion to study many properties [15-18]. E zhilmaran and sankar [19 - 20] have introduced bipolar intuitionistic fuzzy set and studied it on graph theory. A.Alnaser et.al in 2020 [21] used this concept to graph theory also. The concept of bipolar intuitionistic fuzzy set is considered a new and important concept as it has entered many sciences such as networks and engineering, mathematics, control systems, medicine and other sciences. In our future study we will use this concept to develop some of the results reached in many research papers such as [22 – 23].

In this paper, we will introduce and discuss total strong (weak) domination concept of bipolar intuitionistic fuzzy graphs and define strong domination bipolar intuitionistic fuzzy graph & strong domination. Theorems, examples and some properties of these concepts will also be discussed.

II. Preliminaries

Definition 2.1: [1] Let G be a set, a fuzzy set δ on G just function$\delta: G \to [0,1]$.

Definition 2.2: [3] A fuzzy set δ is said to be fuzzy relation on G if the map $\gamma : G \times G \to [0,1]$ satisfy $\gamma(a,d) \leq \min\{\delta(a), \delta(d)\}$ for all $a, d \in G$. A fuzzy relation is symmetric if $\gamma(a,d) = \gamma(d,a)$ *for all* $a, d \in G$.

Definition 2.3: [14] If $G \neq \varphi$. A bipolar fuzzy set λ of G is object with form $\varphi = \{(i, \lambda^+(i), \lambda^-(i); i \in G)\}$ such that $\lambda^+ : G \to [0,1]$ and $\lambda^- : G \to [-1,0]$ are mappings.

Definition 2.4: [9] If G is anon empty set. An intuitionistic fuzzy set $\Im = \{(k; \mu(k), \lambda(k); k \in G)\}$ such that $\mu : G \to [0,1]$ and $\lambda : G \to [0,1]$ are mapping such that $0 \leq \mu(k) + \lambda(k) \leq 1$.

Definition 2.5: [24] An ordered pair $G^* = (V, E)$ is graph such that V the vertices set in G^* & E the edge set in G^*.

Remark 2.6: [24] 1) If c and e are two vertices in G^* then its called adjacent of G^* when (c, e) is edge of G^*.

2) An undirected graph which has at most one edge between any two different vertices no loops called simple graph.

Definition 2.7: [24] A sub graph of G^* is a graph $S = (W, F)$ such that $W \leq V$ and $F \leq E$.

Definition 2.8: [24] $(G^*)^C$ is complementary graph of a simple graph with the same vertices of G^*.

Remark 2.9: [24] Two vertices are adjacent in $(G^*)^C$ iff they are not adjacent in G^*.

III. Mean Results

Definition 3.1: [19] If $G \neq \varphi$. A bipolar intuitionistic fuzzy sets $\Im = \{(e)\, \mu^+(e), \mu^-(e), \lambda^+(e), \lambda^-(e); e \in G\}$ such that $\mu^+ : G \to [0,1]$, $\mu^- : G \to [-1,0]$, $\lambda^+ : G \to [0,1]$, $\lambda^- : G \to [-1,0]$. Are mapping, where $0 \leq \mu^+(e) + \lambda^+(e) \leq 1, -1 \leq \mu^-(e) + \lambda^-(e) \leq 0$.

Using the degree of positive membership $\mu^+(i)$ to represent the degree of satisfaction of "e" to the corresponding of property of a bipolar intuitionistic fuzzy sets $\Im$ also the negative degree of membership $\mu^-(e)$ for represent the satisfaction degree of "e" for any implicit counter property corresponding for a bipolar intuitionistic fuzzy sets. By the same cases, we use the degree of positive none membership $\lambda^+(e)$ for represent the satisfaction degree of "e" to the property corresponding for a bipolar intuitionistic fuzzy sets also, the degree of negative non membership $\lambda^-(e)$ for represent the satisfaction degree "e" to some implicit counter property corresponding for a bipolar intuitionistic fuzzy sets.

A note on domination in fuzzy graph using strong arc

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Abstract

Somasundaram.A and somasundaram.S(1998) introduced the domination in fuzzy graphs by effective edges. A.Nagoorgan(2006) introduced the domination in fuzzy graphs by strong arcs. In this paper we establish the relation between effective edge domination number and strong arc domination number and we determine the strong arc domination number for some standard fuzzy graphs.

Keywords: **Fuzzy graph, Domination number, Effective edge domination, Strong arc, Non strong arc, Strong arc domination.**
AMS classification : 05C72

1. INTRODUCTION

Fuzzy graph is the generalization of the ordinary graph. Therefore it is natural that though fuzzy graph inherits many properties similar to those of ordinary graph, it deviates at many places. The earliest idea of dominating sets date back to the origin of game of chess in India over 400 years ago in which placing the minimum number of a chess piece (such as Queen, knight ext..) over chess board so as to dominate all the squares of chess board was investigated. The formal mathematical definition of domination was given by Ore.O in 1962. In 1975 A.Rosenfeld introduced the notion of fuzzy graph and several analogs of theoretic concepts such as path, cycle and connectedness. A.Somasundaram and S. Somasundaram discussed the domination in fuzzy graph using effective arc. A.Nagoorgani and V.T. Chandrasekarn discussed the domination in fuzzy graph using strong arc. Before introducing new results on fuzzy graphs using strong arcs , we are placed few preliminary definitions and results for new one.

2. PRELIMINARIES

Definition 2.1

Fuzzy graph $G(\sigma,\mu)$ is pair of function $V \to [0,1]$ and $\mu: V \times V \to [0,1]$ where for all u, v in V , we have $\mu(u,v) \leq \sigma(u) \wedge \sigma(v)$.

Definition 2.2

The fuzzy graph $H(\tau,\rho)$ is called a fuzzy subgraph of $G(\sigma,\mu)$ if $\tau(u) \leq \sigma(u)$ for all u in V and $\rho(u,v) \leq \mu(u,v)$ for all u, v in V.

Definition 2.3

A fuzzy subgraph $H(\tau,\rho)$ is said to be a spanning sub graph of $G(\sigma,\mu)$ if $\tau(u) = \sigma(u)$ for all u in V. In this case the two graphs have the same fuzzy node set, they differ only in the arc weights.

Definition 2.4

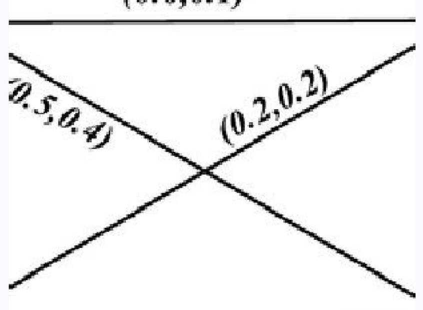
Let $G(\sigma,\mu)$ be a fuzzy graph and τ be fuzzy subset of σ, that is, $\tau(u) \leq \sigma(u)$ for all u in V. Then the fuzzy subgrpah of $G(\sigma,\mu)$ induced by τ is the maximal fuzzy subgraph of $G(\sigma,\mu)$ that has fuzzy node set τ. Evidently, this is just the fuzzy graph $H(\tau,\rho)$ where $\rho(u,v) = \tau(u) \wedge \tau(v) \wedge \mu(u,v)$ for all u,v in V.

Definition 2.4

The underlying crisp graph of a fuzzy graph $G(\sigma,\mu)$ is denoted by $G^* = (\sigma^*, \mu^*)$, where $\sigma^* = \{u \in V \mid \sigma(u) > 0\}$ and $\mu^* = \{(u,v) \in V \times V \mid \mu(u,v) > 0\}$.

Definition 2.5

A fuzzy graph $G(\sigma,\mu)$ is a strong fuzzy graph if $\mu(u,v) = \sigma(u) \wedge \sigma(v)$ for all $u, v \in \mu^*$ and is a complete fuzzy graph if $\mu(u,v) = \sigma(u) \wedge \sigma(v)$ for all u, v in σ^*. Two nodes u and v are said to be neighbors if $\mu(u,v) > 0$.



The study of vertex-transitive graphs has a long and rich history in discrete mathematics. 2. , n}, νL′(x) ≤ ∧{νA(x1) ∨ νA(x2) ∨ . Then G′ is weakly connected if and only if < A ∪ A−1 >⊇ V − v1, where A−1 = {x−1 : x ∈ A}. Similarly, we have Remark 4.2. Let (L, ∗) be a semigroup and A = (μA, νA) be an intuitionistic fuzzy subset of L. We now observe the following definition and lemma to study different types of connectedness of G. Also ψ(a) = b. In this paper, we will write xy ∈ E to mean x → y ∈ E, and if e = xy ∈ E, we say x and y are adjacent such that x is a starting node and y is an ending node. Namboothiri et al.[18] studied Cayley fuzzy graphs. Thus A′ = (μ′A, ν′A) is the meet of all intuitionistic fuzzy subsemigroup containing (μA, νA). By routine computations, it is easy to see from Fig. By Remark 6.1 and by Theorems 4.5, 5.8, Theorem 6.5. G is semi α−connected if and only if (< A >α ∪ < A−1 >α) ⊇ V − v1. Then we define A−1 as intuitionistic fuzzy subset of L given by A−1(x) = A(x−1) for all x ∈ L. ∨ νA(xn) : x = x1x2. Conversely, suppose that A = (μA, νA) is an intuitionistic fuzzy subsemigroup of (G, ∗). Then intuition- istic fuzzy relation R is symmetric if and only if (μA(x), νA(x)) = (μA(x−1), νA(x−1)) for all x ∈ V. Theorem 3.7. The Cayley intuitionistic fuzzy graph G is vertex transitive. ∧μA(xn) : x = x1x2 . Definition 2.9. Let X be intuitionistic fuzzy set. Example 3.5. Consider the group Z3 and take V = Z3 = {0, 1, 2}. Wu [22] discussed fuzzy digraphs. Again , if μA(x) ≠ 0, νA(x) ≠ 0, then by definition of μ′A(x) and ν′A(x), we have μ′A(xy) ≥ μA(x) ∧ μA(y) and ν′A(xy) ≤ νA(x) ∨ νA(y). xn with μA(xi) > 0 for i = 1, 2, . Atanassov added a new component (which determines the degree of nonmembership) in the definition of fuzzy set. Then the fuzzy relation R on V × V defined by induces a fuzzy graph G = (V,R), called the Cayley fuzzy graph induced by the (V, ∗, μ). Max Dehn in his unpublished lectures on group theory from 1909-10 reintroduced Cayley graphs under the name Gruppenbild (group diagram), which led to the geometric group theory of today. Let u, v ∈ V. The intuitionistic fuzzy relation R satisfies μR(x, y) + νR(x, y) ≤ 1 for all x, y ∈ X. By Remark 4.1,4.2 and by Theorem 5.3, Theorem 5.10. 2 that G = (V,R) is a Cayley intuitionistic fuzzy graph, and it is regular. Two vertices g1 and g2 are adjacent if g2 = g1.s, where s ∈ S. Suppose that R is anti symmetric and let x ∈ V. Let G denotes the Cayley intuitionistic fuzzy graphs G = (V, R) induced by (V, ∗, A) and G′ = (V′, R′) be the crisp Cayley graph induced by (V′, ∗, A). Theorem 3.13. Conversely, suppose that the conditions (i), (ii) and (iii) hold. For other notations, terminologies and applications not mentioned in the paper, the readers are referred to [5-7,11,21]. Then the subsemigroup generated by A is the meet of all intuitionistic fuzzy subsemigroups of L which contains A. TABLE 1R(a, b) for Cayley intuitionistic fuzzy graph FIGURE 2Cayley Intuitionistic fuzzy graph By routine computations, it is easy to see from Fig. In-regular digraphs are defined similarly. Let G denotes the Cayley intuitionistic fuzzy graphs G = (V, R) induced by (V, ∗, A). Cayley Intuitionistic Fuzzy Graphs In this section, we introduce Cayley intuitionistic fuzzy graphs and prove that all Cayley intuitionistic fuzzy graphs are regular. By Remark 4.1,4.2 and by Theorem 5.2, Theorem 5.9. G is semi- connected if and only if supp (< A > ∪ < A−1 >) ⊇ V − v1. We also describe different types of α- connectedness in Cayley intuitionistic fuzzy graphs. Let (V, ∗) be a group and let μ be a fuzzy subset of V . Hence μL′(x) ≥ μ′A(x), νL′(x) ≤ ν′A(x), for all x ∈ L. Definition 2.3. Let (V, ∗) be a group and A be any subset of V . Therefore, (< μα >,< να >) = (< μ >α,< ν >α). Atanassov [8] introduced the concept of intuitionistic fuzzy relations and intuitionistic fuzzy graphs and further were studied in [4,12,19,20]. Definition 3.1. An intuitionistic fuzzy digraph of a digraph G∗ is a pair G = (A, B), where A =< V, μA, νA > is an intuitionistic fuzzy set in V and B =< V × V, μB, νB > is an intuitionistic fuzzy relation on V such that 0 ≤ μB(xy)+νB(xy) ≤ 1 for all x, y ∈ V. Hence R is anti symmetric. In this paper, we introduce the notion of Cayley intuitionistic fuzzy graphs and investigate some of their properties. For any subset A of X, the support of A is the set{x ∈ X|μA(x) ≥ 0, νA(x) > 0}. It is denoted by Definition 2.10. It is denoted by Aα. Note that Hence, G is regular. Let x, y ∈ L. We discuss connectedness in Cayley intuitionistic fuzzy graphs. Definition 2.6 ([18]). ∧νL′ (xn) ≤ νA(x1) ∧ νA(x2) ∧ . Now Hence R is reflexive if and only if μA(1) = 1 and νA(0) = 0. Theorem 5.3. Let A be any subset of a set V′ and G′ = (V′, R′) be the Cayley graph induced by the triplet (V′, ∗, A). Then G′ is semi-connected if and only if < A > ∪ < A−1 >⊇ V − v1, where A−1 = {x−1 : x ∈ A}. An intuitionistic fuzzy relation R = (μR(x, y), νR(x, y)) in a universe X × X (R(X → X), for short) is an intuitionistic fuzzy set of the form where μR : X × X → [0, 1] and νR : X × X → [0, 1]. Then G′ is locally connected if and only if < A >=< A−1 >, where A−1 = {x−1 : x ∈ A}. Let a, b ∈ V. The Cayley graph was first considered for finite groups by Cayley in 1878. A finite Cayley intuitionistic fuzzy graph G is quasi connected if and only if it is connected. Then by Theorem 3.15, R is partial order. Let G is locally connected if and only if supp(< A >) = supp(< A−1 >). Definition 5.6. Let (L, ∗) be a group and A be an intuitionistic fuzzy subset of L. Hence {x : μA(x) ∨ μA(x−1) > 0, νA(x) ∧ νA(x−1) > 0}. We notice that Cayley intuitionistic fuzzy graphs are actually intuitionistic fuzzy digraphs. Prominent examples of vertex-transitive graphs are Cayley graphs which are important in both theory as well as applications, e.g., Cayley graphs are good models for interconnection networks. Then A′ is said to be an intuitionistic fuzzy subsemigroup of S if for all x, y ∈ S, μA′(xy) ≥ min(μA′(x), μA′(y)) and νA′(xy) ≤ max(μA′(x), νA′(y)). 5. Theorem 6.3. G is α−connected if and only if < A >α⊇V − v1. It is denoted by < A >. Theorem 3.17. It was introduced by Zadeh in 1965, and the concepts were pioneered by various independent researches. Then for any x ∈ L with x = x1x2 . An intuitionistic fuzzy set (IFS, for short) on a universe X is an object of the form where μA(x) ∈ [0, 1] is called degree of membership of x in A and νA(x) ∈ [0, 1] is called degree of nonmembership of x in A, and μA, νA satisfies the following condition for all x ∈ X, μA(x) + νA(x) ≤ 1. , vn is defined as min(μ2(vi, vj)) for all i and j and is denoted by Sμ. It is denoted by supp(A). Then G′ is connected if and only if < A > ⊇ V − v1. Then G is said to be: Remark 6.1. Let G = (V, R) be any intuitionistic fuzzy graph, then G is α-connected (weakly α-connected, semi α-connected, locally α-connected or quasi α-connected) if and only if the induce intuitionistic fuzzy graph is connected(weakly connected, semi-connected, locally connected or quasi connected). A fuzzy subset μ on a set X is a map μ : X → [0, 1]. The fuzzy sets give the degree of membership of an element in a given set (and the nonmembership degree equals one minus the degree of membership), while intuitionistic fuzzy sets give both a degree of membership and a degree of nonmembership which are more-or-less independent from each other, the only requirement is that the sum of these two degrees is not greater than 1. Now for any x, y ∈ V, we have (x−1y), (y−1x) ∈ V. Example 3.3. Consider an intuitionistic fuzzy digraph G of G∗ = (V,E), where V = {v1, v2, v3, v4}, E = {v1v2, v2v3, v3v4, v4v1}. That is R(1, x) ∨ R(x, 1) > 0. Hence (μ′A, ν′A) is an intuitionistic fuzzy subsemigroup of L containing (μA, νA). Theorem 5.7. G is connected if and only if supp < A >⊇ V − v1. Theorem 3.8. Every vertex transitive intuitionistic fuzzy graph is regular. Also for any α ∈ [0, 1], then we have the following results. By Remark 4.1,4.2 and by Theorem 5.1, Theorem 5.8. G is weakly connected if and only if supp (< A∪A−1 >) ⊇ V−v1. Definition 2.12. Note that a generating set S is minimal if S generates G but no proper subset of S does. For any x ∈ V, (R ∨ R−1)(1, x) > 0. Definition 2.5 ([22]). Define μA : V → [0, 1] and νA : V → [0, 1] by μA(0) = μA(1) = μA(2) = 0.5, νA(0) = νA(1) = νA(2) = 0.4. Then the Cayley intuitionistic fuzzy graph G = (V,R) induced by (Z3, +, A) is given by the following Table 1 and Figure 2. Theorem 3.10. By Remark 6.1 and by Theorems 4.5, 5.11, This completes the proof. Then for any x ∈ V, Conversely, suppose that (μA(x), νA(x)) = (μA(x−1), νA(x−1)) for all x ∈ V. For any subset A and for α ∈ [0, 1], {x|μA(x) > α, νA(x) < α} is called strong α - cut of A. Arrows on the arcs are used to encode the directional information: an arc from vertex (node)x to vertex y indicates that one may move from x to y but not from y to x. Let G denote an intuitionistic fuzzy graph G = (V,R) induced by the triple (V, ∗, A). Furthermore, the relation R in the above definition describes the strength of each directed edge. For any subset A and for α ∈ [0, 1], {x|μA(x) ≥ α, νA(x) ≤ α} is called α - cut of A. Suppose that R is symmetric. Then intuitionistic fuzzy subset < A > is precisely given by < μA >(x) = ∨{μA(x1)∧μA(x2)∧ . A Cayley graph (G, S) has elements of G as its vertices, the edge-set is given by {(g, gs) : g ∈ G, s ∈ S}. Hence G is vertex transitive. ∧ μA(xn) and νL′(xi) ≤ νL′(x1) ∧ νL′(x2)∧ . Suppose R is a linear order. , vn is defined as max(ν2(vi, vj)) for all i and j and is denoted by Sν. Theorem 5.1. Let A be any subset of V′ and G′ = (V′, R′) be the Cayley graph induced by (V′, ∗, A). Proof. ∨ νA(xn) : x = x1x2 . This implies that R(1, x) ∨ R(x, 1) > 0. , n, we have μL′(xi) ≥ μL′(x1) ∧ μL′(x2) ∧ . Thus μL′(x) ≥ ∨{μA(x1) ∧ μA(x2)∧ . Then R is called an intuitionistic fuzzy linear order relation on X if it satisfies the following conditions: 3. For each x, y ∈ V, Therefore, R(ψ(x), ψ(y)) = R(x, y). Let G = (V, R) be an intuitionistic fuzzy graph. Then for any x, y ∈ V, Hence Hence R is transitive. Define ψ : V → V by ψ(x) = ba−1x ∀x ∈ V. Theorem 5.5. Let G′ = (V′, R′) be the Cayley graph induced by the triplet (V′, ∗, A), where V′ is finite. Rosenfeld [17] introduced the fuzzy analogue of several basic graph-theoretic concepts. An intuitionistic fuzzy relation R is transitive if and only if (μA, νA)is an intuitionistic fuzzy subsemigroup of (G, ∗). That is ∨{μR(z) ∧ μR(z−1xy)|z ∈ V } ≤ μR(xy) and ∧{νR(z) ∨ νR(z−1xy)|z ∈ V } ≥ νR(xy). By Remark 6.1 and by Theorems 4.5, 5.10, Theorem 6.7. A finite Cayley intuitionistic fuzzy graph G is quasi α−connected if and only if it is α−connected. Then by Theorem 3.15, the conditions (i),(ii) and (iii) are satisfied. xn with νA(xi) > 0 for i = 1, 2, . An intuitionistic fuzzy relation R is a partial order if and only if A = (μB, νB) is an intuitionistic fuzzy subsemigroup of (V, ∗) satisfying Theorem 3.16. . Then G′ is quasi connected if and only if it is connected. ∧ νA(xn). FIGURE 1Intuitionistic fuzzy digraph Definition 3.4. Let (G, ∗) be a group and let S be a nonempty finite subset of G. Theorem 4.5. Let (L, ∗) be a semigroup and A = (μA, νA) be an intuitionistic fuzzy subset of L. Now let L′ be any intuitionistic fuzzy subsemigroup of L′ containing (μA, νA). Therefore, μ′A(xy) ≥ μA(x) ∧ μA(y) and ν′A(xy) ≤ νA(x) ∨ νA(y). Then the Cayley graph induced by (V, ∗, A) is the graph G = (V,R), where R = {(x, y) : x−1y ∈ A}. Definition 4.2. Let (L, ∗) be a semigroup and let A = (μA, νA) be an intuitionistic fuzzy subset of L. That is x−1y = 1. Kaufmann's initial definition of a fuzzy graph [13] was based on Zadeh's fuzzy relations [24]. ∧ μA(xn) : x = x1x2 . For any α ∈ [0, 1], let Aα be α− cut of be the strong α− cut of A. Definition 2.8. Let X be intuitionistic fuzzy set. Theorem 3.14. Hence (R ∨ R−1)(x, y) > 0. A digraph is a graph whose edges have direction and are called arcs (edges). Theorem 2.2. All Cayley graphs are vertex transitive. Then for any where (< μα >,< να >) denotes the subsemigroup generated by (μα, να) and < (μ, ν) > denotes intuitionistic fuzzy subsemigroup generated by (μ, ν). Fuzzy set is a newly emerging mathematical frame work to exemplify the phenomenon of uncertainty in real life tribulations. Let V be a finite set, A =< V, μA > a fuzzy set of V and B =< V × V, μB > a fuzzy relation on V , then the ordered pair (A, B) is called a fuzzy digraph. From Theorem 3.6 and Theorem 3.7, we have. His most important application was the solution of the word problem for the fundamental group of surfaces with genus, which is equivalent to the topological problem of deciding which closed curves on the surface contract to a point [6,7]. Then for any x, y ∈ V, R(x, y) = R(y, x) ⇔ (μA(x−1y), νA(y−1x)). Hence μA(xy) ≥ μA(x) ∧ μA(y) and νA(xy) ≤ μA(x) ∨ νA(y). Shahzamanian et al.[21] introduced the notion of roughness in Cayley graphs and investigated several properties. Cayley graphs induced by Cayley intuitionistic fuzzy graphs Definition 4.1. Let (V, ∗) be a group, let A be an intuitionistic fuzzy set of V and G = (V,R) be the Cayley intuitionistic fuzzy graph induced by (V, ∗, A). It can also be denoted as Definition 2.11. The strength of P = {μ − strength, μ − strength} Definition 6.2. Let G be an intuitionistic fuzzy digraph. Then for all x, y ∈ V, Hence R is symmetric. Let R be an intuitionistic fuzzy relation on universe X. Mordeson and Peng [16] defined the concept of complement of fuzzy graph and studied some operations on fuzzy graphs. , n} for any x ∈ L. Hence ψ is an automorphism on G. The in-degree of a vertex x in G is defined by ind(x) = (indμ(x), indν(x)), where Similarly, the out-degree of a vertex x in G is defined by outd(x) = (outdμ(x), outdν(x)), where An intuitionistic fuzzy digraph in which each vertex has same out-degree r is called an out-regular digraph with index of out-regularity r. Let A′ = (μ′A, ν′A) be an intuitionistic fuzzy subset of S. Definition 2.7 ([8]). Example 4.3. Consider L = Z3 and A = (μA, νA) as in Example 3.5. Then < A > is given by < μA > (0) = 1, < νA > (0) = 0, and < μA > (y) = 0.5, < νA > (y) = 0.5 for y = 1, 2. Definition 3.2. Let G be an intuitionistic fuzzy digraph. Theorem 3.11. Definition 3.6 ([15]). Then R is called an intuitionistic fuzzy equivalence relation on X if it satisfies the following conditions: Definition 2.13. xn with μA(xi) > 0, νA(xi) > 0, for i = 1, 2, . The intuitionistic fuzzy relation R(x, y) on V is defined by R(x, y) = {(μA(x−1y), μA(x−1y))|x, y ∈ G and x−1y ∈ S}. The ν−strength of a path P = v1, v2, . If for all u,v ∈ V, Then Cayley intuitionistic fuzzy graphs are regular. Then by condition (iv), {x : μA(x) ∨ μA(x−1) > 0, νA(x) ∧ νA(x−1) > 0}. Let A′ = (μ′A, ν′A) be an intuitionistic fuzzy subset of L defined by μ′A(x) = ∨{μA(x1) ∧ μA(x2) ∧ . Then intuitionistic fuzzy relation R is reflexive if and only if R(1, 1) = (1, 0), that is, μA(1) = 1 and νA(1) = 0. We present some interesting properties of intuitionistic fuzzy graphs in terms of algebraic structures. Definition 2.4 ([23,24]). Let (S, ∗) be a semigroup. By Remark 4.1,4.2 and by Theorem 5.5, 6. Hence (μA, νA) is an intuitionistic fuzzy subsemigroup of (S, ∗). Then the Cayley intuitionistic fuzzy graph G = (V, R) is an intuitionistic fuzzy graph with the vertex set V = G and let A = (μA, νA) be an intuitionistic fuzzy subset of V. That is, for all x, y ∈ V μA(xy) ≥ μA(x) ∧ μA(y) and νA(xy) ≤ νA(x) ∨ νA(y). , n}, for any x ∈ L. We note that B may not be symmetric relation. A digraph is a pair G∗ = (V,E), where V is a finite set and E ⊆ V × V . View PDFVolume 17, Issue 3, November 2015, Pages 87-96 rights and contentIntuitionistic fuzzy graphsProduct intuitionistic fuzzy graphs Graph theory has numerous applications to problems in different areas including computer science, electrical engineering, system analysis, operations research, economics, networking routing, transportation, and optimization. Theorem 5.4. Let G′ = (V′, R′) be the Cayley graph induced by the triplet (V′, ∗, A). In 1983, Atanassov [9] introduced the concept of intuitionistic fuzzy sets as a generalization of fuzzy sets [23]. We conclude that: Theorem 3.15. 4. R is reflexive if and only if R(x, x) = (1, 0) for all x ∈ V. , n}, < νA >(x) = ∧{νA(x1) ∨ νA(x2) ∨ . Thus μ′A(x) ≤ μL′(x), ν′A(x) ≥ μA(x). Then there is an automorphism f on G such that f(u) = v. An intuitionistic fuzzy relation R is a equivalence relation if and only if (μA, νA) is an intuitionistic fuzzy sub semigroup of (G, ∗) satisfying Proof. Different types of α-connectedness in Cayley intuitionistic fuzzy graphs Definition 6.1. The μ−strength of a path P = v1, v2, . Now for any x ∈ V, we have R(1, x) = (μA(x), νA(x)). Then by Theorem 4.5, we have < supp(A) >= supp < A >. By Remark 4.1,4.2 and by Theorem 5.4, Theorem 5.11. Clearly, ψ is a bijective map. Definition 2.1. Let G be a finite group and let S be a minimal generating set of G. This implies that ∨{R(1, z) ∧ R(z, xy)|z ∈ V } = R2(1, xy) ≤ R(1, xy). Theorem 3.12. Suppose that R is transitive and let x, y ∈ V. Connectedness in Cayley intuitionistic fuzzy graphs In this section, first we state the the basic Theorems which are used to prove the forthcoming Theorems. Point-to-point interconnection networks for parallel and distributed systems are usually modeled by directed graphs (or digraphs). 1 that the intuitionistic fuzzy digraph is nether out-regular digraph nor in-regular digraph. Then we conclude the following results. If μA(x) = 0 or μA(y) = 0, then μA(x)∧μA(y) = 0 and νA(x) = 0 or νA(y) = 0, then νA(x) ∨ νA(y) = 0. We define Then it is clear that for any α ∈ [0, 1], the Cayley intuitionistic fuzzy graph induced by (V, ∗, A) induces the Cayley graphs Note that for any Thus for any α ∈ [0, 1], the Cayley intuitionistic fuzzy graph (V, R) induced by Cayley intuitionistic graphs Remark 4.1. Let G = (V, R) be any intuitionistic fuzzy graph, then G is connected(weakly connected, semi-connected, locally connected or quasi connected) if and only if the induce fuzzy graph is connected(weakly connected, semi-connected, locally connected or quasi connected). Preliminaries In this section, we review some elementary concepts whose understanding is necessary fully benefit from this paper. Let G = (V, R) be any vertex transitive intuitionistic fuzzy graph. This implies that (μA(x−1y), νA(y−1x)) = (μA((x−1y)−1), νA((x−1y)−1)). ∧ μL′(xn) ≥ μA(x1) ∧ μA(x2) ∧ . By Remark 6.1 and by Theorems 4.5, 5.9, Theorem 6.6. Let G is locally α−connected if and only if Proof. Equivalently, x = y. A fuzzy binary relation on X is a fuzzy subset μ on X × X. Therefore R is linear order. Then Conversely, suppose that {x : (μA(x), νA(x)) = (μA(x−1), νA(x−1))} = {(1, 0)}. Akram et al.[1-3] introduced many new concepts, including intuitionistic fuzzy hypergraphs, strong intuitionistic fuzzy graphs, intuitionistic fuzzy cycles and intuitionistic fuzzy trees. Theorem 3.9. Cayley intuitionistic fuzzy graphs are in-regular and out-regular. By Remark 6.1 and by Theorems 4.5, 5.7, Theorem 6.4. G is weakly α−connected if and only if < A∪A−1 >α⊇ V−v1. , n}, ν′A(x) = ∧{νA(x1) ∨ νA(x2) ∨ . An intuitionistic fuzzy relation R is anti symmetric if and only if {x : (μA(x), νA(x)) = (μA(x−1), νA(x−1))} = {(1, 1)}. An intuitionistic fuzzy relation R is a linear order if and only if (μB, νB) is an intuitionistic fuzzy subsemigroup of (V, ∗) satisfying Proof. We have used standard definitions and terminologies in this paper. Theorem 5.2. Let A be any subset of a set V′ and G′ = (V′, R′) be the Cayley graph induced by the triplet (V′, ∗, A). Proof follows from Theorem 3.15 and Theorem 3.16. Then R2 ≤ R. Lemma 4.4. Let (L, ∗) be a semigroup and A = (μA, νA) be an intuitionistic fuzzy subset of L. Let X be intuitionistic fuzzy set. Then R is called an intuitionistic fuzzy partial order relation on X if it satisfies the following conditions: Definition 2.14.

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