RESEARCH PAPER

EDGE GEODETIC PARAMETERS ON SWITCHING OF A VERTEX

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ABSTRACT
In this paper, we study the concept of edge geodetic parameters on switching of pendant vertex, central vertex of path, switching of arbitrary vertex of a cycle, switching of arbitrary vertex of a wheel, switching of apex vertex of helm graph.

Keywords: Connected edge geodetic set, Edge geodetic set, Restrained edge geodetic set, Split edge geodetic set.
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1. Introduction

All graphs considered here are non-trivial, simple and undirected. The order and size of a graph G are denoted by n and m. A set S of vertices of a graph G is an edge geodetic set if every edge of G lies on an $x-y$ geodesic for some elements x and y in S. The minimum cardinality of an edge geodetic set of G is the edge geodetic number of G denoted by $g_1(G)$. The edge geodetic number (g_1) was introduced and studied in [4]. The concept of connected edge geodetic number (g_{1c}) and restrained edge geodetic number (eg_r) was introduced in [5, 6]. The concept of split edge geodetic number (g_{1s}) and total edge geodetic number (g_{1t}) was introduced in [8, 9]. In our present work, we have obtained the results on different edge geodetic parameters for the graph obtained by switching of pendant vertex and central vertex of P_n, switching of any vertex of C_n, switching of rim vertex of W_n and switching of apex vertex of H_n. For any undefined terms or notations in this paper can be found in Harary [3]. The switching of a vertex v of G means removing all the edges incident to v and adding edges joining v to every vertex which is not adjacent to v in G. The resultant graph is denoted by G. An edge geodetic set $S \subseteq V$ is said to be a total edge geodetic set if the subgraph induced by S has no isolated vertex. The minimum cardinallity of a total edge geodetic set of G is the total edge geodetic number and is denoted by $g_{1t}(G)$. A total edge geodetic set of cardinallity $g_{1t}(G)$ is called $g_{1t}(G)$-set. An edge geodetic set $S \subseteq V$ is said to be a split edge geodetic set if the subgraph $G[V-S]$ induced by $V-S$ is disconnected. The minimum cardinality of a split edge geodetic set of G is the split edge geodetic number and is denoted by $g_{1s}(G)$. An edge geodetic set $S \subseteq V$ is said to be a restrained edge geodetic set if the subgraph $G[V-S]$ induced by $V-S$ has no isolated vertices. The minimum cardinality of a restrained edge geodetic set of G is restrained edge geodetic number of G and is denoted by $eg_r(G)$. An edge geodetic set $S \subseteq V$ is said to be a connected edge geodetic set if the subgraph $G[S]$ induced by S connected. The minimum cardinality of a connected edge geodetic set of G is connected edge geodetic number of G and is denoted by $g_{1c}(G)$. The vertex covering number α_0 is the minimum number of vertices covers all the edges in a connected graph. The vertex independence number of a graph β_0 is the maximum independent vertex set in a graph.

2. Switching of a pendant vertex of P_n

Consider a path $P_n : v_1, v_2, v_3, \dots, v_n$. Now, we obtain the results on switching of pendant vertex. Example: In Figure 1, the graph obtained by switching of a pendant vertex v_1 is shown in which the set of solid vertices is its g_1- set.

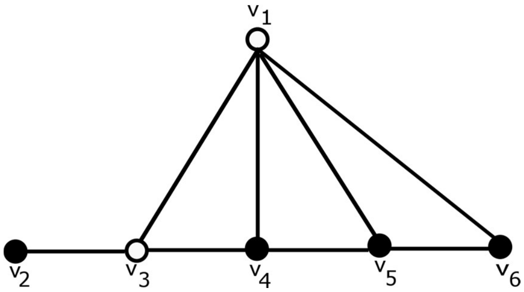

Figure 1: Switching of a pendant vertex v_1

Theorem 2.1. Let $P_n, n \geq 3$ be a path then

$$g_1(\tilde{P}_n) = \begin{cases} n-1, & for\ n = 3,4,5 \\ \alpha_0(P_n) + \left\lceil \frac{n-4}{2} \right\rceil, & for\ \ n \geq 6 \end{cases}$$

Proof. Let $\tilde{P}_n$ be the graph obtained by switching of pendant vertex of P_n. Without loss of generality, let the switched vertex be v_1. Let $V(\tilde{P}_n) = \bigcup_{i=1}^{n} v_i$ where $\Delta(\tilde{P}_n) = n-2 = deg\tilde{P}_n(v_1), deg\tilde{P}_n(v_2) = 1, deg\tilde{P}_n(v_n) = 2, \bigcup_{i=3}^{n-1} deg\tilde{P}_n(v_i) = 3$. Let α_0 be the vertex covering number of path P_n and $\alpha_0(P_n) = \left\lfloor \frac{n}{2} \right\rfloor$. To prove the result we consider the following cases:

Case i) For n=3, $\tilde{P}_3 \cong P_3$. Therefore $g_1(\tilde{P}_n) = 2$.

Case ii) For n=4, let $S = \{v_1, v_2, v_4\}$ be the vertex set with distance between any two vertices is either one or two. Clearly, S is g_1-set of P_4. Therefore, $g_1(\tilde{P}_4) = 3$.

Case iii) For n=5, let $S = \{v_1, v_2, v_4, v_5\}$. Clearly, S is g_1-set. Therefore, $g_1(\tilde{P}_5) = 4$.

Case iv) For $n \geq 6$, let us construct a set of vertices S_1 as follows: $S_1 = \{v_2, v_n\} \cup \{\bigcup_{i=4}^{n-1} v_i\}$ where v_i are the internal non-adjacent vertices of v_2. Clearly, all the edges of $\tilde{P}_n$ lies in geodesic joining any two vertices of S_1 and hence S_1 is $g_1 - set$ Therefore, $g_1(\tilde{P}_n) = \alpha_0(P_n) + \left\lceil \frac{n-4}{2} \right\rceil$.

Theorem 2.2. *Let $P_n, n \geq 6$ be a path. Then* $eg_r(\tilde{P}_n) = g_1(\tilde{P}_n)$.

Proof. Let $V(\tilde{P}_n) = \{v_1, v_2, v_3 \ldots\ldots v_n\}$. Let $S = V(\tilde{P}_n) - \{v_1, v_3\}$ be g_1 –set of $\tilde{P}_n$ and $\langle V(\tilde{P}_n) - S \rangle$ has no isolated vertex. Then the set S itself forms eg_r –set. By Theorem 2.1 $eg_r(\tilde{P}_n) = g_1(\tilde{P}_n)$.

Theorem 2.3. Let $P_n, n \geq 3$ be a path then

$$g_{1t}(\tilde{P}_n) = \begin{cases} n, & \text{for } n = 3,4,5 \\ \alpha_0 + \left\lceil \frac{n-2}{2} \right\rceil, & \text{for } \ n \geq 6. \end{cases}$$

Proof. Let $\tilde{P}_n$ be the graph obtained by switching of pendant vertex v_1 of P_n and $V(\tilde{P}_n) = \{v_1, v_2, \ldots., v_n\}$. Then $|V(\tilde{P}_n)| = n$ and $|E(\tilde{P}_n)| = 2n-4$. We discuss the following cases:

Case i): For $n = 3, n = 4$ and $n = 5$ the result is obvious. Hence $g_{1t}(\tilde{P}_3) = 3, g_{1t}(\tilde{P}_4) = 4, g_{1t}(\tilde{P}_5) = 5$.

Case ii): For $n \geq 5$, by Theorem 2.1, $S_1 = \{v_2, v_n\} \cup \{\bigcup_{i=3}^{n-1} v_i\}$ and $g_1(\tilde{P}_n) = \alpha_0(P_n) + \left\lceil \frac{n-4}{2} \right\rceil$. But S_1 has isolated vertices. Let $S_2 = S_1 \cup \{v_3\}$. Clearly, S_2 is the g_{1t} –set of $\tilde{P}_n$. Therefore, $g_{1t}(\tilde{P}_n) = |S_2| = \alpha_0 + \left\lceil \frac{n-2}{2} \right\rceil$.

Corollary 2.4. For any path $P_n, n \geq 5, g_{1c}((\tilde{P}_n)) = g_{1t}((\tilde{P}_n))$.

3. Switching of internal vertex in a path

The graph obtained by switching the supporting vertices of the pendant vertices becomes disconnected, hence we consider the internal vertices other than the supporting vertices.

Example: We depicted the graph obtained by switching of an internal vertex v_5 as shown in the Figure 2.

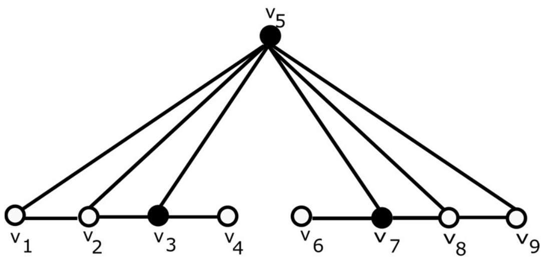

Figure 2: Switching of internal vertex v

The set $S = \{v_1, v_2, v_4, v_6, v_8, v_9\}$ is g_1–set of $\tilde{P}_9$.

Theorem 3.1. For any path $P_n, n \geq 5, g_1(\tilde{P}_n) = \begin{cases} 2, & forn = 5 \\ n-3, & for\ \ n \geq 6. \end{cases}$

Proof. Let $\widetilde{P_n}$ be the graph obtained by switching of pendant vertex of $v_{\left\lceil\frac{n}{2}\right\rceil}$ *or* $v_{\frac{n}{2}+1}$ of path P_n. Let $V(\widetilde{P_n}) = \{v_1, v_2, \ldots., v_n\}, \deg \widetilde{P_n}\left(\frac{n}{2}\right) = n - 3 = \Delta(\widetilde{P_n}), \deg \widetilde{P_n}(v_1) = \deg \widetilde{P_n}(v_n) = 2, and \ \deg \widetilde{P_n}(v_2) = 2, \deg \widetilde{P_n}(v_3) = \ldots.. = \deg \widetilde{P_n}\left(v_{\frac{n}{2}-2}\right) = \deg \widetilde{P_n}\left(v_{\frac{n}{2}+2}\right) = \ldots. = \deg \widetilde{P_n}(v_{n-1}) = 3$.

Let

$$S = \begin{cases} \{v_2, v_4, v_6\}, & \text{for } n = 6 \\ \{v_1, v_3, v_5, v_7\}, & \text{for } n = 7 \\ V(\widetilde{P_n}) - \left\{v_{\frac{n}{2}-2}, v_{\frac{n}{2}+2}\right\}, & \text{for } n \ is \ even \\ V(\widetilde{P_n}) - \left\{v_{\left\lceil\frac{n}{2}\right\rceil-1}, v_{\left\lfloor\frac{n}{2}\right\rfloor+2}\right\}, & \text{for } n \ is \ odd. \end{cases}$$

Thus, S is g_1 −set of $\widetilde{P_n}$. Therefore, $g_1(\widetilde{P_n}) = |S| = n - 3$.

Theorem 3.2. For any path $P_n, n \geq 6$, $g_{1s}(\widetilde{P_n}) = g_1(\widetilde{P_n}) + 1$.

Proof. Let $V(\widetilde{P_n}) = \{v_1, v_2, \ldots., v_n\}$. Without loss of generality, let the switching vertex be $v_{\left\lceil\frac{n}{2}\right\rceil}$ *or* $v_{\frac{n}{2}+1}$ of path P_n. By Theorem 3.1, S be g_1 −set of $\widetilde{P_n}$ and $\langle V(\widetilde{P_n}) - S\rangle$ is connected. Now, consider $S' = S \cup \{v_k\}$, where $\{v_k\}$is a vertex with maximum degree of P_n. Clearly, $\langle V(\widetilde{P_n}) - S'\rangle$ is disconnected. Therefore, $g_{1s}(\widetilde{P_n}) = |S'| = g_1(\widetilde{P_n}) + 1$.

Theorem 3.3. Let $P_n, n \geq 5$, be a path, then $g_{1t}(\widetilde{P_n}) = n - 1$.

Proof. Let $V(\widetilde{P_n}) = \{v_1, v_2, \ldots., v_n\}$ and $v_{\left\lceil\frac{n}{2}\right\rceil}$ *or* $v_{\frac{n}{2}+1}$of path $P_n$be the switching vertex. By Theorem 3.1, S be g_1 −set of $\widetilde{P_n}$. Clearly, $\langle S\rangle$ has no isolated vertex.

Let

$$S_1 = \begin{cases} S \cup \left\{v_{\frac{n}{2}-1}, v_{\frac{n}{2}+1}\right\}, \text{for } n \ is \ even, \\ S \cup \left\{v_{\left\lceil\frac{n}{2}\right\rceil-1}, v_{\left\lfloor\frac{n}{2}\right\rfloor+1}\right\}, \text{for } n \ is \ odd. \end{cases}$$

Clearly, S_1 has no isolated vertex and is g_{1t}-set of $\widetilde{P_n}$ Therefore, $g_{1t}(\widetilde{P_n}) = |S_1| = n - 1$.

Theorem 3.4. For any path $P_n, n \geq 5$, $g_{1c}(\widetilde{P_n}) = g_{1t}(\widetilde{P_n}) + 1$.

Proof. By Theorem 3.3 S_1 is g_{1t} −set and $g_{1t}(\widetilde{P_n}) = n - 1$. But $\langle S_1\rangle$is disconnected. Let $S_2 = S_1 \cup \{v_k\}$, where $\{v_k\}$ is a vertex with maximum degree. Therefore, $g_{1c}(\widetilde{P_n}) = g_{1t}(\widetilde{P_n}) + 1$.

4. Switching of an arbitrary vertex of C_n

In this section, we consider the cycle C_n: $v_1, v_2, v_3, \ldots, v_n, v_1$.

Observation 4.1. Switching of an arbitrary vertex v of C_n means complementing all the edges incident to v while leaving all other edges unchanged. Without loss of generality, let the switched vertex be v_1. Then the vertex set of $\tilde{C}_n$ is : $deg_{C_n}(v_1) = \Delta(\tilde{C}_n) = n - 3, deg_{C_n}(v_2) = deg_{C_n}(v_n) = 1$ and $deg_{C_n}(v_i) = 3$ for all $i \in \{3,4,5,\ldots.,n-1\}$.

Example: We depicted the graph obtained by switching of arbitrary vertex v_1 as shown in the Figure 3.

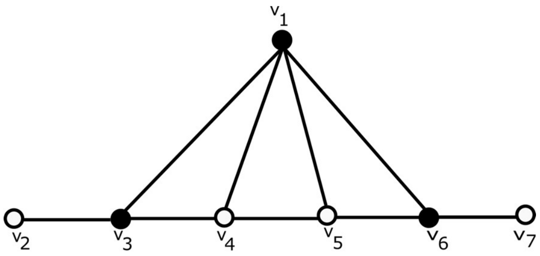

Figure 3: Switching of arbitrary vertex v_1

The set $S = \{v_2, v_4, v_5, v_7\}$ is g_1−set of $\widetilde{C_7}$.

Theorem 4.2. If $\tilde{C}_n$is the graph obtained by switching of an arbitrary vertex of cycle $C_n, n \geq 7$ then $g_1(\tilde{C}_n) = eg_r(\tilde{C}_n) = \alpha_0(\tilde{C}_n) + \beta_0(\tilde{C}_n) - 3$.

Proof. Let $V(\widetilde{P_n}) = \{v_1, v_2, \ldots., v_n\}$. Here, without loss of generality, we have switched the vertex v_1. Let $\alpha_0(C_n) = \beta_0(C_n) = \frac{n}{2}$ for n is even and $\alpha_0(C_n) = \frac{n+1}{2}, \beta_0(C_n) = \frac{n-1}{2}$for n is odd. We consider the following cases:

Case i): For n=4 $g_1(\tilde{C}_n) = 3$ as $\tilde{C}_n \cong K_{1,3}$.

For $n = 5$. We construct $S = \{v_1, v_2, v_5\}$ where v_2 and v_5 are the pendant vertices of $\tilde{C}_n$. Then $|S| = 3$. Therefore, $g_1(\tilde{C}_n) = 3$. For $n = 6$. Let $S = \{v_1, v_2, v_4, v_6\}$ with $|S| = 4$. Clearly, S is g_1-set of $\tilde{C}_n$ as every vertex of S lies in geodesic joining every pair of vertices of $\tilde{C}_n$. Therefore, $g_1(\tilde{C}_n) = 4$.

Case ii) For $n \geq 7$.

Let

$$S = \begin{cases} \left\{v_2, v_n, v_{2i+2}, v_{2j+3} / 1 \leq i \leq \left\lceil\frac{n-5}{2}\right\rceil, 1 \leq j \leq \left\lfloor\frac{n-5}{2}\right\rfloor\right\}, \text{for } n \ is \ even, \\ \left\{v_2, v_n, v_{2i+2}, v_{2j+3} \leq i \leq \left\lceil\frac{n-4}{2}\right\rceil, 1 \leq j \leq \left\lfloor\frac{n-6}{2}\right\rfloor\right\}, \quad \text{for } n \ is \ odd. \end{cases}$$

Clearly, all the edges of $\tilde{C}_n$ lies in geodesic joining any two vertices of S and hence S is g_1 −set of $\tilde{C}_n$. Therefore, $g_1(\tilde{C}_n) = eg_r(\tilde{C}_n) = \alpha_0(\tilde{C}_n) + \beta_0(\tilde{C}_n) - 3$.

Corollary 4.4 For any cycle $C_n, n \geq 7, g_{1c}(\tilde{C}_n) = \alpha_0(\tilde{C}_n) + \beta_0(\tilde{C}_n) - 1$.

Theorem 4.5. For any cycle $C_n, n \geq$

7,$g_{1s}(\tilde{C}_n) = g_1(\tilde{C}_n) + 1$.

Proof. By the Theorem 4.2, let

$$S = \begin{cases} \left\{v_2, v_n, v_{2i+2,} v_{2j+3} / 1 \le i \le \left\lceil \frac{n-5}{2} \right\rceil, 1 \le j \le \left\lfloor \frac{n-5}{2} \right\rfloor \right\}, \text{for } n \; is \; even, \\ \left\{v_2, v_n, v_{2i+2,} v_{2j+3} / 1 \le i \le \left\lceil \frac{n-4}{2} \right\rceil, 1 \le j \le \left\lfloor \frac{n-6}{2} \right\rfloor \right\}, \text{for } n \; is \; odd. \end{cases}$$

But $\langle V(\tilde{C}_n) - S \rangle$ is connected. Let $S' = \mathrm{S} \cup \{v_k\}$ where $\{v_k\}$ is a vertex with maximum degree. Clearly, $\langle S' \rangle$is disconnected and hence $S'$is $g_{1s}(\tilde{C}_n) - g_1(\tilde{C}_n) + 1$.

5. Switching of a rim vertex of W_n

Consider a wheel $W_n = v_1, v_2, v_3, \ldots, v_{n-1}, x$ where $\{v_1, v_2, v_3, \ldots, v_{n-1}\}$ are called rim vertices of wheel W_n.

Observation 5.1. Let $\widetilde{W}_n$ is the graph obtained by switching of a rim vertex of wheel W_n. Without loss of generality, we switch the rim vertex v_1. The graph possess the following types of vertices: $\deg \widetilde{W}_n = n - 2 = \Delta(\widetilde{W}_n), \deg \widetilde{\widetilde{W}}_n (v_1) = n - 4, \deg \widetilde{W}_n (v_2) = \deg \widetilde{W}_n (v_{n-1}) = 2, \deg \widetilde{W}_n (v_3) = \deg \widetilde{W}_n (v_4) = \cdots = \deg \widetilde{W}_n (v_{n-2}) = 4, \deg \widetilde{W}_n (x) = n - 2$.

Example: In Figure 4, the graph obtained by switching of a rim vertex (say v_1) is shown in which the set of solid vertices is its $g_{1t}-$ set.

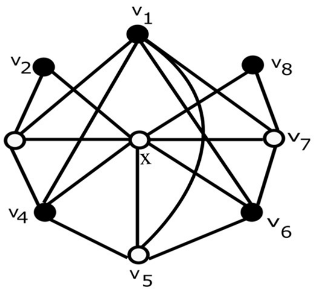

Figure 4: switching of a rim vertex v_1

The g_1-set $S = \{v_1, v_2, v_4, v_6, v_8, v_9\}$ and the edge geodetic number is 6.

Theorem 5.2. For any wheel $W_n, n \ge 7$, $g_1(\widetilde{W}_n) = \begin{cases} \frac{n}{2} + 2, \text{for } n \; is \; even, \\ \left\lceil \frac{n}{2} \right\rceil + 1, \text{for } n \; is \; odd. \end{cases}$

Proof. Let $W_n = C_{n-1} + K_1$ and let $\widetilde{W}_n$ be the graph obtained by switching of rim vertex of W_n . Let $V(\widetilde{W}_n) = \{x, v_1, v_2, \ldots., v_{n-1}\}$. We observe that $|V(\widetilde{W}_n)| = n + 1$ and $|E(\widetilde{W}_n)| = 3n - 5$.

Let us discuss the following cases:

Case i) When n=5. We construct a set of vertices $S_1 = \{x, v_1, v_3, v_4\}$ with $|S_1| = 4$. Clearly, S_1 is g_1- set of $\widetilde{W}_n$. Hence $g_1(\widetilde{W}_n) = 4$.

When n=6. We construct a set of vertices $S_2 = \{x, v_1, v_2, v_3, v_5\}$ with $|S_2| = 5$ and S_2 is g_1- set of $\widetilde{W}_n$. Therefore, $g_1(\widetilde{W}_n) = 5$.

Case ii) Let $n \ge 7$. We construct the set $S_3 = \{x, v_1, v_{n-1}\} \cup v_{2i} / 1 \le i \le \left\lfloor \frac{n-2}{2} \right\rfloor$. Every edge of $\widetilde{W}_n$lies in any geodesic joining two vertices of S_3. Therefore, $S_3$is g_1-set of $\widetilde{W}_n$. Hence, $g_1(\widetilde{W}_n) = |S_3| = \left\lceil \frac{n}{2} \right\rceil + 1$.

Corollary 5.3. For any $\widetilde{W}_n, n \ge 5$, then $g_{1c}(\widetilde{W}_n) = g_{1s}(\widetilde{W}_n) = g_{1t}(\widetilde{W}_n) = g_1(\widetilde{W}_n)$.

6. Switching of apex vertex of H_n

Definition 6.1. The Helm graph H_n is the graph obtained from a wheel W_n by attaching a pendant edge to each of its rim vertices.

Observation 6.2. Let $\widetilde{\boldsymbol{H}}_{\boldsymbol{n}}$be the graph obtained by switching of an apex vertex of Helm graph $\boldsymbol{H}_{\boldsymbol{n}}$, the vertex set of $\widetilde{\boldsymbol{H}}_{\boldsymbol{n}} = \{\boldsymbol{v}, \boldsymbol{v}_1, \boldsymbol{v}_2, \ldots, \boldsymbol{v}_{\boldsymbol{n}}, \boldsymbol{u}_1, \boldsymbol{u}_2, \ldots, \boldsymbol{u}_{\boldsymbol{n}}\}$ where $\{\boldsymbol{v}_1, \boldsymbol{v}_2, \ldots, \boldsymbol{v}_{\boldsymbol{n}}\}$ are rim vertices, $\{\boldsymbol{u}_1, \boldsymbol{u}_2, \ldots, \boldsymbol{u}_{\boldsymbol{n}}\}$ are pendant vertices and x is an apex vertex of $\widetilde{\boldsymbol{H}}_{\boldsymbol{n}}$.

Example: In Figure 5, the graph obtained by switching of an apex vertex (say x) is shown in which the set of solid vertices is its g_1- set.

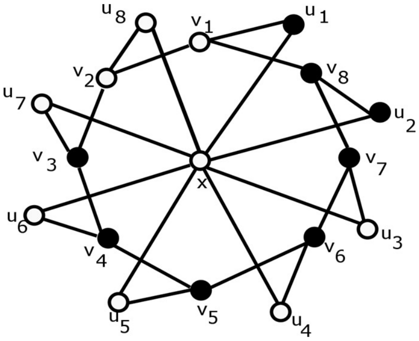

Figure 5: Switching of an apex vertex x

The g_1–set of $\widetilde{H}_8$ is $S = \{v_3, v_4, v_5, v_6, v_7, v_7, u_1, u_2,\}$ so that $g_1(\widetilde{H}_8) = 8$.

Theorem 6.3. Let $H_n, n \ge 6$, be the helm graph then $g_1(\widetilde{H}_n) = n$.

Proof. Let $\widetilde{H}_n$ be the graph obtained by switching of an apex vertex of Helm graph H_n and consider v an apex vertex of H_n. Let $V(\widetilde{H}_n) = \{v, v_1, v_2, \ldots, v_n, u_1, u_2, \ldots, u_n\}$ so that $|V(\widetilde{H}_n)| = 2n+1, |E(\widetilde{H}_n)| = 3n$ and $\deg \widetilde{H_n}\,(v) = n$, $\deg \widetilde{H_n}\,(v_i) = 3$, $\deg \widetilde{H_n}\,(u_j) = 2$, Let us discuss the following cases.

Case i) For n=5. Consider the set $S = \{u_1, u_2, v_3, v_4, v_5\}$ which forms g_1- set of G. Therefore, $g_1(\widetilde{H}_n) = 5$.

Case ii) For $n \geq 6$. Consider the sets $X = \{v_i/3 \leq i \leq n\}$ and $Y = \{u_j\}$ where $\{u_j\}$ are the vertices adjacent to $v_1 and v_n$. Let $S_1 = X \cup Y$. Clearly, S_1 is g_1-set of $\widetilde{H}_n$. Therefore, $g_1(\widetilde{H}_n) = |S_1| = n$.

Corollary 6.4. For the helm graph $H_n, n \geq 6$ then $eg_r(\widetilde{H}_n) = g_{1s}(\widetilde{H}_n) = n$.

Theorem 6.5. Let $\widetilde{H}_n, n \geq 7$ be the graph obtained by switching of an apex vertex in helm graph then $g_{1t}(\widetilde{H}_n) = g_1(\widetilde{H}_n) + 1$.

Proof. Let $\boldsymbol{V(\widetilde{H}_n)} = \boldsymbol{\{v, v_1, v_2, \ldots, v_n, u_1, u_2, \ldots, u_n\}}$.

For $n \geq 7$, by the Theorem 6.3, $S_2 = X \cup Y$ and S_1 is g_1 −set of $\widetilde{H}_n$. But $\langle S_1 \rangle$ has isolated vertices. Let $S_2 = S_1 \cup \{v\}$ where $\{v\}$ is an apex vertex of $\widetilde{H}_n$. Clearly, $\langle S_2 \rangle$has no isolated vertices and hence S_2 is g_{1t} − set of $\widetilde{H}_n$. Therefore, $g_{1t}(\widetilde{H}_n) = |S_2| = g_1(\widetilde{H}_n) + 1$.

Theorem 6.6. Let $\widetilde{H}_n, n \geq 8$ be the graph obtained by switching of an apex vertex in helm graph then $g_{1c}(\widetilde{H}_n) = g_1(\widetilde{H}_n) + 2$.

Proof. By the Theorem 6.3, $\boldsymbol{S_1 = X \cup Y}$ and S_1 is g_1 −set of $\widetilde{H}_n$. Clearly, S_1 has two components. Let $S_2 = S_1 \cup \{v, v_i\}$where $\{v\}$ is an apex vertex and $\{v_i\}$is a vertex adjacent to vertices of X. But $\langle S_2 \rangle$ is connected. Hence, S_2 is g_{1c} − set of $\widetilde{H}_n$.Therefore $g_{1c}(\widetilde{H}_n) = |S_2| = g_1(\widetilde{H}_n) + 2$.

7 CONCLUSIONS

In this paper, we established the results on edge geodetic number, connected edge geodetic number, restrained edge geodetic number, split edge geodetic number on switching of path *Pn*, cycle *Cn*, wheel *Wn* and helm graph *Hn*.

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