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On Matching Girth Domination Number of Graphs

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Abstract: ***A set M of edges of a graph G is a matching if no two edges in M are incident to the same vertex. A set S of vertices in G is a girth dominating set of G if every vertex in V-S is adjacent to at least one vertex of girth graph is called the girth dominating set. the matching number is the maximum cardinality of a matching of G, while the girth domination number of G is the minimum cardinality taken over all girth domination number and is denoted by γ_g (G) also the addition of any edge decreases the girth domination number denoted by γ_{mg} (G).***

Mathematics Subject Classification: 05C69

Keywords: Matching, Domination Number, Girth Domination, Girth Domination Number, Girth dominating set and Matching Girth domination number

1. Introduction

The concept of domination in graphs evolved from a chess board problem known as the Queen problem- to find the minimum number of queens needed on an 8x8 chess board such that each square is either occupied or attacked by a queen. C.Berge [3] in 1958 and 1962 and O.Ore [8] in 1962 started the formal study on the theory of dominating sets. Thereafter several studies have been dedicated in obtaining variations of the concept. The authors in [7] listed over 1200 papers related to domination in graphs in over 75 variation.

Throughout this paper, G (V, E) a finite, simple, connected and undirected graph where V denotes its vertex set and E its edge set. Unless otherwise stated the graph G has n vertices and m edges. Degree of a vertex v is denoted by d (v), the *maximum degree* of a graph G is denoted by Δ (G). Let C_n a cycle on n vertices, P_n a path on n vertices by and a complete graph on n vertices by K_n. A graph is *connected* if any two vertices are connected by a path. A maximal connected subgraph of a graph G is called a *component* of G. The *number of components* of G is denoted by *ω* (G). The *complement* $\bar{G}$ of G is the graph with vertex set V in which two vertices are adjacent iff they are not adjacent in G. A tree is a connected acyclic graph. A *bipartite graph* is a graph whose vertex set can be divided into two disjoint sets V_1 and another in V_2. A *complete bipartite graph* is a bipartite graph with partitions of order $|V_1|$ =m and $|V_2|$=n, is denoted by $K_{m,n}$. A star denoted by $K_{1,n-1}$ is a *tree* with one root vertex and n-1 pendant vertices. A bistar, denoted by B (m, n) is the graph obtained by joining the root vertices of the stars denoted by F_n can be constructed by identifying n copies of the cycle C_3 at a common vertex. A *wheel* graph denoted by W_n is a graph with n vertices formed by connecting a single vertex to all vertices of C_{n-1}. A *Helm* graph denoted by H_n is a graph obtained from the wheel W_n by attaching a pendant vertex to each vertex in the outer cycle of W_n.

The *chromatic number* of a graph G denoted by χ (G) is the smallest number of colors needed to colour all the vertices of a graph G in which adjacent vertices receive different colours. For any real number x, $\lceil x \rceil$ denotes the largest integer greater than or equal to x and $\lfloor x \rfloor$ the smallest integer less than or equal to x. A Nordhaus-Gaddum – type result is a lower or upper bound on the sum or product of a parameter of a graph and its complement. Throughout this paper, we only consider undirected graphs with no loops. The basic definitions and concepts used in this study are adopted from [11].

Given a graph G = (V (G), E (G)), the cardinality $|V(G)|$ of the vertex set V (G) is the order of G is n. The distance d_G (u, v) between two vertices u and v of G is the length of the *shortest path* joining u and v.If d_G (u, v) = 1, u and v are said to be adjacent.

For a given vertex v of a graph G, The open neighbourhood of v in G is the set N_G (v) of all vertices of G that are adjacent to v.
The degree deg_G (v) of v refers to $|N_G(v)|$, and $\Delta(G) = \max\{deg_G(v)$: v ϵ $V(G)\}$. The closed neighbourhood of v is the set $N_G[v] = N_G(v) \cup v$ for $S \subseteq V(G)$, $N_G(S) = \cup_{v \epsilon s} N_G(v)$ and $N_G[v] = N_G(S) \cup S$. If $N_G[v]$==V (G), then S is a dominating set in G. The minimum cardinality among dominating sets in G is called the *domination number* of G and is denoted by $\gamma(G)$.

Definition [18]: In a connected graph G, a chord of a spanning tree T is a line of G which is not in T.Clearly the subgraph of G consists of T and any chord of T has exactly one cycle.

Definition [18]: If T is a regular of degree 2, every component is a cycle and regular graphs of degree 3 are called cubic.

Definition [18]: If all the edges of the girth are the edges of any other cycles in a graph G.

Theorem [18]: Let x be a line of a connected graph G, The following statements are equivalent (1)x is a bridge of G. (2) x is not on any cycle of G. (3)There exist points u and v of G s.t the line x is on every path joining u and v. (4)There exists a partition of v into subsets U and W s.t for any points u∈Uand w∈W the line x is on every path joining u and w.

Theorem [18]: Let G be a connected graph with at least three points. The following statements are equivalent. (1)G is a block (2) Every two points of G lie on a common cycle (3)Every point and line of G lie on a common cycle (4) Every two lines of G lie on a common cycle (5)Given two points and one line of G, there is a path joining the points which contains the line (6)For every three distinct points of G, There is a path joining any two of them which contains the third.

2. Main Results

Definition 2.0: A set S⊂V (G) is called a girth dominating set of G if every vertex in V-S is adjacent to at least one vertex in the girth (cycle) graph of G. The minimum cardinality of a girth dominating set of G is called girth domination number of G denoted by $\gamma_g\ (G)$ also the addition of any edge decreases the girth domination number denoted by $\gamma_{mg}\ (G)$.

Example 2.1: For any graph $|G|=K_4\ =C_3+v=4$ and $\cup N(v_i)\ =C_3$ has girth dominating set of G with $\gamma_{mg}\ (G)$=n-1=3 for n= 4 if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_3$. Hence $\gamma_{mg}\ (G)$=n-1 with $|M| = 0$.

Example 2.2: For any graph $|G|$=C_4. (k_2, k_2, k_2, k_2) and $\cup N(v_i)\ =C_3$ is a girth dominating set of G with $\gamma_{mg}\ (G)$=n-1=3 for n= 4 if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_3$. Hence $\gamma_{mg}\ (G)$=n-1 with $|M| = 2$.

Example 2.3: Every Corona graph of a girth graph G is G∘H = $(C_4 - e) \circ k_1$ has a girth dominating set if V-S= (G-S) ∪ H_v and $|\cup N(H_v)| \neq C_4$ since if $|\cup N(H_v)| = C_4$ and $|\cup N(H_v)| = C_3$ where v_i ∈V-S and there exists M_1, M_2∈M such that N (v_i)= u_i
Suppose if $\cup N(v_i) = C_3\ or\ C_4$ has a girth dominating set of G with $\gamma_g(G)$ =n-1 or n with $|M| = 2$ or 1 hence we have $\gamma_g\ (G)$= n-1 or n for n= 4 if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_3\ or\ C_4$ also $|N(u_i) \cap (V - S)| = 1$, i≠1. Hence $\gamma_{mg}\ (G)$= n-1 or n with $|M| = 2$ or 1 respectively. Hence a graph G has a addition of any edge decreases the girth domination number.

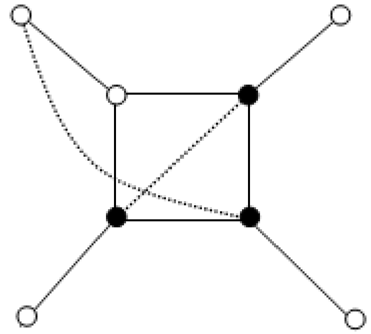

Figure 1: G∘H = $(C_4 - e) \circ k_1, \gamma_{mg}\ (G)$=n-1 with $|M| = 2$.

Example 2.4: Every Corona graph of a girth graph G is G∘H = $(K_4 - e) \circ k_2$ has a girth dominating set if V-S= (G-S)∪ H_v and $|\cup N(H_v)| = C_4$.

Suppose if $\cup N(v_i)\ = C_3$ has a girth dominating set of G with $\gamma_g\ (G)$=n-1=3 for n= 4 if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_3$. Hence $\gamma_{mg}\ (G)$=n-1 with $|M| = 2$.

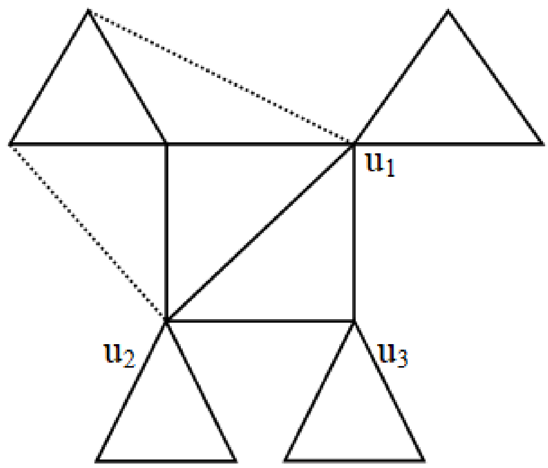

Figure 2: G∘H = $(K_4 - e) \circ k_2, \gamma_{mg}\ (G)$=n-1 with $|M| = 2$

Example 2.5: Every Corona graph of a girth graph G is G∘H = $(k_n - e) \circ k_{n-1}$ has a girth dominating set if V-S= (G-S)∪ H_v and $|\cup N(H_v)| = C_4$.

Suppose if $\cup N(v_i)\ = C_3$ is a girth dominating set of G with $\gamma_g\ (G)$=n-1 for all n if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_{n-1}$. Hence $\gamma_{mg}\ (G)$=n-1 with $|M| = n - 1$.

Example 2.6: Every Corona graph of a girth graph G is G∘H = $(C_4) \circ k_3$ has a girth dominating set if V-S= (G-S)∪ H_v and $|\cup N(H_v)| = C_4$.

Suppose if $\cup N(v_i)\ = C_3$ has a girth dominating set of G with $\gamma_g\ (G)$=n-1=3 for n= 4 if Max{d (u_i, u_j)} ≥n-2, $i \neq j$ where $u_i \in C_3$. Hence $\gamma_{mg}\ (G)$=n-1 with $|M| = 1$.

Example 2.7: Every Corona graph of a girth graph G is G∘H = $(C_5 + e) \circ k_1$ has not a girth dominating set if V-S= (G-S)∪ H_v since $|\cup N(H_v)| \neq C_4\ or\ C_3$ where v_i ∈V-S and there exists M_1, M_2∈M such that N (v_i)= u_i

Suppose if $\cup N(v_i) = C_3$ or C_4 has a girth dominating set of G with γ_{mg} (G) =n-2 or n-1 for n = 5 if Max{d $(u_i, u_j)\} \geq$ n-3, $i \neq j$ where $u_i \in C_3$ or C_4 . Hence γ_{mg} (G)=n-2 or n-1 with $|M| = 2$ or 1 respectively.

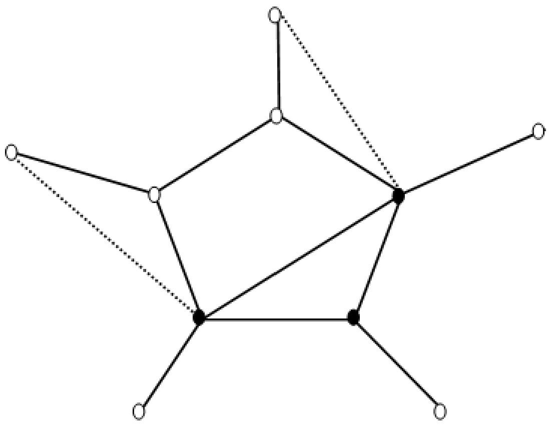

Figure 3: G∘H = $(C_5 + e) \circ k_1, \gamma_{mg}$ (G)=n-2 or n-1 with $|M| = 2$ or 1 respectively

Example 2.8: Every Corona graph of a girth graph G is G∘H = $(C_5 - e) \circ k_1$ cannot have a girth dominating set if V-S= (G-S) $\cup H_v$ and $|\cup N(H_v)| = C_5$ since $|\cup N(H_v)| \neq C_5$ or C_4 or C_3 where $v_i \in$ V-S and there exists $M_1, M_2 \in M$ such that N $(v_i)= u_i$

Suppose if $\cup N(v_i) = C_3$ or $C_4 or$ C_5 has a girth dominating set of G with γ_g (G) $\neq$n-2 with $|M| = 2$ hence we have γ_g (G)= n-1 or n for n = 5 if Max{d $(u_i, u_j)\} \geq$n-2, $i \neq j$ where $u_i \in C_4$ or C_5 also $|N(u_i) \cap$ *(V−S)=1 ,* i≠1. Hence *γmg (G)*= n-1 or n with *M=2* or 1 respectively.

Theorem 2.9: Every Connected graph is of girth dominating set C_3 with $|M| \leq 3$ and its γ_{mg} $(G) = n - (n-3)$ ....or n-2 or n-1 or n with $|M| = n - (n-3) or$ … … … 3 or 2 or 1 respectively.

Proof: Let C_n be the girth subgraph of G and S = C_n with V-S=G-S. If $|\cup N\ (V - S)| = 3$ then C_n is the girth dominating set of G with n≥ 3. If d (u_i, u_j)=1 where $u_i \in C_n$ since if $|\cup N(v_i)| =$ C_n is the girth subgraph of G where v_i ∈V-S and there exists $M_1, M_2 \in M$ such that N (v_i)= u_i if Max{d $(u_i, u_j)\} \geq$ n-1, $i \neq j$ where $u_i \in$ *Cn−1 or Cn* also *Nui∩ (V−S)=1 ,* i≠1. Hence *γmg (G)*= n-1 or n with $|M| = 2$ or 1 respectively.

Suppose if $|\cup N(v_i)| =$ C_n and $|\cup N(v_i)| =$ C_n is the girth subgraph of G where v_i ∈V-S and there exists $M_1, M_2, M_3 \in M$ such that N (v_i)= u_i if Max{d $(u_i, u_j)\} \geq$n-1, $i \neq j$ where $u_i \in C_{n-2}$ or $C_{n-1} or$ C_n also $|N(u_i) \cap$ *(V − S)=1 ,* i≠1. Hence *γmg (G)*= n-2 or n-1 or n with *M=3* or 2 or 1 respectively.

Suppose if $|\cup N(v_i)| =$ C_n and $|\cup N(v_i)| =$ C_n is the girth subgraph of G where v_i ∈V-S and there exists $M_1, M_2, \ldots M_n \in M$ such that N (v_i)= u_i if Max{d $(u_i, u_j)\} \geq$n-1, $i \neq j$ where $u_i \in C_{n-(n-3)}, \ldots\ldots, C_{n-2}$ or $C_{n-1} or$ C_n also $|N(u_i) \cap\ (V - S)| = 1$, i≠1. Hence γ_{mg} $(G) = n - (n-3)$ or........or n-2 or n-1 or n with $|M| = n - (n-3)$ or … … … 3 or 2 or 1 respectively. Hence a graph G has a girth domination number and addition of any edge decreases the girth domination number.

Theorem 2.10: Suppose for any graph $|G| = (k_4 - e).(k_{1,2}, k_{1,2}, k_{1,2}, k_{1,2})$ and $\cup N(v_i) = C_3$ has a matching girth dominating set of G with some conditions. Here if $|\cup N(v_i)| =\ 3$ or 4 its γ_{mg} (G)=3 or 4 with $|M| = 2$ or 0 respectively.

Proof: Suppose for any graph $|G|= (k_4 - e).(k_{1,2}, k_{1,2}, k_{1,2}, k_{1,2})$ and $\cup N(v_i) = C_3$ and if $|\cup N(v_i)| =\ 3$ then we have Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap (V - S)| = 2$, i≠1 hence we have $|N(u_1) \cap$ *V−S= Nu4, u2, v11, v12∩V−S=2, Nu2∩V−S= Nu1, u3, v21, v22∩V−S=2, Nu3∩V−S= Nu4, u2, v31, v32∩V−S=2, Nu4∩V−S= Nu3, u2, v31, v32∩V−S=2,* but N (u_4)∉S and it is belongs to V-S. Hence N (k_4) ≠u_i. Hence N (u_1)= $|(u_3, u_2, u_4, v_{11}, v_{12}) \cap (V - S)| \geq 2$ and its Max{d $(u_i, u_j)\} = 2$ and now we have $|N(u_i) \cap$ *V−S≥2* also its *γmgG*=3 with *M=2.*

If $|\cup N(v_i)| =\ 4$ then we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V - S)| = 2$ and we have N (u_i)= (S, V-S) hence we have γ_{mg} (G)=4 with $|M| = 0$.

Hence a graph G has a girth domination number and addition of any edge decreases the girth domination number.

Theorem 2.11: Suppose for any graph $|G|= (C_4 or\ (k_4 - e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$ has a matching girth dominating set with conditions if $|\cup N(v_i)| =\ 3$ or 4 and its γ_{mg} (G)=3 or 4 with $|M| = 3$ or 0 respectively.

Proof: Suppose for any graph $|G| = (C_4 or\ (k_4 - e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$ has a matching girth dominating set with conditions if $|\cup N(v_i)| =\ 3$ or 4 and its γ_{mg} (G)=3 or 4 with $|M| = 3$ or 0 respectively.

Suppose if $|\cup N(v_i)| =\ 3$, then we have the Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap (V - S)| = 3$

But at least one $u_i \notin C_n = S$ hence $N(u_i) = |N(u_i) \cap$ *V−S≥3* and its *γmgG*=3 with *M=3.*

If $|M| = 2$ that is $|\cup N(v_i)| \neq\ 4$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V - S)| \neq 3$ hence at least one v_i ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 2$ that is $|\cup N(v_i)| =\ 4$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V - S)| = 3$ hence at least three v_i ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap$ *V−S=4* also *γmgG*=4 with *M=0* and its G is isomorphic to $(C_4 or\ (k_4 - e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$.

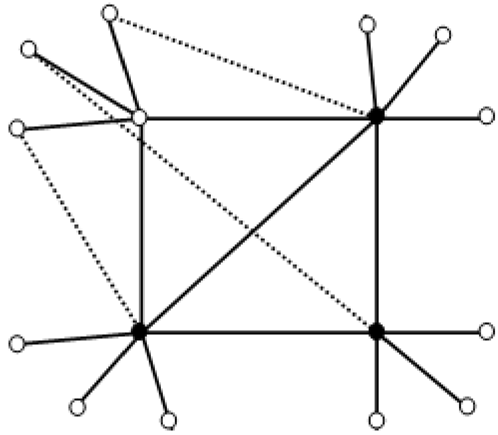

Figure 4: $|G|= (C_4 or\ (k_4 - e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$, $\gamma_{mg}\,(G)$=3 or 4 with $|M| = 3\ or\ 0$ respectively.

Theorem 2.12: Suppose for any graph $|G|= (C_4 or\ (k_4 - e)).(k_{1,4}, k_{1,4}, k_{1,4}, k_{1,4})$ has a matching girth dominating set with conditions if $|\cup N(v_i)| = 3\ or\ 4$ and its $\gamma_{mg}\,(G)$= 4 with $|M| = 0$ respectively.

Proof: Suppose for any graph $|G| = (C_4 or\ (k_4 - e)).(k_{1,4}, k_{1,4}, k_{1,4}, k_{1,4})$ if $|\cup N(v_i)| = 3$ then we have the Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap (V - S)| = 4$ but at least one $u_i \notin C_n$ =S hence $N(u_i) = |N(u_i) \cap V{-}S \geq 3$ and its γmgG=3 but M cannot be equal to 4 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

Hence we must have $|\cup N(v_i)| = 4$. Hence if $|M| = 3$ then we can have at least one v_i ∈V-S

and $\cup N(v_i) \neq C_3$ and if $|M| = 2$ then we have at least 2 v_i ∈V-S and $\cup N(v_i) \neq C_3$ and if $|M| = 1$ then we have at least 3 $v_i \in$ V-S and $\cup N(v_i) \neq C_3$. Hence we have $\cup N(v_i) = C_4$ and its $|N(u_i) \cap (V - S)| = 4$ also its Max{d $(u_i, u_j)\} = 3$. Hence its $\gamma_{mg}\,(G)$=4 with $|M| = 0$.

Theorem 2.13: Suppose for any graph $|G|= (C_4 or\ (k_4 - e)).(k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n})$ has a matching girth dominating set with the following conditions if $|\cup N(v_i)| = 3\ or\ 4$ and its $\gamma_{mg}\,(G)$= 4 with $|M| = 0$ respectively.

Proof: Suppose for any graph $|G| = (C_4 or\ (k_4 - e)).(k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n})$ has a matching girth dominating set with the following conditions if $|\cup N(v_i)| = 3$ then we have the Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap V{-}S = n$ but at least one $ui \notin Cn$=S hence $Nui \cap V{-}S \geq n+1$ and its $\gamma_{mg}\,(G)$=3 but $|M|$ cannot be equal to n≥ 3 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

Hence we must have $|\cup N(v_i)| = 4$. Hence if $|M| = 3$ then we can have at least (n-3)v_i ∈V-S and $\cup N(v_i) \neq C_3$ and if $|M| = 2$ then we have at least (n-2)v_i ∈V-S and $\cup N(v_i) \neq C_3$ and if $|M| = 1$ then we have at least (n-1) $v_i \in$ V-S and $\cup N(v_i) \neq C_3$ Hence we have $\cup N(v_i) = C_4$ and its $|N(u_i) \cap (V - S)| = n$ also its Max{d $(u_i, u_j)\} = 3$. Hence its $\gamma_{mg}\,(G)$=4 with $|M| = 0$.

Theorem 2.14: Suppose for every Corona graph of a girth graph G is G∘H = $|G|= (C_5 or\ (C_5 + e)) \circ (k_1)$ has a girth dominating set if V-S= (G-S) ∪ H_v and $|\cup N(H_v)| \neq C_5$ since if $|\cup N(H_v)| = C_4$ and $|\cup N(H_v)| = C_3$ where v_i ∈V-S and there exists M_1, M_2, M_3∈M such that N (v_i)= u_i and γ_{mg} (G)= n-2 or n-1 or n with $|M| = 2$ or 1 or 0 respectively.

Proof: Suppose for every Corona graph of a girth graph G is G ∘ H = $|G| = (C_5 or\ (C_5 + e)) \circ (k_1)$ has a girth dominating set if $\cup N(v_i) = C_3\ or\ C_4$ or C_5 has a girth dominating set of G with $\gamma_g(G)$ =n-2 or n-1 or n with $|M| = 2$ or 1 or 0 hence we have γ_{mg} (G)=n-2 or n-1 or n for n = 5 if Max { $(u_i, u_j)\} \geq$ n-3, $i \neq j$ where $u_i \in$ $C3\ or\ C4\ or\ C5$ also $Nui \cap (V{-}S)=1$, i≠1. Hence γmg (G)= n-2 or n-1 or n with $|M| = 2$ or 1 or 0 respectively.

Suppose if $|\cup N(v_i)| = n - 2$ then we have the Max{d $(u_i, u_j)\} = n - 3$ and its $|N(u_i) \cap (V - S)| = 1$ but at least one $v_i \in$ V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V - S)| = 1$ also $\gamma_{mg}\,(G)$=3 with $|M| = 2$.

If $|M| = 1$ that is $|\cup N(v_i)| \neq 3$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V - S)| \neq 1$ hence at least one v_i ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 1$ that is $|\cup N(v_i)| = 4$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V - S)| = 1$ hence at least three v_i ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap V{-}S=1$ also γmgG=4 with M=1.

If $|M| = 0$ that is $|\cup N(v_i)| \neq 4$ since we have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V - S)| \neq 1$ hence every v_i ∈V-S is adjacent with $u_i \in C_n$.

If $|M| = 0$ that is $|\cup N(v_i)| = 5$ since we have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V - S)| = 1$ hence every v_i ∈V-S is adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V - S)| = 1$ also $\gamma_{mg}\,(G)$=5 with $|M| = 0$.Hence a graph G has a addition of any edge decreases the girth domination number.

Theorem 2.15: Suppose for every Corona graph of a girth graph G is G∘H = $|G|= (C_5 or\ (C_5 + e)) \circ (k_2)$ has a girth dominating set if V-S= (G-S) ∪ H_v and $|\cup N(H_v)| \neq C_5$ since if $|\cup N(H_v)| = C_4$ and $|\cup N(H_v)| = C_3$ where v_i ∈V-S and there exists M_1, M_2∈M such that N (v_i)= u_i and γ_{mg} (G)= n-2 or n-1 or n with $|M| = 2$ or 1 or 0 respectively

Proof: Suppose for every Corona graph of a girth graph G is G ∘ H = $|G| = (C_5 or\ (C_5 + e)) \circ (k_2)$ if $\cup N(v_i) = C_3\ or\ C_4$ or C_5 has a girth dominating set of G with $\gamma_g(G)$ =n-2 or n-1 or n with $|M| = 4\ or\ 3\ or$ 2 or 1 or 0 hence we have γ_{mg} (G)=n-2 or n-1 or n for n= 5 if Max{d $(u_i, u_j)\} \geq$ n-3, $i \neq j$ where $u_i \in$ $C3\ or\ C4\ or\ C5$ also $Nui \cap (V{-}S) \geq 2$, i≠1. Hence γmg (G)= n-2 or n-1 or n with $|M| = 2$ or 1 or 0 respectively.

If $|\cup N(v_i)| = n-2$ then we have the Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| = 2$ but at least $4v_i$ ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G)$=3 but $|M|$ cannot be equal to 4 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

If $|M| = 3$ and also if $|\cup N(v_i)| = n-2$ then we have the Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| = 2$ but at least one v_i ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G) \neq 3$ but $|M|$ cannot be equal to 4 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

If $|M| = 2$ that is $|\cup N(v_i)| \neq 3$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least $2v_i$ ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 2$ that is $|\cup N(v_i)| = 4$ since we have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least $2\,v_i \in$ V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap$ $V-S=1$ also $\gamma mg G$=4 with $M=2$.

If $|M| = 0$ that is $|\cup N(v_i)| \neq 4$ since we have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V-S)| \neq 1$ hence every v_i ∈V-S is adjacent with $u_i \in C_n$.

If $|M| = 0$ that is $|\cup N(v_i)| = 5$ since we have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V-S)| = 2$ hence every v_i ∈V-S is adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| = 2$ also $\gamma_{mg}(G)$=5 with $|M| = 0$.

Theorem 2.16: Suppose for any Corona graph of a girth graph G is G∘H = $|G|$= $(C_6 or\ (C_6 + e)) \circ (k_2)$ has a girth dominating set if V-S= (G-S) ∪ H_v and $|\cup N(H_v)| \neq C_5$ since if $|\cup N(H_v)| = C_4$ and $|\cup N(H_v)| = C_3$ where v_i ∈V-S and there exists M_1, M_2∈M such that N (v_i)= u_i and $\gamma_{mg}(G)$ = n-3 or n-2 or n-1 or n with $|M| = 4\ or\ 3\ or\ 2$ or 1 or 0.

Proof: Suppose for any Corona graph of a girth graph G is G ∘ H = $|G|$ = $(C_6 or\ (C_6+e)) \circ (k_2)$ if $\cup N(v_i) = C_3\ or\ C_4$ or C_5or C_6 has a girth dominating set of G with $\gamma_{mg}(G)$ =n-3 or n-2 or n-1 or n with $|M| = 4\ or\ 3\ or\ 2$ or 1 or 0 hence we have γ_{mg} (G)=n-3 or n-2 or n-1 or n for n= 6 if Max{d $(u_i, u_j)\}$ ≥n-4, $i \neq j$ where $u_i \in C_3\ or\ C_4\ or\ C_5$ or C_6 also $|N(u_i) \cap (V-S)| \geq 2$, i≠1. Hence γ_{mg} (G)= n-2 or n-1 or n with $|M|$ = 2 or 1 or 0 respectively.

If $|\cup N(v_i)| = n-3$ then we have the Max{d $(u_i, u_j)\} = n-4$ and its $|N(u_i) \cap (V-S)| = 2$ but at least $6v_i$ ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G)$=3 but $|M|$ cannot be equal to 6 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

If $|M| = 3$, If $|\cup N(v_i)| = n-3$ then we have the Max{d $(u_i, u_j)\} = n-4$ and its $|N(u_i) \cap (V-S)| = 2$ but at least $3v_i$ ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G)$ ≠3 but $|M|$ cannot be equal to 3 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

If $|M| = 4$ that is $|\cup N(v_i)| \neq 3$ since we have Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least $4v_i$ ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 4$ that is $|\cup N(v_i)| = 4$ since we have Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least $4v_i$ ∈V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap$ $V-S=2$ also $\gamma mg G$=n-2=4 with $M=4$.

If $|M| = 3$ that is $|\cup N(v_i)| \neq 3$ since we have Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least one v_i ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 3$ that is $|\cup N(v_i)| = 4$ since we have Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least one $v_i \in$ V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G) \neq$ n-2=4 with $|M| = 3$.

If $|M| = 2$ that is $|\cup N(v_i)| \neq 4$ since we have Max{d $(u_i, u_j)\} = n-2 = 4$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence every v_i ∈V-S is adjacent with $u_i \in C_n$.

If $|M| = 2$ that is $|\cup N(v_i)| = 5$ since we have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V-S)| = 2$ hence at least $2v_i \in$ V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap$ $V-S=2$ also $\gamma mg G$=5 with $M=2$.

If $|M| = 1$ that is $|\cup N(v_i)| = 5$ since we have Max{d $(u_i, u_j)\} = n-2$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least one v_i ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 1$ that is $|\cup N(v_i)| = 5$ since we have Max{d $(u_i, u_j)\} = n-2$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least one $v_i \in$ V-S is non adjacent with $u_i \in C_n$ but $|N(u_i) \cap (V-S)| \neq 2$ also $\gamma_{mg}(G) \neq$ n-1=5 with $|M| = 1$.

If $|M| = 0$ that is $|\cup N(v_i)| \neq 5$ since we have Max{d $(u_i, u_j)\} = n-2$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence at least one v_i ∈V-S is non adjacent with $u_i \in C_n$.

If $|M| = 0$ that is $|\cup N(v_i)| = 6$ since we have Max{d $(u_i, u_j)\} = n-1$ and its $|N(u_i) \cap (V-S)| \neq 2$ hence every $v_i \in$ V-S adjacent with $u_i \in C_n$ but $|N(u_i) \cap$ $V-S=2$ also $\gamma mg G$=n=6 with $M=0$.

Theorem 2.17: Suppose for any graph $|G|$= $(C_5 or\ (C_5 + e)).(k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n})$ has a matching girth dominating set with the following conditions if $|\cup N(v_i)| = 3\ or\ 4\ or\ 5$. And $\gamma_g(G)$ = n-2 or n-1 or n with $|M| =$ 3 or 0.

Proof: Suppose for any graph $|G|$ = $(C_5 or\ (C_5 + e)).(k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n}, k_{1,n})$ if $|\cup N(v_i)| = 3$ then we have the Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap (V-S)| =$

3 but at least one $u_i \notin C_n$ =S hence $N(u_i) = |N(u_i) \cap (V-S)| \geq n+2$ and its $\gamma_{mg}(G)$=n+1 but $|M|$ cannot be equal to n+1 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.

Hence we must have $|\cup N(v_i)| = 3$. Hence if $|M| = 3$ then we can have at least (n-3)v_i ∈V-S and $\cup N(v_i) \neq C_3$ and if $|M| = 2$ then we have at least (n-2)v_i ∈V-S and $\cup N(v_i) \neq C_3$ and if $|M| = 1$ then we have at least (n-1)v_i ∈V-S and $\cup N(v_i) \neq C_3$. similarly if $|\cup N(v_i)| = 4$ then we can have Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap$ $V-S=n$ but at least one $ui \notin Cn$=S hence $Nui \cap V-S \geq n+1$ and we must have $\gamma_{mg}(G)$=n+1 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$.Hence we must have $|\cup N(v_i)| = 4$.

If $|M| = 4$ then we can have atmost (n-4)v_i ∈V-S and $\cup N(v_i) \neq C_3$. If $|M| = 2$ then we can have at least (n-2)v_i ∈V-S and $\cup N(v_i) \neq C_3$ that is 3n+5=V and if . If $|M| = 1$ then we can have at least (n-2)v_i ∈V-S and $\cup N(v_i) \neq C_3$. By similar way $|\cup N(v_i)| = 5$

Then we can have Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap$ $V-S=n$, Hence we have $Nvi=C5$ and its $Nui \cap V-S=n$ also its Max{d $(u_i, u_j)\} = 4$. Hence its $\gamma_{mg}(G)$=5 with $|M| = 0$.

Theorem 2.18: Suppose for any graph $|G|$= $(C_6 or (C_6 + e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$ has a matching girth dominating set with condition if $|\cup N(v_i)| = 3$ *or* 4 *or* 5 or 6 and $\gamma_{mg}(G)$ =n-3 or n-2 or n-1 or n with $|M| = 3$ *or* 2 or 1 or 0

Proof: Suppose for any graph $|G|$ = $(C_6 or (C_6 + e)).(k_{1,3}, k_{1,3}, k_{1,3}, k_{1,3})$ if $|\cup N(v_i)| = 3$ then we have the Max{d $(u_i, u_j)\} = 2$ and its $|N(u_i) \cap (V-S)| \neq n$ but it has n=6, then |G| =K_n =$C_{n-3} + 3v = n, C_{n-3} = n - 3v$, that is 3v=6- (n-3) and V-S=6m+3v =6m+3 but 3m+1 vertices are non adjacent with C_3 and (n-3)m + (n-3)- (n-5) = 3m+2 are the vertices adjacent with C_3at least one $u_i \notin C_n$ =S hence $N(u_i) = |N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=3 but $|M|$ cannot be equal to 3m+1 since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$. If m=0, we have $\gamma_{mg}(G) = 3$ with $|M| = 3$.

Suppose if $|\cup N(v_i)| = 4$ then we have the Max{d $(u_i, u_j)\} = 3$ and its $|N(u_i) \cap (V-S)| \neq n$ but it has n=6, then |G| =K_n =$C_{n-2} + 2v = n, C_{n-2} = n - 2v$, that is 2v=6- (n-2) and V-S=6m+n- (n-2) =6m+6- (6-2)=6m+6-4=6m+2 but 2m+0 vertices are non adjacent with C_4 and (n-2)m + (n-4)- (n-6) = 4m+2 are the vertices adjacent with C_4 at least one $u_i \notin C_n$ =S hence $N(u_i)$=$|N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=4 but $|M|$ cannot be equal to 2m since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$. If m=0, we have $\gamma_{mg}(G)$ =4 with $|M| = 2$.

Suppose if $|\cup N(v_i)| = 5$ then we have the Max{d $(u_i, u_j)\} = 4$ and its $|N(u_i) \cap (V-S)| \neq n$ but it has n=6, then |G| =K_n =$C_{n-1} + v = n, C_{n-1} = n - v$, that is v=6- (n-1) and V-S=6m+n- (n-1) =6m+6- (6-1)=6m+6-5=6m+1 but we have [n- (n-1)]m+ov= [6- (6-1)]m+0= (6-5)m=m vertices are non adjacent with C_5 and (n-1)m + (n-1)- (n-2) = 5m+1 are the vertices adjacent with C_5at least one $u_i \notin C_n$=S hence $N(u_i)$=$|N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=5 but $|M|$ cannot be equal to m since by theorem every connected graph is of girth dominating set C_3 with $|M| \leq 3$. If m=0, we have $\gamma_{mg}(G) = 5$ with $|M| = 1$ and hence if m=1 it does not have $\gamma_{mg}(G) \neq$5.

If $|\cup N(v_i)| = 6$ then we have the Max{d $(u_i, u_j)\} = 5$ and its $|N(u_i) \cap (V-S)| \neq n$ but it has n=6, then |G| =$K_n = C_n + 0v = n, C_n = n$, that is v = 6- (n) and V-S=6m+n- (n) = 6m+6- (6)=6m but we have [n- (n)]m+ov= [6- (6)]m+0= (0)m vertices are non adjacent with C_6 and (n)m = 6m are the vertices adjacent with C_6 at least one $u_i \notin C_n$=S hence $N(u_i)$=$|N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=6. If m=0, we have $\gamma_{mg}(G)$ =6 with $|M| = 0$.

Theorem 2.19: Suppose for any graph $|G|$= $(C_n or (C_n + e)).(k_{1,m}, k_{1,m}, k_{1,m}, k_{1,m})$ has a matching girth dominating set with conditions if $|\cup N(v_i)| = 3$ *or* 4 *or* 5 or 6...... n with $|M| = n$ since by theorem every connected graph is of girth dominating set C_n with $|M| \leq n$ and its $\gamma_{mg}(G)$=n-r with $|M| \leq n - r$ but it is $|M| = m$ since we have m≤n-r.

Proof: Suppose for any graph $|G|$ = $(C_n or (C_n + e)).(k_{1,m}, k_{1,m}, k_{1,m}, k_{1,m})$if $|\cup N(v_i)| = n$ then we have the Max{d $(u_i, u_j)\} = n-1$ and its $|N(u_i) \cap (V-S)| \neq n$ but it has n vertices, then |G| =K_n =$C_n + 0v = n, C_n = n$, that is v=n- (n) and V-S=nm+n- (n) = nm+n- (n)=nm but we can have [n- (n)]m+ov= [n- (n)]m+0= (0)m vertices are non adjacent with C_n and (n)m = nm are the vertices adjacent with C_n at least one $u_i \notin C_n$=S hence $N(u_i) = |N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=n with $|M| = 0$.

If $|\cup N(v_i)| = n-1$ then we have the Max{d $(u_i, u_j)\} = n-2$ and its $|N(u_i) \cap (V-S)| \neq n-1$ but it has n vertices, then |G| =K_n =$C_{n-1} + 1v = n$, $C_{n-1} = n-1$, that is v=n- (n-1) and V-S=nm+ [n- (n-1)]m =nm+m=m (n+1) but we can have [n- (n-1)]m+ov= [n- (n)]m+0=m vertices are non adjacent with C_{n-1} and (n-1)m+ [n- (n-1)]v = (n-1)m+1 are the vertices adjacent with C_{n-1}at least one $u_i \notin C_n$=S hence $N(u_i)$=$|N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=n-1 with $|M| \leq n$ but it is $|M| = m$ since we have m≤n-1.

Suppose if $|\cup N(v_i)| = n-2$ then we have the Max{d $(u_i, u_j)\} = n-3$ and its $|N(u_i) \cap (V-S)| \neq n-2$ but it has n vertices, then |G| =K_n =$C_{n-2} + 2v = n$, $C_{n-2} = n-2$, that is v=n- (n-2) and V-S=nm+ [n- (n-2)]m =nm+2m=m (n+2) but we can have [n- (n-2)]m+ov=2m vertices are non adjacent with C_{n-2} and (n-2)m+ [n- (n-2)]v = (n-2)m+2 are the vertices adjacent with C_{n-2}at least one $u_i \notin C_n$=S hence $N(u_i)$=$|N(u_i) \cap (V-S)| \geq m$ and its $\gamma_{mg}(G)$=n-2 with $|M| \leq n$ but it is $|M| = m$ since we have m≤n-2.

If $|\cup N(v_i)| = n-r=m$ then we have the Max{d $(u_i,u_j)\} = n-r-1$ and its $|N(u_i)\cap(V-S)| \neq n-r-1$ but it has n vertices, then |G| =K_n =$C_{n-r}+rv=n, C_{n-r}=n-r$, that is v=n- (n-r) and V-S=n (n-r)+ [n-(n-r)]m =n (n-r)+2 (n-r)= (n-r) (n+2) but we can have [n-(n-r)]m+ov=rm vertices are non *adjacent* with C_{n-r} and also (n-r)m+ [n- (n-r)]v = (n-r)m+r=nm-rm+r are the vertices adjacent with C_{n-r} at least one $u_i \notin C_n$=S hence $N(u_i)$=$|N(u_i)\cap(V-S)| \geq m$ and its $\gamma_{mg}(G)$=n-r with $|M| \leq n-r$ but it is $|M|=m$ since we have m≤n-r.

3. Conclusion

In this paper we found an upper bound for the girth domination number and Relationships between Matching girth domination number and characterized the corresponding extremal graphs. Similarly also the addition of any edge decreases the girth domination number denoted by $\gamma_{mg}(G)$ .with other graph theoretical parameters can be considered.

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