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Reverse super edge-trimagic labeling for star related graphs

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Abstract
A reverse edge-trimagic labeling on a graph with p vertices and q edges is a one-to-one map taking the vertices and edges onto the integers $1,2,...,p+q$ with the property that satisfies for every edge e, the sum of all vertex labels incident on edge e is subtracted from edge label $f(e)$ is either a constant k_1 or k_2 or k_3. The reverse edge -trimagic labeling is said to be reverse super edge - trimagic labeling if $f(v)=\{1,2,...,p\}$ and $f(e)=\{p+1,p+2,...,p+q\}$. In this paper, we investigate the reverse super edge -trimagic labeling of barycentric subdivision of Bi star, Degree Splitting graph of $K_{1,n}\wedge K_{1,n}$ and $K_{1,n}\bigcup K_{1,n}$, Corona product of $P_3\square K_1$, splitting graph of star.

Keywords
Degree splitting graph, splitting graph, Subdivision of Bi star graph, Reverse super edge-trimagic labeling.

AMS Subject Classification
05C78

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Contents

1. Introduction

All graphs in this paper are finite, simple and undirected. Labeling of a graph is a mapping from a set of vertices, edges or both subject to certain conditions. Motivated by magic square notation in number theory, Sedlacek [8] introduced the magic type labeling. Kotzing and Rosa [7] defined edge magic labeling in 1970.

In 2004, J.Baskar Babujee [3] introduced edge - bi magic labeling. In 2013, Jayasekaran et al.[5] introduced edge - bi magic labeling. The concept of reverse edge - magic labeling and reverse super edge -magic labeling was introduced by S. Sharif Basha [9].

Motivated by these notions, we have introduced the concept of reverse super edge - bi magic labeling in [1, 2]. Now we extend our idea to introduced the concept of reverse super edge - trimagic labeling.

In this paper we investigate reverse super edge - trimagic labeling of barycentric subdivision of bi star, degree splitting graph of $K_{1,n}\wedge K_{1,n}$ and $K_{1,n}\bigcup K_{1,n}$, Corona product of $P_3\square K_1$, splitting graph of star.

2. Definition

Definition 2.1. *[4] Let $G=(V,E)$ be a graph. Let $e=uv$ be an edge of G and w is not a vertex of G. The edge e is subdivided when it is replaced by the edge $e^{'}=uw$ and $e^{''}=wv$.*

Definition 2.2. *[4] Let $G=(V,E)$ be a graph. If every edge of graph G is subdivided then the resulting graph is called barycentric subdivision of graph G. In other words barycentric subdivision is the graph obtained by inserting a vertex of degree 2 into every edge of original graph. The barycentric subdivision of any graph G is denoted by $S^{'}(G)$.*

Definition 2.3. *[6] Let $G=(V,E)$ be a graph with $V=S_1\bigcup S_2\bigcup S_3\bigcup ...\bigcup S_t\bigcup T$ where each S_i is a set of vertices having atleast two vertices of the same degree and $T=V\bigcup_{i=1}^{t} S_i$.*

The degree splitting graph of G denoted by $DS(G)$ is obtained from G by adding vertices $u_1, u_2, ..., u_t$ and joining to each vertex of S_i for $1 \leq i \leq t$.

Definition 2.4. *A wedge is defined as an edge connecting two components of a graph, denoted as $\wedge$, $\omega(G\wedge) < \omega(G)$. $K_{1,m} \bigcup K_{1,n}$ is a two star and is a two component or a disconnected graph, whereas $K_{1,m} \wedge K_{1,n}$ is a two star but a connected graph. Which means adding a wedge to a disconnected graph with two components becomes a connected or a single component graph. And a disconnected graph with three components and two wedges becomes a connected or a single component graph.*

Note: In this paper wedge is considered to connect the non – pendent vertices

Definition 2.5. *The splitting graph of a graph G is obtained by adding to each vertex v a new vertex v' is adjacent to every vertex that is adjacent to v in $G(i.e.)N(v) = N(v')$. The resultant graph is denoted by $S'(G)$.*

Definition 2.6. *The Corona $G_1 \Box G_2$ of two graphs G_1 and G_2 is defined as the graph G obtained by taking one copy of G_1 (which has P_1 vertices) and P_1 copies of G_2 and then joining i^{th} vertex of G_1 to every vertices in the i^{th} copy of G_2.*

3. Main results

Theorem 3.1. *Barycentric subdivision of Bi star $S[B_{n,n}]$ is a reverse super edge- tri magic graph for $n \geq 4$.*

Proof. Let $B_{n,n}$ be the bistar graph.

$$V(B_{n,n}) = \{u, v, u_i, v_i; 1 \leq i \leq n\}$$

Where u_i and v_i are pendent vertices

$$E(B_{n,n}) = \{uv, uv_i, vv_i; 1 \leq i \leq n\}$$

Let $w, u_i', v_i'; 1 \leq i \leq n$ be the newly added vertices to obtain $S(B_{n,n})$ where w is added between u and v, u_i' is added between u and u_i for $1 \leq i \leq n$ and v_i' is added between v and v_i for $1 \leq i \leq n$

$$|V(B_{n,n})| = 4n+3$$
$$|E(B_{n,n})| = 4n+2$$

Define $f : V \bigcup E \to \{1, 2, ..., 8n+5\}$ as follows

The vertex labels are defined by

$$f(u) = 2$$
$$f(w) = 1$$
$$f(v) = 3$$

For $1 \leq i \leq n$,

$$f(u_i') = 3+i$$
$$f(v_i') = 3+n-i$$

For $1 \leq i \leq n-2$,

$$f(u_i) = 4n-2i+2$$
$$f(v_i) = 4n-2i+5$$
$$f(u_{n-1}) = 4n+2$$
$$f(u_n) = 2n+4$$

The edge labels are defined by

$$f(uw) = 4n+4$$
$$f(vw) = 4n+5$$

For $1 \leq i \leq n$,

$$f(uu_i') = 4n+6+i$$
$$f(vv_i') = 5n+7+i$$
$$f(v_iv_i') = 7n+8-i$$

For $1 \leq i \leq n-3$,

$$f(u_iu_i') = 8n+6-i$$

For $-2 \leq i \leq n-1$,

$$f(u_iu_i') = n^2+4n-ni-i+5$$
$$f(u_nu_n') = 7n+8$$

Then the constants k_1, k_2, k_3 of reverse super edge- trimagic are obtained as follows.

To find k_1:

$$\begin{aligned} 3nk_1 = f(uv) - \Big[f(u)+f(w)\Big] \\ + f(vw) - \Big[f(v)+f(w)\Big] \\ + \sum_{i=1}^{n} \Big[f(uu_i') - \Big[f(u)+f(u_i')\Big]\Big] \\ + \sum_{i=1}^{n} \Big[f(vv_i') - \Big[f(v)+f(v_i')\Big]\Big] \\ + \sum_{i=1}^{n-3} \Big[f(u_i'u_i) - \Big[f(u_i')+f(u_i)\Big]\Big] \\ + f(u_n'u_n) - \Big[f(u_n'u_n)\Big] \end{aligned}$$

$$\begin{aligned} 3nk_1 = \{(4n+4)-(2+1)\} + \{(4n+5)-(3+1)\} \\ + \sum_{i=1}^{n} \Big[(5n+7+i)-(3+3+n+i)\Big] \\ + \sum_{i=1}^{n-3} \Big[(8n-i+6)-(3+i+4n-2i+2)\Big] \\ + \Big[(7n+3)-(3+n+2n+4)\Big] \end{aligned}$$

$$k_1 = 4n+1$$

To find k_2:

$$\begin{aligned}(n+1)k_2 &= \sum_{i=1}^{n}\left[f(vv_i^{'}) - \left[f(v)+f(v_i^{'})\right]\right] \\ &\quad + f(u_{n-2}^{'}u_{n-2}) - \left[f(u_{n-2}^{'})+f(u_{n-2})\right] \\ &= \sum_{i=1}^{n}\left(7n+8+i\right) \\ &\quad - \left[(4n-2i+5)+(3+n+i)\right] \\ &\quad + \left[\{n^2+4n-n(n-2)-(n-2)+5\}\right. \\ &\quad \left. + \{(3+(n-2))+(4n-2(n-2)+2)\}\right] \\ K_2 &= 2n\end{aligned}$$

To find k_3:

$$\begin{aligned}k_3 &= f(u_{n-1}^{'}u_{n-1}) - \left[f(u_{n-1}^{'})+f(u_{n-1})\right] \\ k_3 &= \{n^2+4n-n(n-1)-(n-1)+5\} \\ &\quad + \{(3+(n-1))+(4n-2)\} \\ k_3 &= 2-n\end{aligned}$$

Thus f is a reverse edge-trimagic labeling.

Hence, $S(B_{n,n})$ is a reverse super edge- trimagic graph. □

Illustration 3.1

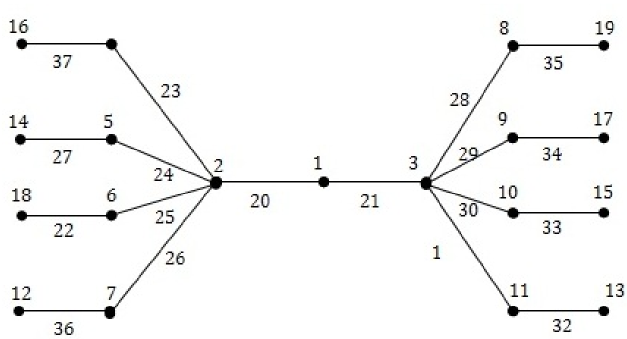

Fig 3.1: $S(B_{4,4})$ is a Reverse Super edge – trimagic graph.

Theorem 3.2. *The degree splitting graph*

$$DS[K_{1,n} \bigcup K_{1,n}]$$

is a reverse super edge-trimagic graph for $n \geq 2$.

Proof. Let

$$V[K_{1,n} \bigcup K_{1,n}] = \{u, u_i, v, v_i; 1 \leq i \leq n\}$$

where u_i's and v_i's are pendent vertices.

$$V[K_{1,n} \bigcup K_{1,n}] = V_1 \bigcup V_2$$

where $V_1 = \{u, v\}$

$$V_2 = \{u_i, v_i; 1 \leq i \leq n\}$$

Now, in order to obtain $DS[K_{1,n} \bigcup K_{1,n}]$ from $K_{1,n} \bigcup K_{1,n}$ we add w_1 and w_2 corresponding to V_1 and V_2. Then

$$\begin{aligned}V\left[DS[K_{1,n} \bigcup K_{1,n}]\right] &= \{u, u_i, v, v_i, w_1, w_2; 1 \leq i \leq n\} \\ W\left[DS[K_{1,n} \bigcup K_{1,n}]\right] &= \{uw_1, u_iw_2, vw_1, uu_i, vv_i, v_iw_2\} \\ &\qquad 1 \leq i \leq n\end{aligned}$$

We note that

$$\begin{aligned}\left|V\left[DS[K_{1,n} \bigcup K_{1,n}]\right]\right| &= 2n+4 \\ \left|W\left[DS[K_{1,n} \bigcup K_{1,n}]\right]\right| &= 4n+2\end{aligned}$$

Define $f : V \bigcup W \to \{1, 2, ..., 6n+6\}$ as follows

The vertex labels are defined by

$$\begin{aligned}f(u) &= 2 \\ f(v) &= 3 \\ f(w_1) &= 4 \\ f(w_2) &= 1\end{aligned}$$

For $1 \leq i \leq n$,

$$\begin{aligned}f(u_i^{'}) &= 4+i \\ f(v_i^{'}) &= 4+n+i\end{aligned}$$

The edge labels are defined as follows For $1 \leq i \leq n$,

$$\begin{aligned}f(u_iw_2) &= 2n+4+i \\ f(v_iw_2) &= 3n+4+i \\ f(uu_i) &= 4n+6+i \\ f(vv_i) &= 5n+6+i \\ f(uw_1) &= 4n+5 \\ f(vw_1) &= 4n+6\end{aligned}$$

Then the constants k_1, k_2, k_3 of reverse super edge- trimagic are obtained as follows.

To find k_1:

$$\begin{aligned}(n+2)k_1 &= \left[f(uw_1) - \{f(u)+f(w_1)\}\right] \\ &\quad + \left[f(vw_1) - \{f(v)+f(w_1)\}\right] \\ &\quad + \sum_{i=1}^{n}\left[f(v_iv) - \{f(v_i)+f(v)\}\right] \\ (n+2)k_1 &= \left[(4n+5)-(2+4)\right] + \left[(4n+6)-(3+4)\right] \\ &\quad + \sum_{i=1}^{n}\left[(5n+6+i)-(4+n+3+i)\right] \\ k_1 &= 4n-1\end{aligned}$$

To find k_2:

$$nk_2 = \sum_{i=1}^{n}\left[f(uu_i^{'}) - \{f(u)+f(u_i)\}\right]$$
$$= \sum_{i=1}^{n}\left[4n+6+i-\{2+4+i\}\right]$$
$$K_2 = 4n$$

To find k_3:

$$2nk_3 = \sum_{i=1}^{n}\left[f(u_iw_2) - \{f(u_i)+f(w_2)\}\right] + \sum_{i=1}^{n}\left[f(v_iw_2) - \{f(v_i)+f(w_2)\}\right]$$
$$= \sum_{i=1}^{n}\left[(2n+4+i)-\{4+i+1\}\right] + \sum_{i=1}^{n}\left[(3n+4+i)-\{4+n+i+1\}\right]$$
$$k_3 = 2n-1$$

Thus f is a reverse super edge-trimagic labeling.

Hence $DS[K_{1,n} \bigcup K_{1,n}]$ is a reverse super edge- trimagic graph for $n \geq 2$. □

Illustration 3.2

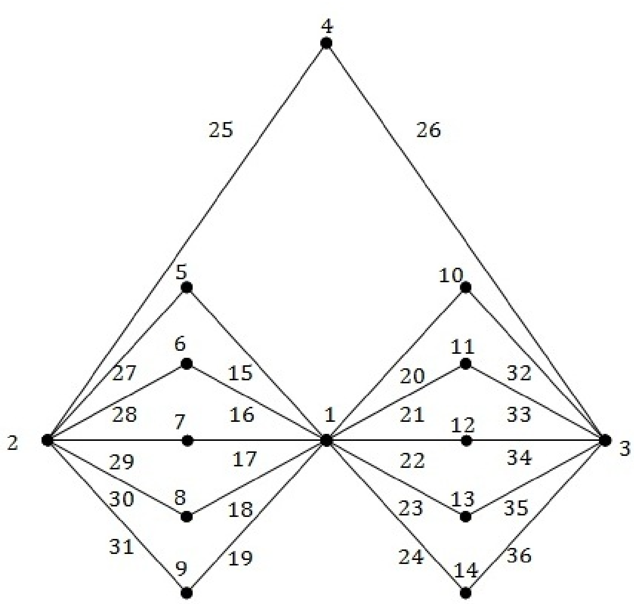

Fig 3.2: $DS[K_{1,5} \bigcup K_{1,5}]$ is a Reverse Super Edge–Trimagic Graph

Theorem 3.3. *The degree splitting graph*

$$DS[K_{1,n} \wedge K_{1,n}]$$

is a reverse super edge-trimagic graph for $n \geq 2$.

Proof. Let

$$V[K_{1,n} \wedge K_{1,n}] = \{u, u_i, v, v_i; 1 \leq i \leq n\}$$

where u_i's and v_i's are pendent vertices.

$$V[K_{1,n} \wedge K_{1,n}] = V_1 \bigcup V_2$$

where $V_1 = \{u, v\}$

$$V_2 = \{u_i, v_i; 1 \leq i \leq n\}$$

Now, in order to obtain $DS[K_{1,n} \wedge K_{1,n}]$ from $K_{1,n} \wedge K_{1,n}$ we add w_1 and w_2 corresponding to V_1 and V_2. Then

$$V\left[DS[K_{1,n} \wedge K_{1,n}]\right] = \{u, u_i, v, v_i, w_1, w_2; 1 \leq i \leq n\}$$
$$W\left[DS[K_{1,n} \wedge K_{1,n}]\right] = \{uv, uw_1, u_iw_2, vw_1, uu_i, vv_i, v_iw_2\}$$
$$1 \leq i \leq n$$

We note that

$$\left|V\left[DS[K_{1,n} \wedge K_{1,n}]\right]\right| = 2n+4$$
$$\left|W\left[DS[K_{1,n} \wedge K_{1,n}]\right]\right| = 4n+3$$

Define $f : V \bigcup W \rightarrow \{1, 2, ..., 6n+6\}$ as follows

The vertex labels are defined by

$$f(w_1) = 1$$
$$f(u) = 2$$
$$f(v) = 3$$
$$f(w_2) = 2n+4$$

For $1 \leq i \leq n$,

$$f(u_i^{'}) = 3+i$$
$$f(v_i^{'}) = 3+n+i$$

The edge labels are defined as follows

$$f(uw_1) = 2n+5$$
$$f(vw_1) = 2n+6$$
$$f(uv) = 2n+7$$

For $1 \leq i \leq n$,

$$f(uu_i) = 4n+7+i$$
$$f(vv_i) = 5n+7+i$$
$$f(u_iw_2) = 2n+7+i$$
$$f(v_iw_2) = 3n+7+i$$

Then the constants k_1, k_2, k_3 of reverse super edge- trimagic are obtained as follows.

To find k_1:

$$(n+3)k_1 = \left[f(uv) - \{f(u)+f(v)\}\right] + \left[f(uw_1) - \{f(u)+f(w_1)\}\right] + \left[f(vw_1) - \{f(v)+f(w_1)\}\right] + \sum_{i=1}^{n}\left[f(uw_i) - \{f(u)+f(u_i)\}\right]$$

$$(n+3)k_1 = \left[(2n+7)-(1+3)\right] + \left[(2n+5)-(2+1)\right] + \left[(2n+6)-(3+1)\right] + \sum_{i=1}^{n}\left[(2n+7+i)-(2+3+i)\right]$$

$$k_1 = 2n+2$$

To find k_2:

$$nk_2 = \sum_{i=1}^{n}\left[f(vv_i^{'}) - \{f(v)+f(v_i)\}\right]$$

$$= \sum_{i=1}^{n}\left[3n+7+i-\{3+3+n+i\}\right]$$

$$K_2 = 2n+1$$

To find k_3:

$$2nk_3 = \sum_{i=1}^{n}\left[f(u_iw_2) - \{f(u_i)+f(w_2)\}\right] + \sum_{i=1}^{n}\left[f(v_iw_2) - \{f(v_i)+f(w_2)\}\right]$$

$$= \sum_{i=1}^{n}\left[(4n+7+i)-\{3+i++2n+4\}\right] + \sum_{i=1}^{n}\left[(5n+7+i)-\{3+n+i+2n+4\}\right]$$

$$k_3 = 2n$$

Thus f is a reverse super edge-trimagic labeling.

Hence

$$DS[K_{1,n} \wedge K_{1,n}]$$

is a reverse super edge- trimagic graph for $n \geq 2$. □

Illustration 3.3

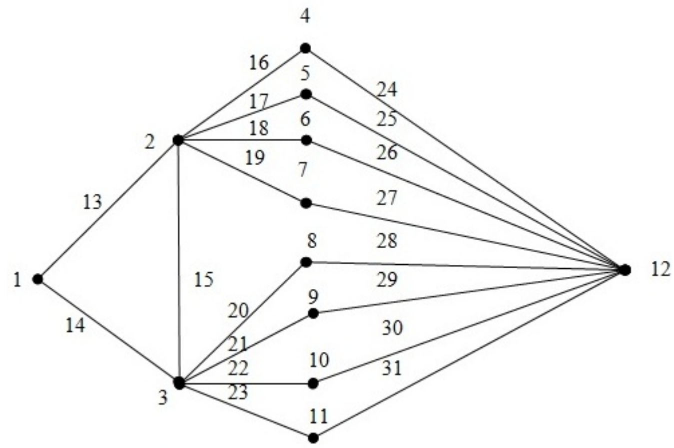

Fig 3.3: $DS[K_{1,4} \wedge K_{1,4}]$ is a Reverse Super Edge–Trimagic graph

Theorem 3.4. *The graph*

$$P_3 \square K_{1,n}$$

is a reverse super edge-trimagic labeling for $n \geq 2$.

Proof. Let

$$V[P_3 \square K_{1,n}] = \{u, u_i, v, v_i, w, w_i; 1 \leq i \leq n\}$$

$$W[P_3 \square K_{1,n}] = \{uv, uu_i, vw, vv_i, ww_i; 1 \leq i \leq n\}$$

$$\left|V\left[P_3 \square K_{1,n}\right]\right| = 3n+3$$

$$\left|W\left[P_3 \square K_{1,n}\right]\right| = 3n+2$$

Define $f: V \bigcup W \to \{1, 2, \ldots, 6n+5\}$ as follows

The vertex labels are defined by

$$f(u) = 1$$
$$f(v) = 2$$
$$f(w) = 3$$

For $1 \leq i \leq n$,

$$f(u_i) = 3+2n+i$$
$$f(v_i) = 3+n+i$$
$$f(w_i) = 3+i$$

The edge labels are defined by

$$f(uv) = 3n+4$$
$$f(vw) = 3n+5$$

For $1 \leq i \leq n$,

$$f(uu_i) = 5n+5+i$$
$$f(vv_i) = 4n+5+i$$
$$f(ww_i) = 3n+5+i$$

Then the constants k_1, k_2, k_3 of reverse super edge- trimagic labeling are obtained as follows.

To find k_1:

$$(n+1)k_1 = \left[f(uv) - \{f(u)+f(v)\}\right] + \left[f(uu_i) - \{f(u)+f(u_i)\}\right]$$
$$(n+1)k_1 = \left[(3n+4)-(1+2)\right] + \sum_{i=1}^{n}\left[(5n+5+i)-(1+3+2n+i)\right]$$
$$k_1 = 3n+1$$

To find k_2:

$$(n+1)k_2 = \left[f(vw) - \{f(v)+f(w)\}\right] + \sum_{i=1}^{n}\left[f(vv_i) - \{f(v)+f(v_i)\}\right]$$
$$= \left[(3n+5) - \{2+3\}\right] + \sum_{i=1}^{n}\left[4n+5+i-\{2+3+n+i\}\right]$$
$$K_2 = 3n$$

To find k_3:

$$nk_3 = \sum_{i=1}^{n}\left[f(ww_i) - \{f(w)+f(w_i)\}\right]$$

$$nk_3 = \sum_{i=1}^{n}\left[(3n+5+i) - \{3+3+i\}\right]$$
$$k_3 = 3n-1$$

Thus f is a reverse super edge-trimagic labeling.

Hence

$$P_3 \square K_{1,n}$$

is a reverse super edge- trimagic labeling for $n \geq 2$. □

Illustration 3.4

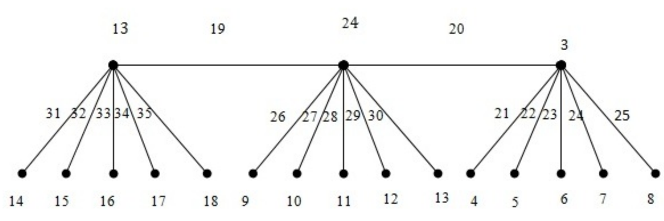

Fig 3.4: $P_5 \square K_{1,5}$ is a Reverse Super Edge – Trimagic graph

Theorem 3.5. *The Splitting graph of star graph $S'(K_{1,n})$ is a reverse super edge- trimagic graph for $n \geq 3$.*

Proof. The splitting graph of star graph $S'(K_{1,n})$ is obtained by adding vertices v and $v_i, 1 \leq i \leq n$ such that u and $u_i, 1 \leq i \leq n$ is adjacent to every vertex that is adjacent to v and $v_i, 1 \leq i \leq n$ in $K_{1,n}$.

Let

$$V[S'(K_{1,n})] = \{u, u_i, v, v_i; 1 \leq i \leq n\}$$
$$E[S'(K_{1,n})] = \{vv_i, vu_i, uv_i; 1 \leq i \leq n\}$$

We note that

$$\left|V\left[S'(K_{1,n})\right]\right| = 2n+2$$
$$\left|E\left[S'(K_{1,n})\right]\right| = 3n$$

Define $f : V \bigcup E \to \{1, 2, ..., 5n+2\}$ as follows

The vertex labels are defined by For $1 \leq i \leq n$,

$$f(u_i) = 1$$
$$f(v_i) = n+i$$
$$f(u) = 2n+i$$
$$f(v) = 2n+2$$

The edge labels are defined by For $1 \leq i \leq n$,

$$f(vu_i) = 2n+3+i$$
$$f(vv_i) = 3n+3+i$$
$$f(uv_i) = 2n+3$$

For $2 \leq i \leq n$,

$$f(uv_i) = 4n+2+i$$

Then the constants k_1, k_2, k_3 of reverse super edge- trimagic labeling are obtained as follows.

To find k_1:

$$2nk_1 = \sum_{i=1}^{n}\left[f(vu_i) - \{f(v)+f(u_i)\}\right] + \sum_{i=1}^{n}\left[f(vv_i) - \{f(v)+f(v_i)\}\right]$$
$$2nk_1 = \sum_{i=1}^{n}\left[(2n+3+i) - ((2n+2)+i)\right] + \sum_{i=1}^{n}\left[(3n+3+i) - ((2n+2)+(n+i))\right]$$
$$k_1 = 1$$

To find k_2:

$$(n-1)k_2 = \sum_{i=1}^{n}\left[f(uv_i) - \{f(u)+f(v_i)\}\right]$$
$$(n-1)k_2 = \sum_{i=1}^{n}\left[(4n+2+i) - \{(2n+1)+(n+i)\}\right]$$
$$K_2 = n+1$$

To find k_3:

$$k_3 = f(uv_i) - \{f(u) + f(v_i)\}$$
$$k_3 = (2n+3) - \{2n+1+n+1\}$$
$$k_3 = 1-n$$

Thus f is a reverse super edge-trimagic labeling.

Hence

$$S^{'}(K_{1,n})$$

is a reverse super edge- trimagic graph $n \geq 3$. □

Illustration 3.5

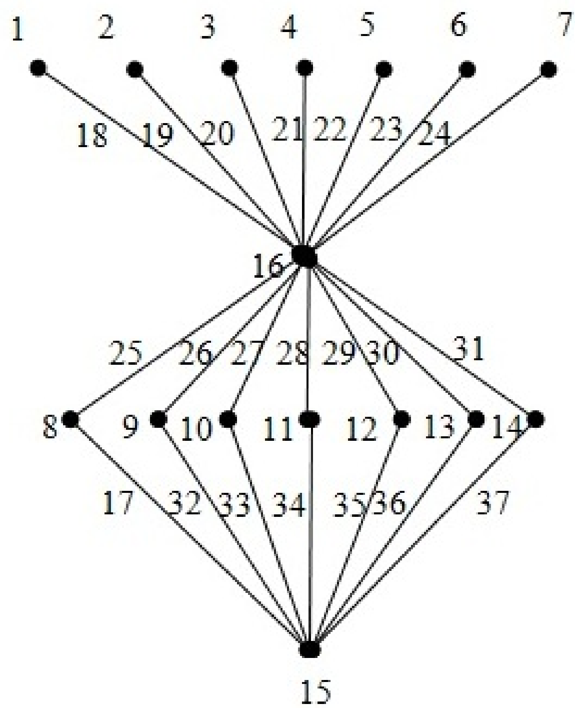

Fig 3.5: $S^{'}(K_{1,7})$ is a Reverse Super Edge – Trimagic graph

4. Conclusion

The concept of reverse super edge - trimagic labeling of several classes of graphs are discussed here.

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