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**In the Name of Allah
Most Compassionate, Most Merciful**

Edition Word

O Allah, my Lord

Cast felicity in me , facilitate my cause and unknot my tongue to perceive my speech , thanks be upon Him the Evolver of the universe and peace be upon Mohammad and his immaculate and benevolent progeny .

A fledged edition of Al-Bahr , peer reviewed scientific journal, embraces a constellation of research studies pertinent to engineering and natural sciences we do hope to overlap a scientific gap the specialists observe as an academic phenomenon worth being under the lenses of the researchers, that is why there is diversity in the studies to meet the requirements of the journal readership . For the journal, now, comes to the fore , at the efforts of the editorial and advisory boards and the researchers who strain every sinew to publish in Al-Bahr, to be global as to be published in an international publishing house in line with the global scientific journals.

On such an occasion we do pledge the promise of fealty and loyalty to those who observe our issues with love and heed in the International Al-`Ameed for Research and Studies , Department of Cultural and Intellectual Affairs in the Holy Al-`Abbas Shrine and the strenuous endeavour to cull whatever invigorates the scientific interaction and academic research in Iraq and worldwide to create a new generation keeping pace with the development of the current scientific phase and to lay the hands of the researchers, nationwide and worldwide, upon the desired missions.

Thanks be upon Him ,the Evolver ad infinitum .

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Inverse Co-Independent Domination of Graphs

A.A. Omran

Department of Mathematics, College of Education for Pure Science, Babylon University,
Babylon, Iraq

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الخلاصة

في هذا البحث، نقدم نموذجين جديدين من الهيمنة في الرسوم البيانية التي تسمى تشكيلة المجموعة المستقلة الهيمنة وتشكيلة المجموعة المستقلة الهيمنة العكسية وتناقش في بعض الرسوم البيانية.

الكلمات المفتاحية

الهيمنة في الرسوم البيانية، تشكيلة المجموعة المستقلة الهيمنة، وتشكيلة المجموعة المستقلة الهيمنة العكسية.

Abstract

In this paper, we introduce two new models of domination in graphs which are called co-independent dominating set and inverse co-independent dominating set and they are discussed in some graphs.

Keywords

Domination in graphs, Co-independent dominating set, Inverse co-independent dominating set.



1. Introduction

We consider a finite undirected and simple graph $G(E, V)$ with a set $V(G)$ of vertices and a set $E(G)$ of edges. For a vertex $v \in V(G)$, the open neighborhood $N(v)$ of v is the set of vertices adjacent to v , and the closed neighborhood $N[v]$ of v is the set $N(v) \cup \{v\}$.

A subgraph H of a graph G is said to be induced (or full) if, for any pair of vertices x and y of H , xy is an edge of H if and only if xy is an edge of G . If H is an induced of G with S is a set of its vertices then H is said to be induced by S and denoted by $G[S]$. [2]

The concept of domination was first studied by Ore [6] and C. Berge [3]. A set $D \subseteq V$ is said to be a dominating set of G if every vertex in $V - D$ is adjacent to some vertex in D . The cardinality of a minimum dominating set D is called the domination number of G and is denoted by $\gamma(G)$. The first one was given independently by Y. Caro and V. Wei [2]. An independent set or stable set is a set of vertices in a graph G , where no two of which are adjacent. An independence number denoted by $\beta(G)$ of a graph G is the cardinality of a maximum independent set of G .

1.1. Definition, [4] (Complete z-ary trees)

A tree T is a connected graph with no cycles. In a tree, a vertex of degree one is referred to as a pendant (leaf) and a vertex which is adjacent to a pendant is a support vertex. A tree is called a rooted tree if one vertex has been designated the root.

In a rooted tree, the parent of a vertex is the vertex connected to it on the path to the root; every vertex except the root has a unique parent. A child of a vertex v is a vertex of which v is the parent. In a rooted tree, the depth r is the longest length of a path from the root to a vertex v . An internal vertex in a rooted tree is any vertex that has at least one child. A z -ary tree, $z \geq 2$ is a rooted tree in which every vertex has z or fewer children. A complete z -ary tree ($T_{c,z,r}$) is a z -ary tree in which every internal vertex has exactly z children and all pendant vertices have the same depth.

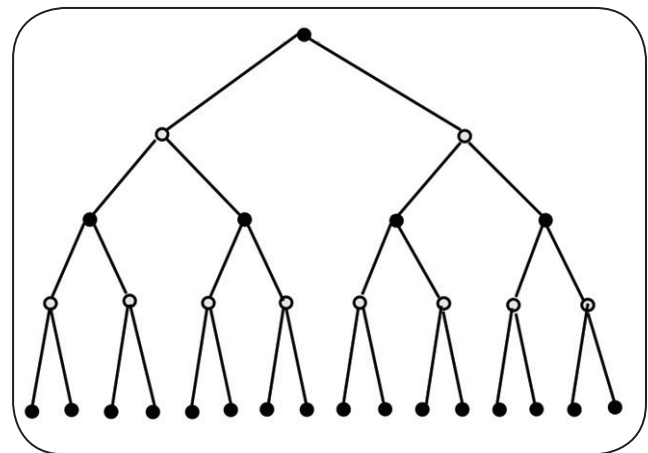


Fig. (1): 1: $T_{c,2,4}$

1.2. Definition [1] (Jahangir graph)

For n and m ; $m \geq 3$ and $n \geq 2$ the Jahangir graph $J_{n,m}$, is a graph of $nm + 1$ vertices consisting of a cycle C_{nm} with one additional central vertex which is adjacent to certain m vertices of C_{nm} where these vertices at distance n in order (sequence) on C_{nm} . Consider v_0 be the center vertex of $J_{n,m}$ and v_1 be one vertex in C_{nm} which is adjacent to v_0 , and $v_1, v_2, v_3, \dots, v_m$ are the other vertices that incident clockwise in C_{nm} .



In this section, we take v_1 is the first vertex adjacent to the center v_0 (see Figure 2) for J_{44} .

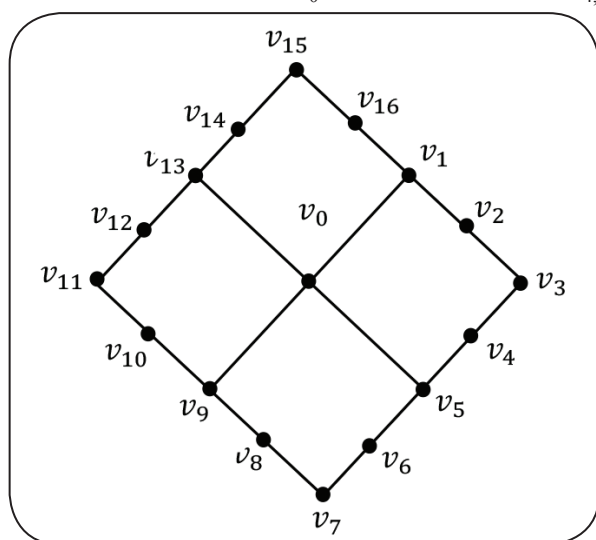


Fig. (2): $J_{4.4}$

Here, we introduce the concept of co-independent domination in graphs. The co-independent domination number for some graphs are determined.

The reader is referred to [5] for survey or results on domination. Any notion or definition of graph which is not found here could be found in [4].

2. Co-independent dominating and inverse co-independent dominating sets

In this section new definitions of domination number are introduced with some results for these definitions in some graphs are discussed.

2.1. Definition

A dominating set $D \subseteq V(G)$ is a co-independent dominating set in G if the complement of D is an independence set. The co-in-

dependent domination number of G , denoted by $\gamma_{\text{coi}}(G)$, is a minimum cardinality over all co-independent dominating set of G .

2.2. Definition

Let $D \subseteq V(G)$ be a minimum cardinal of co-independent dominating set in graph G . If $V - D$ contains co-independent dominating set in G , then this set is called an inverse set of D in G and denoted by D^{-1} . The symbol $\gamma_{\text{coi}}^{-1}(G)$ refers to the minimum cardinality over all inverse co-independent dominating set in G .

2.3. Proposition

- 1) $\gamma_{\text{coi}}(\mathbf{P}_n) = \lfloor n/2 \rfloor$.
- 2) $\gamma_{\text{coi}}(\mathbf{C}_n) = \lfloor n/2 \rfloor$.
- 3) $\gamma_{\text{coi}}(\mathbf{K}_n) = n-1$.
- 4) $\gamma_{\text{coi}}(\mathbf{S}_n) = 1$.
- 5) $\gamma_{\text{coi}}(\mathbf{K}_{n,m}) = \min\{n, m\}$.

For a complete z -ary tree $G \equiv T_{-}(c, z, r)$ with n vertices, have the following co -independence domination number:

2.4. Theorem

$$\gamma_{coi}(G) = \frac{z^{r+1} \left(1 - z^{-2} \left(\left\lfloor \frac{r-1}{2} \right\rfloor + 1 \right) \right)}{z^2 - 1}.$$

Proof.

Consider $D^{coi} = \bigcup_{i=0}^{\lfloor \frac{r-1}{2} \rfloor}$ where D_i is the set of all vertices with depth $r-1-2i$ in $T_{s,z,r}$ and



$E_i = \{v: v \text{ is a vertex of depth } r-2i, r-1-2i \text{ and } r-2-2i \text{ in } G\}, i=0,1,\dots, \lfloor (r-1)/2 \rfloor$. It is clear that D_0 is the minimum dominating and $E_0 - D_0$ is an independent set in $G[E_0]$. Also D_1 is the minimum dominating set in $G[E_1]$ and $E_1 - D_1$ is an independent set in $G[E_1]$ and so on.... Thus D^{coi} is the co-independent dominating set in G with $|D^{\text{coi}}| = \sum_{i=0}^{\lfloor \frac{r-1}{2} \rfloor} z^{r-1-2i}$. Let's consider that there is a set F of vertices such that $|F| < |D^{\text{coi}}|$, F is not co-independent dominating set in G , since $V-F$ is not an independent set (it contains at least two adjacent vertices). Thus $\gamma_{\text{coi}}(G) = \sum_{i=0}^{\lfloor \frac{r-1}{2} \rfloor} z^{r-1-2i} = \frac{z^{r+1}(1-z^{-2}(\lfloor \frac{r-1}{2} \rfloor + 1))}{z^2 - 1}$. \square

2.5. Theorem

$$\gamma_{\text{coi}}^{-1}(G) = \frac{z^{r+2}(1-z^{-2}(\lfloor \frac{r}{2} \rfloor + 1))}{z^2 - 1}.$$

Proof.

Consider $(D^{\text{coi}})^{-1} = \bigcup_{i=0}^{\lfloor \frac{r-1}{2} \rfloor} D_i$, where D_i is the set of all vertices with depth $r-2i$ in $T_{c,z,r}$ and $E_i = \{v: v \text{ is a vertex of depth } r+1-2i, r-2i \text{ and } r-1-2i \text{ in } T_{c,z,r}\}, i=0,1,\dots, \lfloor r/2 \rfloor$. $E_0 = \{v: v \text{ is a vertex of depth } r \text{ and } r-1 \text{ in } T_{c,z,r}\}$. It is clear that D_0 is the minimum co-independent set in $G[E_0]$. As same the manner in the previous theorem $(D^{\text{coi}})^{-1}$ is the minimum dominating set in G where, $(D^{\text{coi}})^{-1} \subseteq V - D^{\text{coi}}$.

$$\text{Thus } \gamma_{\text{coi}}^{-1}(T_{c,z,r}) = \sum_{i=0}^{\lfloor \frac{r}{2} \rfloor} z^{r-2i} = \frac{z^{r+2}(1-z^{-2}(\lfloor \frac{r}{2} \rfloor + 1))}{z^2 - 1}.$$

We note that if $r \equiv 0 \pmod{2}$, then $E_{\lfloor (r-1)/4 \rfloor} = \{v: v \text{ is a vertex of depths } 1 \text{ or } 0\}$. \square

For Jahangir $J_{-}(n,m)$ with $n \geq 3$, we have the following co-independence domination number:

2.6. Theorem

$$\gamma_{\text{coi}}(J_{n,m}) = \left\lfloor \frac{mn}{2} \right\rfloor + \left\lfloor \frac{n}{2} \right\rfloor - \left\lfloor \frac{n}{2} \right\rfloor.$$

Proof.

Consider $D = \{v_{2i+1}; i = 0, 1, \dots, \lfloor \frac{mn}{2} \rfloor - 1\}$, then we have two cases as follows.

(i) If n is odd, then D is the minimum dominating set and the set of vertices $V-D$ is not independent set in $J_{n,m}$, since v_0 is adjacent to some vertices in $V-D$. For this reason we add v_0 to D . Therefore $D \cup \{v_0\}$ is a dominating set in $J_{n,m}$, and $V-(D \cup \{v_0\})$ is independent set in $J_{n,m}$, then $\gamma_{\text{coi}}(J_{n,m}) \leq |D \cup \{v_0\}| = \lfloor mn/2 \rfloor + 1$. If there is a set F of vertices; $|F| < \lfloor mn/2 \rfloor + 1$, then F is not co-independent dominating set, since $G[V-F]$ contains at least two adjacent vertices. Thus $D \cup \{v_0\}$ is minimum co-independent dominating set in $J_{n,m}$, and we have $\gamma_{\text{coi}}(J_{n,m}) = \lfloor mn/2 \rfloor + 1$.

(ii) If n is even, then D is minimum dominating set such that the set of vertices

$V-D$ is independent set in $J_{n,m}$, since D has no vertex adjacent to v_0 , then $\gamma_{\text{coi}}(J_{n,m}) \leq \lfloor mn/2 \rfloor$. Again if F is a set of vertices; $|F| < |D|$, then F is not co-independent dominating set, since $G[V-F]$ contains at least two adjacent vertices. Thus D is minimum co-independence dominating set, and $\gamma_{\text{coi}}(J_{n,m}) = mn/2$.

We combine the formulas in (i) and (ii) as one formula for any n , we get

$$\gamma_{\text{coi}}(J_{n,m}) = \left\lfloor \frac{mn}{2} \right\rfloor + \left\lfloor \frac{n}{2} \right\rfloor - \left\lfloor \frac{n}{2} \right\rfloor. \quad \square$$

2.7. Theorem

There is no inverse co-independent dom-



inating set in $J_{n,m}$.

Proof.

Consider $(D^{\text{coi}})^{-1} = V - D^{\text{coi}}$, where D^{coi} is a minimum co-independent dominating set in $J_{n,m}$, there are two cases which depend on n as follows.

(i) If n is even there is no any vertex in $(D^{\text{coi}})^{-1}$ dominate the vertex v_0 . Thus there is no any dominating set in $J_{n,m}$ such that the vertices of $(D^{\text{coi}})^{-1}$ contains in $V - D^{\text{coi}}$.

(ii) If n is odd then $(D^{\text{coi}})^{-1}$ is not co-independence dominating set since $V - D^{\text{coi}}$ not independent (there are some vertices adjacent to v_0) and we cannot include v_0 to the set $(D^{\text{coi}})^{-1}$ since $v_0 \in D^{\text{coi}}$. Thus there is no any dominating set in $J_{n,m}$ such that the vertices of $(D^{\text{coi}})^{-1}$ contains in $V - D^{\text{coi}}$. \square

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