Advances and Applications in Mathematical Sciences
Volume 20, Issue 9, July 2021, Pages 1767-1786

GAUSSIAN ANTI MAGIC LABELING IN SOME RELATED GRAPHS

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Abstract

In this paper we examine the existence of Gaussian antimagic labeling for some special graphs such as Shadow, Split, Jewel, Jellyfish, Modified extended duplicate graph of Star and Path, Some Corona graphs like $K_p \odot \overline{K}_t$, $W_p \odot \overline{K}_t$, $S_p \odot \overline{K}_t$, $H_p \odot \overline{K}_t$, Mongolian tent, Umbrella, $C_m + T_1$ graph, Petersen, Coconut tree, Centipede tree and Square graph of path.

I. Introduction

The concept of graph labeling was introduced by Rosa [2] in 1967. Graph labeling is an assignment of integers to the vertices or edges or both subject to certain conditions. In the intervening years various labeling of graphs such as graceful labeling, harmonious labeling, magic labeling, antimagic labeling, bimagic labeling, prime labeling, cordial labeling, total cordial labeling, k-graceful labeling and odd graceful labeling etc., have been studied in over 2300 papers [1].

The concept of Gaussian antimagic labeling was recently introduced in [3]. It is proved that graphs such as paths, cycles, Y-tree, comb, triangular snake and chordal graphs are Gaussian antimagic. In this paper we prove that Shadow, Jewel, Jelly fish, Modified extended duplicate graph of Star and

2010 Mathematics Subject Classification: 05C78.
Keywords: Graph labeling, Magic graphs, Antimagic graphs, Gaussian antimagic graphs.
Received November 27, 2019; Accepted May 19, 2020

Path, Some Corona graphs like $K_p \odot \overline{K}_t$, $W_p \odot \overline{K}_t$, $S_p \odot \overline{K}_t$, $H_p \odot \overline{K}_t$, Mongolian tent, Umbrella, $C_m + T_1$ graph, Petersen, Coconut tree, Centipede tree and Square graph of path are Gaussain antimagic.

II. Preliminaries

In this section we give the basic notions relevant to this paper.

Definition 2.1. The shadow graph $D_2(G)$ of a connected graph G is constructed by taking two copies of G say G' and G". Join each vertex u' in G' to the neighbors of the corresponding vertex u" in G".

Definition 2.2. For a graph G the spilt graph is obtained by adding to each vertex u a new vertex such that u' is adjacent to every vertex that is adjacent to u in G. The resultant graph is denoted as spl(G).

Definition 2.3. The jewel J_n is the graph with vertex set $V(J_n) = \{u, v, x, y, u_i : 1 \le i \le n\}$ and edge set $E(J_n) = \{ux, uy, xy, xv, yv, uu_i, vu_i : 1 \le i \le n\}$.

Definition 2.4. The jelly fish graph $J(r, s)$ is obtained from a 4-cycle y_1, y_2, y_3, y_4 by joining y_1 and y_3 with an edge and appending r pendent edges to y_2 and s pendent edges to y_4.

Definition 2.5. The extended duplicate graph of star denoted by $EDG(S_m)$, is obtained from the duplicate graph of star by joining v_1 and v_1.

Definition 2.6. The extended duplicate graph of path graph is denoted by $EDG(P_m)$ has $2m + 2$ vertices and $2m + 1$ edges.

Definition 2.7. If G has order n, the corona of G with H, $G \odot H$ is the graph obtained by taking one copy of G and n copies of H and joining the j^{th} vertex of G with and edge to every vertex in the j^{th} copy of H.

Definition 2.8. Corona graph $K_p \odot \overline{K}_t$ is the complete graph on p vertices with t pendent vertices attached at each vertex of the complex graph. It is also denoted by $K_p \odot \overline{K}_t$.

Definition 2.9. Corona graph $W_p \odot \overline{K}_t$ is the wheel graph on $p+1$ vertices with t pendent vertices attached at p vertices on the boundary of the wheel graph. It is also denoted by $W_p \odot n\overline{K}_1$.

Definition: 2.10. Corona graph $S_p \odot \overline{K}_t$ is the star graph on $p+1$ vertices with t pendent vertices attached at p vertices on the boundary of the star graph. It is also denoted by $S_p \odot n\overline{K}_1$.

Definition 2.11. Corona graph $H_p \odot \overline{K}_t$ is the helm graph on $2p+1$ vertices with t pendent vertices attached at p vertices on the boundary of the helm graph. It is also denoted by $H_p \odot n\overline{K}_1$.

Definition 2.12. A Mongolian tent as a graph obtained from $V_r.XV_s$ by adding one extra vertex above the grid and joining every other vertex of the top row of the $V_r.XV_s$ to the new vertex.

Definition 2.13. For any integers $m > 2$ and $n > 1$, the Umbrella graph $U(m, n)$ whose vertex set and edge set is defined as $V\{U(m, n)\} = \{x_1, x_2, \ldots x_m; y_1, y_2, \ldots, y_n\}$,

$$E\{U(m, n)\} = \begin{cases} (xi, xi+1), \text{ for } i = 1, 2, \ldots, m-1 \\ (yi, yi+1), \text{ for } i = 1, 2, \ldots, n-1 \\ (xi, y1), \text{ for } i = 1, 2, \ldots, m. \end{cases}$$

Definition 2.14. The sum of two graphs T_1 and C_m, $C_m + T_1$ is obtained by joining the vertex of T_1 with every vertex of C_m with an edge.

Definition 2.15. Petersen graph P_h is a graph with 10 vertices and 15 edges, Whose vertex set, $\{u_1, u_2, u_3, u_4, u_5, v_1, v_2, v_3, v_4, v_5\}$ and the edge set, $\{v_i v_{i+1} / 1 \le i \le 3, v_5 v_1\} \cup \{u_i v_i / 1 \le i \le 4\} \cup \{u_1 u_3, u_3 u_5, u_5; u_2, u_2 u_4, u_4 u_1\}$.

Definition 2.16. A Coconut tree is the graph obtained from the path P_s by appending t new pendent edges at an end vertex of P_s.

Definition 2.17. The $(m, 2)$ Centipede tree has m vertices on its spine each v_m on the spine has two leaf nodes adjacent to it.

Definition 2.18. The Square of a graph H denoted by H^2 has the same vertex set as of H and two vertices are adjacent in H^2 if they are at a distance of one or two apart in H.

Definition 2.19. Gaussian antimagic labeling in a $G(p, q)$ graph is a function $f : V \to \{a + ib/a, b \in N\}, 1 \leq a < b \leq q$, such that the induced function $f^* : E \to N$ defined by $f^*(uv) = |f(u)|^2 + |f(v)|^2$ results all the edge labels are distinct. A graph which admits Gaussian antimagic labeling is called Gaussian antimagic graph.

III. Main Results

Theorem 1. *The* $D_2(K_{1,n})$ *admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+2}\}$ be the vertices and $E = \{\{v_k, v_{2m+1}/1 \leq k \leq m, m \in N\} \cup \{v_k, v_{2m+2}/1 \leq k \leq m, m \in N\} \cup \{v_k, v_{2m+2}/m + 1 \leq k \leq 2m, m \in N\} \cup \{v_k, v_{2m+1}/m + 1 \leq k \leq 2m, m \in N\}$ be the edges of the $D_2(K_{1,n})$.

Define a function $f : V \to \{a + ib/a, b \in N, b = a + 1, 1 \leq a \leq n\}$ such that $f(v_s) = s + (s + 1)i, 1 \leq s \leq n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$$f^*(v_k, v_{2m+1}) = 4(2m^2 + 3m) + 2(k^2 + k + 3), 1 \leq k \leq m, m \in N$$

$$f^*(v_k, v_{2m+2}) = 4(2m^2 + 5m) + 2(k^2 + k + 7), 1 \leq k \leq m, m \in N$$

$$f^*(v_k, v_{2m+2}) = 4(2m^2 + 5m) + 2(k^2 + k + 7), m + 1 \leq k \leq 2m, m \in N$$

$$f^*(v_k, v_{2m+1}) = 4(2m^2 + 3m) + 2(k^2 + k + 3), m + 1 \leq k \leq 2m, m \in N.$$

Thus $f^*(E) = \{(8m^2 + 12m + 10, 8m^2 + 12m + 18, 8m^2 + 12m + 30, \ldots, 10m^2 +$

$14m+6), (8m^2+20m+18, 8m^2+20m+26, 8m^2+20m+38, \ldots, 10m^2+22m+14)$, $(10m^2+26m+18, 10m^2+30m+26, 10m^2+34m+38, \ldots, 16m^2+24m+14)$, $(10m^2+18m+10m^2+22m+18, 10m^2+26m+30, \ldots, 16m^2+16m+6)\}$ in which all the elements are distinct. Therefore, the $D_2(K_{1,n})$ admits Gaussian antimagic labeling.

Theorem 2. *The* $Spl(K_{1,n})$ *admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+2}\}$ be the vertices and $E = \{\{v_k\, k_{2m+1}/1 \le k \le m,\ m \in N\} \cup \{v_{2m+1}\, v_k/m+1 \le k \le 2m,\ m \in N\}$ $\cup \{v_{2m+2}\, v_k/m+1 \le k \le 2m,\ m \in N\} \cup \{v_{2m+1}\, v_{2m+2}\}\}$ be the edges of the $Spl(K_{1,n})$.

Define a function $f : V \to \{a+ib/a,\ b \in N,\ b \in N,\ b = a+1,\ 1 \le a \le n\}$ such that $f(v_s) = s+(s+1)i,\ 1 \le s \le n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$$f^*(v_k, v_{2m+1}) = 4(2m^2+3m) + 2(k^2+k+3),\ 1 \le k \le m,\ m \in N$$

$$f^*(v_k, v_{2m+1}) = 4(2m^2+3m) + 2(k^2+k+3),\ m+1 \le k \le 2m,\ m \in N$$

$$f^*(v_k, v_{2m+2}) = 4(2m^2+5m) + 2(k^2+k+7),\ 1 \le k \le m,\ m \in N$$

$$f^*(v_{2m+1}, v_{2m+2}) = 16m^2+32m+18.$$

Thus $f^*(E) = \{(8m^2+12m+10, 8m^2+12m+18, 8m^2+12m+30, \ldots, 10m^2+14m+6), (10m^2+18m+10, 10m^2+22m+18, 10m^2+26m+30, \ldots, 16m^2+16m+6)$, $(10m^2+26m+18, 10m^2+30m+26, 10m^2+34m+38, \ldots, 16m^2+24m+14)$, $16m^2+32m+18)\}$ in which all the elements are distinct.

Therefore, the $Spl(K_{1,n})$ admits Gaussian antimagic labeling.

Theorem 3. *The Jewel graph admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+2}\}$ be the vertices and $E = \{\{v_1 v_2\} \cup \{v_1 v_{m+1}\} \cup \{v_1 v_{m+2}\} \cup \{v_{m+1} v_k / 2 \le k \le 2m, m \in N\} \cup \{v_{m+2} v_k / 2 \le k \le m, m \in N\}\}$ be the edges of the Jewel graph.

Define a function $f : V \to \{a + ib/a, b \in N, b = a + 1 = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s + 1)i, 1 \le s \le n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = | f(u) |^2 + | f(v) |^2$. The edge labels are obtained as follows:

$f^*(v_1, v_2) = 18$

$f^*(v_1, v_{m+1}) = 2m^2 + 6m + 10$

$f^*(v_1, v_{m+2}) = 2m^2 + 10m + 18$

$f^*(v_{m+1}, v_k) = 2(m^2 + 3m) + 2(k^2 + k + 3), 2 \le k \le m, m \in N$

$f^*(v_{m+2}, v_k) = 2(m^2 + 5m) + 2(k^2 + k + 7), 2 \le k \le m, m \in N.$

Thus $f^*(E) = \{18, 2m^2 + 6m + 10, 2m^2 + 10m + 18, (2m^2 + 6m + 18, 2m^2 + 6m + 30, \ldots, 4m^2 + 8m + 6), (2m^2 + 10m + 26, 2m^2 + 10m + 38, \ldots, 4m^2 + 12m + 14)\}$ in which all the elements are distinct.

Therefore, the Jewel graph admits Gaussian antimagic labeling.

Theorem 4. *The Jelly fish graph admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+4}\}$ be the vertices and $E = \{\{v_{2m+2} v_{2m+4}\} \cup \{v_{2m+2} v_{2m+1}\} \cup \{v_{2m+2} v_{2m+3}\} \cup \{v_{2m+4} v_{2m+1}\} \cup \{v_{2m+4} v_{2m+3}\} \cup \{v_1 v_{m+1}\} \cup \{v_k v_{2m+3} / 1 \le k \le m, m \in N\} \cup \{v_k v_{2m+1} / m + 1 \le k \le 2m, m \in N\}\}$ be the edges of the Jelly fish graph.

Define a function $f : V \to \{a + ib/a, b \in N, b = a + 1 = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s + 1)i, 1 \le s \le n$.

Define the induced function $f^*: E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_{2m+2}, v_k) = 4(2m^2 + 5m) + 2(k^2 + k + 7),\ k = 2m+1,\ 2m+3,\ m \in N$

$f^*(v_{2m+4}, v_k) = 4(2m^2 + 9m) + 2(k^2 + k + 21),\ k = 2m+1,\ 2m+3,\ m \in N$

$f^*(v_{2m+2}, v_{2m+4}) = 16m^2 + 56m + 54$

$f^*(v_k, v_{2m+3}) = 4(2m^2 + 14m) + 2(k^2 + k + 13),\ 1,\ k \le m,\ m \in N$

$f^*(v_k, v_{2m+1}) = 4(2m^2 + 3m) + 2(k^2 + k + 3),\ m + 1 \le k \le 2m,\ m \in N.$

Thus $f^*(E) = \{16m^2 + 32m + 18, 16m^2 + 48m + 38, 16m^2 + 48m + 46, 16m^2 + 64m + 66, 16m^2 + 56m + 54, (8m^2 + 28m + 30, 8m^2 + 28m + 38, \ldots, 10m^2 + 30m + 26), (10m^2 + 18m + 10, 10m^2 + 22m + 18, 10m^2 + 26m + 30, \ldots, 16m^2 + 16m + 6)\}$ in which all the elements are distinct.

Therefore, the Jelly fish graph admits Gaussian antimagic labeling.

Theorem 5. *The Modified extended duplicate graph of star admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+1}\}$ be the vertices and $E = \{\{v_1 v_{2m+1}\} \cup \{v_{2m+1} v_{m+1}\} \cup \{v_1 v_k / m + 2 \le k \le 2m, m \in N\} \cup \{v_{m+1} v_k / 2 \le k \le m, m \in N\}\}$ be the edges of the Modified extended duplicate graph of star.

Define a function $f: V \to \{a + ib/a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i,\ 1 \le s \le n.$

Define the induced function $f^*: E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_1, v_{2m+1}) = 8m^2 + 12m + 10$

$f^*(v_{2m+1}, v_{m+1}) = 10m^2 + 18m + 10$

$f^*(v_1, v_k) = 2(k^2 + k + 3), m + 2 \le k \le 2m, m \in N$

$f^*(v_{m+1}, v_k) = (m^2 + 6m) + 2(k^2 + k + 3), 2 \le k \le m, m \in N.$

Thus $f^*(E) = \{8m^2 + 12m + 10, 10m^2 + 18m + 10, (2m^2 + 10m + 18, 2m^2 + 14m + 30, \dots, 8m^2 + 4m + 6), (m^2 + 6m + 18, m^2 + 6m + 30, \dots 3m^2 + 8m + 6)\}$ in which all the elements are distinct.

Therefore, the modified extended duplicate graph of star admits Gaussian antimagic labeling.

Theorem 6. *The modified extended duplicate graph of path admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \dots, v_{2m+2}\}$ be the vertices and $E = \{\{v_{4k+1}v_{4k+4} / 0 \le k \le (m-1)/2, m \in N\} \cup \{v_{2k}v_{2k+1} / 1 \le k \le m, m \in N\} \cup \{v_{2k+1}v_{2k+4} / 1 \le k \le m-2, m \in N, k \text{ is odd}\} \cup \{v_3v_4\}\}$ be the edges of the Modified extended duplicate graph of path.

Define a function $f : V \to \{a + ib / a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2.$

The edge labels are obtained as follows:

$f^*(v_{4k+1}, v_{4k+4}) = 64k^2 + 96k + 46, 0 \le k \le (m-1)/2, m \in N$

$f^*(v_{2k}, v_{2k+1}) = 16k^2 + 16k + 6, 1 \le k \le m, m \in N$

$f^*(v_{2k+1}, v_{2k+4}) = 16k^2 + 48k + 46, 1 \le k \le m-2, m \in N, k$ is odd

$f^*(v_3, v_4) = 66.$

Thus $f^*(E) = \{46, 206, \dots, 16m^2 + 16m + 14, 38, 102, \dots, 64m^2 + 32m + 6, 110, 334, \dots, 16m^2 - 16m + 14, 66\}$ in which all the elements are distinct.

Therefore, the Modified extended duplicate graph of path admits Gaussian antimagic labeling.

Theorem 7. *The corona graph* $K_p \odot \overline{K}_t$ *admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{4m+4}\}$ be the vertices and $E = \{\{v_{4m+1}v_k / 1 \le k \le m, m \in N\} \cup \{v_{4m+2}v_k / m+1 \le k \le 2m, m \in N\} \cup \{v_{4m+3}v_k / 2m+1 \le k \le 3m, m \in N\} \cup \{v_{4m+4}v_k / 3m+1 \le k \le 4m, m \in N\} \cup \{v_{4m+1}v_{4m+2}\} \cup \{v_{4m+2}v_{4m+3}\} \cup \{v_{4m+3}v_{4m+4}\} \cup \{v_{4m+1}v_{4m+4}\} \cup \{v_{4m+1}v_{4m+3}\} \cup \{v_{4m+2}v_{4m+4}\}\}$ be the edges of the corona graph $K_p \odot \overline{K}_t$.

Define a function $f : V \to \{a + ib / a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$$f^*(v_{4m+1}, v_k) = 8(4m^2 + 3m) + 2(k^2 + k + 3), 1 \le k \le m, m \in N$$

$$f^*(v_{4m+2}, v_k) = 8(4m^2 + 5m) + 2(k^2 + k + 7), m+1 \le k \le 2m, m \in N$$

$$f^*(v_{4m+3}, v_k) = 8(4m^2 + 7m) + 2(k^2 + k + 13), 2m+1 \le k \le 3m, m \in N$$

$$f^*(v_{4m+4}, v_k) = 8(4m^2 + 9m) + 2(k^2 + k + 21), 3m+1 \le k \le 4m, m \in N$$

$$f^*(v_{4m+1}, v_{4m+2}) = 64m^2 + 64m + 18$$

$$f^*(v_{4m+2}, v_{4m+3}) = 64m^2 + 96m + 38$$

$$f^*(v_{4m+3}, v_{4m+4}) = 64m^2 + 128m + 66$$

$$f^*(v_{4m+1}, v_{4m+4}) = 64m^2 + 96m + 46$$

$$f^*(v_{4m+1}, v_{4m+3}) = 64m^2 + 90m + 30$$

$$f^*(v_{4m+2}, v_{4m+4}) = 64m^2 + 112m + 54, m \in N.$$

Thus $f^*(E) = \{(32m^2 + 24m + 10, 32m^2 + 24m + 18, 32m^2 + 24m + 30, \ldots, 34m^2 + 22m + 6, 34m^2 + 26m + 6), (34m^2 + 46m + 18, 34m^2 + 50m + 26, 34m^2 + 54m 38, \ldots, 40m^2 + 36m + 14, 40m^2 + 44m + 14), (40m^2 + 68m + 30, 40m^2 + 76m + 38, 40m^2 + 84m + 50, \ldots, 50m^2 + 50m + 26, 50m^2 + 62m + 26), (50m^2 + 92m + 46, 50m^2 + 102m + 54, 50m^2 + 114m + 66, \ldots, 64m^2 + 80m + 42, 64m^2 + 64m + 42), 64m^2 + 64m + 18, 64m^2 + 96m + 38, 64m^2 + 128m + 66, 64m^2 + 96m + 46, 64m^2 + 90m + 30, 64m^2 + 112m + 54\}$ in which all the elements are distinct.

Therefore, the corona graph $K_p \odot K_t$ admits Gaussian antimagic labeling.

Theorem 8. *The corona graph $W_p \odot \overline{K}_t$ admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{(n+1)m+1}\}$ be the vertices and $E = \{\{v_{nm+1}v_k / 1 \leq k \leq m, m \in N\} \cup \{v_{nm+2}v_k / m+1 \leq k \leq 2m, m \in N\} \cup \{v_{nm+3}v_k / 2m+1 \leq k \leq 3m, m \in N\} \cup \{v_{(n+1)m}v_k / (n-1)m+1 \leq k \leq nm, m, n \in N\} \cup \{v_{(n+1)m+1}v_k / nm+1 \leq k \leq (n+1)m, m, n \in N\} \cup \{v_{nm+k}v_{nm+(k+1)} / 1 \leq k \leq m, m, n \in N\} \cup \{v_{(n+1)m}v_{nm+1}\}\}$ be the edges of the corona graph $W_p \odot \overline{K}_t$.

Define a function $f : V \to \{a + ib / a, b \in N, b = a+1, 1 \leq a \leq n\}$ such that $f(v_s) = s + (s+1)i, 1 \leq s \leq n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$$f^*(v_{nm+1}, v_k) = 2(n^2m^2 + 3mn) + 2(k^2 + k + 3), 1 \leq k \leq m, m \in N$$

$$f^*(v_{nm+2}, v_k) = 2(n^2m^2 + 5mn) + 2(k^2 + k + 7), m+1 \leq k \leq 2m, m \in N$$

$f^*(v_{nm+3}, v_k) = 2(n^2m^2 + 7mn) + 2(k^2 + k + 13),\ 2m + 1 \le k \le 3m,\ m \in N$

$f^*(v_{(n+1)m}, v_k) = 2(n^2m^2 + 2nm^2 + m^2 + mn + m) + 2(k^2 + k + 1),$
$(n-1)m + 1 \le k \le nm,\ m,\ n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+1}) = 4n^2m^2 + 2nm^2 + 2m^2 + 12mn + 6m + 10,\ m,\ n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+2}) = 4n^2m^2 + 4nm^2 + 2m^2 + 16mn + 6m + 18,\ m,\ n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+3}) = 4n^2m^2 + 4nm^2 + 2m^2 + 20mn + 6m + 30,\ m,\ n \in N$

$f^*(v_{(n+1)m+1}, v_{(n+1)m}) = 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 6,\ m,\ n \in N$

$f^*(v_{nm+1}, v_{nm+2}) = 4n^2m^2 + 16mn + 18,\ m,\ n \in N$

$f^*(v_{nm+2}, v_{nm+3}) = 4n^2m^2 + 24mn + 38,\ m,\ n \in N$

$f^*(v_{(n+1)m}, v_{nm+1}) = 4n^2m^2 + 4nm^2 + 2m^2 + 8mn + 2m + 6,\ m,\ n \in N.$

Thus $f^*(E) = \{(2n^2m^2 + 6mn + 10,\ 2n^2m^2 + 6mn + 18,\ 2n^2m^2 + 6mn + 30, \ldots,$ $2n^2m^2 + 2m^2 + 6mn + 2m + 6),\ (2n^2m^2 + 2m^2 + 10mn + 6m + 18,\ 2n^2m^2$ $+ 2m^2 + 10mn + 10m + 26,\ 2n^2m^2 + 2m^2 + 10mn + 14m + 38, \ldots,\ 2n^2m^2 + 8m^2 +$ $10mn + 4m + 14),\ (2n^2m^2 + 8m^2 + 14mn + 12m + 30,\ 2n^2m^2 + 8m^2 + 14mn + 20m$ $+ 38,\ 2n^2m^2 + 8m^2 + 14mn + 28m + 50, \ldots,\ 2n^2m^2 + 18m^2 + 14mn + 6m + 26),$ $(4n^2m^2 + 4m^2 + 8mn - 4m + 6,\ 4n^2m^2 + 4m^2 + 10mn - 6m + 8, \ldots,\ 4n^2m^2 +$ $4nm^2 + 2m^2 + 4mn + 2m + 2),\ 4n^2m^2 + 4nm^2 + 2m^2 + 12mn + 6m + 10,$ $4n^2m^2 + 4nm^2 + 2m^2 + 16mn + 6m + 18,\ 4n^2m^2 + 4nm^2 + 4nm^2 + 2m^2 + 20mn$ $+ 6m + 30,\ 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 6,\ 4n^2m^2 + 4nm^2 + 16mn + 18,$ $4n^2m^2 + 24mn + 38,\ 4n^2m^2 + 2m^2 + 8mn + 2m + 6\}$ in which all the elements are distinct.

Therefore, the corona graph $W_p \odot K_t$ admits Gaussian antimagic labeling.

Theorem 9. *The corona graph* $S_p \odot \overline{K}_t$ *admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{(n+1)m+1}\}$ be the vertices and $E = \{\{v_{nm+1}v_k / 1 \leq k \leq m, m \in N\} \cup \{v_{nm+2}v_k / m+1 \leq k \leq 2m, m \in N\} \cup \{v_{nm+3} v_k / 2m+1 \leq k \leq 3m, m \in N\} \cup \{v_{(n+1)m}v_k / (n-1)m+1 \leq k \leq nm, m, n \in N\} \cup \{v_{(n+1)m+1}v_k / nm+1 \leq k \leq (n+1)m, m, n \in N\}\}$ be the edges of the corona graph $S_p \odot \overline{K}_t$.

Define a function $f : V \to \{a + ib / a, b \in N, b = a+1, 1 \leq a \leq n\}$ such that $f(v_s) = s + (s+1)i, 1 \leq s \leq n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$$f^*(v_{nm+1}, v_k) = 2(n^2m^2 + 3mn) + 2(k^2 + k + 3), 1 \leq k \leq m, m \in N$$

$$f^*(v_{nm+2}, v_k) = 2(n^2m^2 + 5mn) + 2(k^2 + k + 7), m+1 \leq k \leq 2m, m \in N$$

$$f^*(v_{nm+3}, v_k) = 2(n^2m^2 + 7mn) + 2(k^2 + k + 13), 2m+1 \leq k \leq 3m, m \in N$$

$$f^*(v_{(n+1)m}, v_k) = 2(n^2m^2 + 2nm^2 + m^2 + mn + m) + 2(k^2 + k + 1), (n-1)m + 1 \leq k \leq nm, m, n \in N$$

$$f^*(v_{(n+1)m+1}, v_{nm+1}) = 4n^2m^2 + 2nm^2 + 2m^2 + 12mn + 6m + 10, m, n \in N$$

$$f^*(v_{(n+1)m+1}, v_{nm+2}) = 4n^2m^2 + 4nm^2 + 2m^2 + 16mn + 6m + 18, m, n \in N$$

$$f^*(v_{(n+1)m+1}, v_{nm+3}) = 4n^2m^2 + 4nm^2 + 2m^2 + 20mn + 6m + 30, m, n \in N$$

$$f^*(v_{(n+1)m+1}, v_{(n+1)m}) = 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 6, m, n \in N.$$

Thus $f^*(E) = \{(2n^2m^2 + 6mn + 10, 2n^2m^2 + 6mn + 18, 2n^2m^2 + 6mn +$

$30, \ldots, 2n^2m^2 + 2m^2 + 6mn + 2m + 6), (2n^2m^2 + 2m^2 + 10mn + 6m + 18, 2n^2m^2 + 2m^2 + 10mn + 10m + 26, 2n^2m^2 + 2m^2 + 10mn + 14m + 38, \ldots, 2n^2m^2 + 8m^2 + 10mn + 4m + 14), (2n^2m^2 + 8m^2 + 14mn + 12m + 30, 2n^2m^2 + 8m^2 + 14mn + 20m + 38, 2n^2m^2 + 8m^2 + 14mn + 28m + 50, \ldots, 2n^2m^2 + 18m^2 + 14mn + 26), (4n^2m^2 + 4m^2 + 8mn - 4m + 6, 4n^2m^2 + 4m^2 + 10mn - 6m + 8, \ldots, 4n^2m^2 + 4nm^2 + 2m^2 + 4mn + 2m + 2), (4n^2m^2 + 4nm^2 + 2m^2 + 12mn + 6m + 10, 4n^2m^2 + 4nm^2 + 2m^2 + 16mn + 6m + 18, 4n^2m^2 + 4nm^2 + 2m^2 + 20mn + 6m + 30, \ldots, 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 6\}$ in which all the elements are distinct.

Therefore, the corona graph $S_p \odot K_t$ admits Gaussian antimagic labeling.

Theorem 10. *The corona graph $H_p \odot \overline{K}_t$ admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{(n+2)m+1}\}$ be the vertices and $E = \{\{v_{nm+1}v_k / 1 \le k \le m, m \in N\} \cup \{v_{nm+2}v_k / m + 1 \le k \le 2m, m \in N\} \cup \{v_{nm+3} v_k / 2m + 1 \le k \le 3m, m \in N\} \cup \{v_{(n+1)m}v_k / (n-1)m + 1 \le k \le nm, m, n \in N\} \cup \{v_{(n+2)m+1}v_k / (n+1)m + 1 \le k \le (n+2)m, m, n \in N\} \cup \{v_{(n+1)m+k} v_{(n+1)m+(k+1)} / 1 \le k \le m-1, m, n \in N\} \cup \{v_{(n+2)m}v_{(n+1)m+1}\} \cup \{v_{(n+1)m+k} v_{nm+k} / 1 \le k \le m, m, n \in N\}\}$ be the edges of the corona graph $W_p \odot \overline{K}_t$.

Define a function $f : V \to \{a + ib/a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_{nm+1}, v_k) = 2(n^2m^2 + 3mn) + 2(k^2 + k + 3), 1 \le k \le m, m \in N$

$f^*(v_{nm+2}, v_k) = 2(n^2m^2 + 5mn) + 2(k^2 + k + 7), m + 1 \le k \le 2m, m \in N$

$f^*(v_{nm+3}, v_k) = 2(n^2m^2 + 7mn) + 2(k^2 + k + 13), 2m + 1 \le k \le 3m, m \in N$

$f^*(v_{(n+1)m}, v_k) = 2(n^2m^2 + 2nm^2 + m^2 + mn + m) + 2(k^2 + k + 1), (n-1)m + 1 \le k \le nm, m, n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+1}) = 4n^2m^2 + 2nm^2 + 2m^2 + 12nm + 6m + 10, m, n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+2}) = 4n^2m^2 + 4nm^2 + 2m^2 + 16nm + 6m + 18, m, n \in N$

$f^*(v_{(n+1)m+1}, v_{nm+3}) = 4n^2m^2 + 4nm^2 + 2m^2 + 20mn + 6m + 30, m, n \in N$

$f^*(v_{(n+1)m+1}, v_{(n+1)m}) = 4n^2m^2 + 8nm^2 + 4m^2 + 8nm + 8m + 6, m, n \in N$

$f^*(v_{(n+2)m+1}, v_{(n+1)m+k}) = 4n^2m^2 + 12nm^2 + 10m^2 + 8mn + 14m + 4mk + 4nmk + 2k^2 + 2k + 6, 1 \le k \le m, m, n \in N$

$f^*(v_{(n+1)m+k}, v_{(n+1)m+(k+1)}) = 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 8mk + 8nmk + 4k^2 + 8k + 6, 1 \le k \le m-1, m, n \in N$

$f^*(v_{(n+2)m}, v_{(n+1)m+1}) = 4n^2m^2 + 12nm^2 + 10m^2 + 8nm + 10m + 6, m, n \in N.$

Thus $f^*(E) = \{(2n^2m^2 + 6mn + 10, 2n^2m^2 + 6mn + 18, 2n^2m^2 + 6mn + 30, \ldots, 2n^2m^2 + 2m^2 + 6mn + 2m + 6), (2n^2m^2 + 2m^2 + 10mn + 6m + 18, 2n^2m^2 + 2m^2 + 10mn + 10m + 26, 2n^2m^2 + 2m^2 + 10mn + 14m + 38, \ldots, 2n^2m^2 + 8m^2 + 10mn + 4m + 14), (2n^2m^2 + 8m^2 + 14mn + 12m + 30, 2n^2m^2 + 8m^2 + 14mn + 20m + 38, 2n^2m^2 + 8m^2 + 14mn + 28m + 50, \ldots, 2n^2m^2 + 18m^2 + 14mn + 6m + 26), (4n^2m^2 + 4m^2 + 8mn - 4m + 6, 4n^2m^2 + 4m^2 + 10mn - 6m + 8, \ldots, 4n^2m^2 + 4nm^2 + 2m^2 + 4mn + 2m + 2), (4n^2m^2 + 4nm^2 + 2m^2 + 2m^2 + 12mn + 6m + 10, 4n^2m^2 + 4nm^2 + 2m^2 + 16mn + 6m + 18, 4n^2m^2 + 4nm^2 + 2m^2 + 20nm + 6m + 30, \ldots, 4n^2m^2 + 8nm^2 + 4m^2 + 8mn + 8m + 6), (4n^2m^2 + 12nm^2 + 10m^2 + 12nm + 18m + 10, 4n^2m^2 + 12nm^2 + 10m^2 + 16mn + 22m + 18, 4n^2m^2 + 12nm^2 + 10m^2 + 20mn + 26m + 30, \ldots, 4n^2m^2 + 16nm^2$

$+16m^2+8mn+16m+6), (4n^2m^2+8nm^2+4m^2+16mn+16m+18, 4n^2m^2$ $+8nm^2+4m^2+24mn+24m+38, \ldots, 4n^2m^2+16nm^2+16m^2+2), 4n^2m^2+12nm^2$ $+10m^2+8nm+10m+6\}$ in which all the elements are distinct.

Therefore, the corona graph $H_p \odot \overline{K}_t$ admits Gaussian antimagic labeling.

Theorem 11. *The Mongolian tent* $M(2, m)$ *admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m+1}\}$ be the vertices and $E = \{\{v_k v_{k+1}/1 \leq k \leq m-1, m \in N\} \cup \{v_k v_{k+1}/m+1 \leq k \leq 2m-1, m \in N\}$ $\cup \{v_k v_{m+k}/1 \leq k \leq m, m \in N\} \cup \{v_{2m+1} v_k/1 \leq k \leq m, m, n \in N\}$ be the edges of the Mongolian tent $M(2, m)$.

Define a function $f: V \to \{a+ib/a, b \in N, b = a+1, 1 \leq a \leq n\}$ such that $f(v_s) = s+(s+1)i, 1 \leq s \leq n.$

Define the induced function $f^*: E \to N$ such that $f^*(uv) = |f(u)|^2$ $+|f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2+8k+6, 1 \leq m-1, m \in N$

$f^*(v_k, v_{k+1}) = 4k^2+8k+6, m+1 \leq k \leq 2m-1, m \in N$

$f^*(v_k, v_{m+k}) = 4k^2+4k+2m^2+4mk+2m+2, 1 \leq k \leq m, m \in N$

$f^*(v_{2m+1}, v_k) = 2k^2+2k+8m^2+12m+6, 1 \leq k \leq m, m \in N.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2+2), (4m^2+16m+18, 4m^2+24m+$ $38, \ldots, 16m^2+2), (2m^2+6m+10, 2m^2+10m+26, \ldots, 10m^2+6m+2), (8m^2+12m+10,$ $8m^2+12m+18, \ldots, 10m^2+14m+6)\}$ in which all the elements are distinct.

Therefore, the Mongolian tent $M(2, m)$ admits Gaussian antimagic labeling.

Theorem 12. *The Umbrella graph $U(m, 2m)$ admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m}\}$ be the vertices and $E = \{\{v_k v_{k+1}/1 \le k \le m-1, m \in N\} \cup \{v_k v_{k+1}/m+1 \le k \le 2m-1, m \in N\}$ $\cup \{v_{m+1}v_k/1 \le k \le m, m \in N\}\}$ be the edges of the Umbrella graph $U(m, 2m)$.

Define a function $f : V \to \{a + ib/a, b \in N, b = a+1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 1 \le m-1, m \in N$

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, m+1 \le k \le 2m-1, m \in N$

$f^*(v_{m+1}, v_k) = 2k^2 + 2k + 2m^2 + 6m + 6, 1 \le k \le m, m \in N.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2 + 2), (4m^2 + 16m + 18, 4m^2 + 24m + 38, \ldots, 16m^2 + 2), (2m^2 + 6m + 10, 2m^2 + 6m + 18, \ldots, 4m^2 + 8m + 6)\}$ in which all the elements are distinct.

Therefore, the Umbrella graph $U(m, 2m)$ admits Gaussian antimagic labeling.

Theorem 13. *The graph $C_m + T_1$ admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{m+1}\}$ be the vertices and $E = \{\{v_k v_{k+1}/1 \le k \le m-1, m \in N\} \cup \{v_{m+1}v_k/1 \le k \le m, m \in N\} \cup \{v_1 v_m\}\}$ be the edges of the graph $C_m + T_1$.

Define a function $f : V \to \{a + ib/a, b \in N, b = a+1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n$.

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 1 \leq k \leq m - 1, m \in N$

$f^*(v_{m+1}, v_k) = 2k^2 + 2k + 2m^2 + 6m + 6, 1 \leq k \leq m, m \in N$

$f^*(v_1, v_m) = 2m^2 + 2m + 6.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2 + 2), (2m^2 + 6m + 10, 2m^2 + 6m + 18, \ldots, 4m^2 + 8m + 6), 2m^2 + 2m + 6\}$ in which all the elements are distinct.

Therefore, the graph $C_m + T_1$ admits Gaussian antimagic labeling.

Theorem 14. *The Petersen graph* P_t *admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{10}\}$ be the vertices and $E = \{\{v_k v_{k+2} / 1 \leq k \leq 3, k \in N\} \cup \{v_k v_{k+5} / 1 \leq k \leq 5, k \in N\} \cup \{v_k v_{k+3} / 1 \leq k \leq 2, k \in N\} \cup \{v_k v_{k+1} / 6 \leq k \leq 9, k \in N\} \cup \{v_{10} v_6\}\}$ be the edges of the Petersen graph P_t.

Define a function $f : V \to \{a + ib / a, b \in N, b = a + 1, 1 \leq a \leq n\}$ such that $f(v_s) = s + (s + 1)i, 1 \leq s \leq n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2.$

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 12k + 14, 1 \leq k \leq 3, k \in N$

$f^*(v_k, v_{k+5}) = 4k^2 + 24k + 62, 1 \leq k \leq 5, k \in N$

$f^*(v_k, v_{k+3}) = 4k^2 + 16k + 26, 1 \leq k \leq 2, k \in N$

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 6 \leq k \leq 9, k \in N$

$f^*(v_{10}, v_6) = 306.$

Thus $f^*(E) = \{(30, 54, 86), (90, 126, \ldots, 282), (46, 74), (198, 258, 326, 402), 306\}$ in which all the elements are distinct.

Therefore, the Petersen graph P_t admits Gaussian antimagic labeling.

Theorem 15. *The Coconut tree admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{2m}\}$ be the vertices and $E = \{\{v_k v_{k+1} / 1 \le k \le m - 1, m \in N\} \cup \{v_m v_{m+k} / 1 \le k \le m, m \in N\}\}$ be the edges of the Coconut tree.

Define a function $f : V \to \{a + ib / a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s + 1)i, 1 \le s \le n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 1 \le m - 1, m \in N$

$f^*(v_m, v_{m+k}) = 2k^2 + 2k + 4m^2 + 4mk + 4m + 2, 1 \le k \le m, m \in N.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2 + 2), (4m^2 + 8m + 6, 4m^2 + 12m + 14, 4m^2 + 16m + 26, \ldots, 10m^2 + 6m + 2)\}$ in which all the elements are distinct.

Therefore, the Coconut tree admits Gaussian antimagic labeling.

Theorem 16. *The Centipede tree admits Gaussian antimagic labeling*.

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_{3m}\}$ be the vertices and $E = \{\{v_k v_{k+1} / 1 \le k \le m - 1, m \in N\} \cup \{v_k v_{m+k} / 1 \le k \le m, m \in N\} \cup \{v_k v_{2m+k} / 1 \le k \le m, m \in N\}\}$ be the edges of the Centipede tree.

Define a function $f : V \to \{a + ib / a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s + 1)i, 1 \le s \le n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2$.

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 1 \le k \le m-1, m \in N$

$f^*(v_k, v_{m+k}) = 4k^2 + 4k + 2m^2 + 4mk + 2m + 2, 1 \le k \le m, m \in N$

$f^*(v_k, v_{2m+k}) = 4k^2 + 4k + 8m^2 + 8mk + 4m + 2, 1 \le k \le m, m \in N.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2 + 2), (2m^2 + 6m + 10, 2m^2 + 10m + 26, \ldots, 10m^2 + 6m + 2), (8m^2 + 12m + 10, 8m^2 + 20m + 26, \ldots, 20m^2 + 8m + 2)\}$ in which all the elements are distinct.

Therefore, the Centipede tree admits Gaussian antimagic labeling.

Theorem 17. *The square graph of path admits Gaussian antimagic labeling.*

Proof. Let $V = \{v_1, v_2, v_3, \ldots, v_m\}$ be the vertices and $E = \{\{v_k v_{k+1} / 1 \le k \le m-1, m \in N\} \cup \{v_{2k+1} v_{2k+3} / 0 \le k \le (m-4)/2, m \in N\} \cup \{v_{2k} v_{2k+2} / 1 \le k \le (m-2)/2, m \in N\}\}$ be the edges of the square graph of path.

Define a function $f : V \to \{a + ib/a, b \in N, b = a + 1, 1 \le a \le n\}$ such that $f(v_s) = s + (s+1)i, 1 \le s \le n.$

Define the induced function $f^* : E \to N$ such that $f^*(uv) = |f(u)|^2 + |f(v)|^2.$

The edge labels are obtained as follows:

$f^*(v_k, v_{k+1}) = 4k^2 + 8k + 6, 1 \le k \le m-1, m \in N$

$f^*(v_{2k+1}, v_{2k+3}) = 16k^2 + 40k + 30, 0 \le k \le (m-4)/2, m \in N$

$f^*(v_{2k}, v_{2k+2}) = 16k^2 + 24k + 14, 1 \le k \le (m-2)/2, m \in N.$

Thus $f^*(E) = \{(18, 38, 66, \ldots, 4m^2 + 2), (30, 86, \ldots, 4m^2 - 12m + 14) (54, 126, \ldots, 4m^2 + 8m + 18)\}$ in which all the elements are distinct.

Therefore, the Square graph of path admits Gaussian antimagic labeling.

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