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More Results on k-Super Mean Labeling

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Abstract: Let G be a (p, q) graph and $f: V(G) \rightarrow \{k, k + 1, k + 2, \dots, p + q + k - 1\}$ be an injection. For each edge $e = uv$, let $f^*(e) = \frac{f(u)+f(v)}{2}$ if $f(u) + f(v)$ is even and $f^*(e) = \frac{f(u)+f(v)+1}{2}$ iff $f(u) + f(v)$ is odd, then f is called k -super mean labeling if $f(V) \cup \{f^*(e) : e \in E(G)\} = \{k, k + 1, k + 2, \dots, p + q + k - 1\}$. A graph that admits a k -Super mean labeling is called k -Super mean graph. In this paper we investigate k -super mean labeling of $n(S(S_3))$, $(P_n; S_2)$, $[P_n; Q_3]$, $T_n \cup T(L_m)$, $D(F_n)$.

Keywords: k -Super mean labeling, k -Super mean graph, $n(S(S_3))$, $(P_n; S_2)$, $[P_n; Q_3]$, $T_n \cup T(L_m)$, $D(F_n)$.

AMS Subject Classification--- 05C78

I. INTRODUCTION

All graphs in this thesis are finite, simple and undirected. Terms not defined here are used in the sense of Harary [7]. The symbols $V(G)$ and $E(G)$ will denote the vertex set and edge set of a graph G . Graph labeling was first introduced in the late 1960's. Many studies in graph labeling refer to Rosa's research in 1967. Labeled graphs serve as useful models for a broad range of applications such as X-ray, crystallography, radar, coding theory, astronomy, circuit design and communication network addressing. Particularly interesting applications of graph theory can be found in [1-4]. The concept of mean labeling was introduced and studied by S. Somasundaram and R. Ponraj [12]. The concept of super mean labeling was introduced and studied by D. Ramya et al [11]. Further some results on super mean graphs are discussed in [8,9,10,13,15]. B. Gayathri and M. Tamilselvi [5-6, 14] extended super mean labeling to k -super mean labeling. In this paper we investigate k -supermean labeling of $n(S(S_3))$, $(P_n; S_2)$, $[P_n; Q_3]$, $T_n \cup T(L_m)$, $D(F_n)$. Here k denoted as any positive integer greater than or equal to 1.

II. MAIN RESULTS

A. Definition 2.1

Let G be a (p, q) graph and $f: V(G) \rightarrow \{1, 2, 3, \dots, p + q\}$ be an injection. For each edge $e = uv$, let $f^*(e) = \frac{f(u)+f(v)}{2}$ if $f(u) + f(v)$ is even and $f^*(e) = \frac{f(u)+f(v)+1}{2}$ if $f(u) + f(v)$ is odd, then f is called super mean labeling if $f(V) \cup \{f^*(e) : e \in E(G)\} = \{1, 2, 3, \dots, p + q\}$. A graph that admits a super mean labeling is called super mean graph.

B. Definition 2.2

Let G be a (p, q) graph and $f: V(G) \rightarrow \{k, k + 1, k + 2, \dots, p + q + k - 1\}$ be an injection. For each edge $e = uv$, let $f^*(e) = \frac{f(u)+f(v)}{2}$ if $f(u) + f(v)$ is even and $f^*(e) = \frac{f(u)+f(v)+1}{2}$ if $f(u) + f(v)$ is odd, then f is called k -super mean labeling if $f(V) \cup \{f^*(e) : e \in E(G)\} = \{k, k + 1, k + 2, \dots, p + q + k - 1\}$. A graph that admits a k -Super mean labeling is called k -Super mean graph.

C. Definition 2.3

A subdivision of a graph G is a graph resulting from the subdivision of each edge by a new vertex.

D. Definition 2.4

A triangular snake (T_n) is obtained from a path by identifying each edge of the path with an edge of the cycle C_3 .

E. Definition 2.5

A double triangular snake $D(T_n)$ consists of two triangular snake that have a common path. That is, a double triangular snake is obtained from a path v_1, v_2, \dots, v_n by joining v_i and v_{i+1} to a new vertices w_i for $i = 1, 2, \dots, n-1$ and to a new vertices u_i for $i = 1, 2, \dots, n-1$.

F. Definition 2.6

A star graph S_n is the complete bipartite graph $K_{1,n}$.

G. Definition 2.7

The ladder graph L_n is obtained from the Cartesian product of two path graphs.

H. Definition 2.8

For any graph G , the graph mG denotes the disjoint union of m copies of G .

I. Theorem 2.9

The graph $n(S(S_3))$ is a k -Super mean graph for all $n \geq 1$.

Proof

Let $V(n(S(S_3))) = \{u_i, v_i, w_i, s_i, v'_i, w'_i, s'_i; 1 \leq i \leq n\}$ and $E(n(S(S_3))) = \{e_i = (u_i, v'_i), e'_i = (v_i, v'_i), e''_i = (w_i, w'_i); 1 \leq i \leq n\} \cup \{e'''_i = (u_i, s'_i), e^{iv}_i = (s_i, s'_i), e^v_i = (u_i, w'_i); 1 \leq i \leq n\}$ be the vertices and edges of $n(S(S_3))$ respectively.

Define $f: V(n(S(S_3))) \rightarrow \{k, k + 1, k + 2, \dots, k + 13n - 1\}$ by

$$f(u_i) = k + 13i - 9; \quad 1 \leq i \leq n$$

$$f(s_i) = k + 13i - 13; \quad 1 \leq i \leq n$$

$$f(s'_i) = k + 13i - 11; \quad 1 \leq i \leq n$$

$$f(v'_i) = k + 13i - 7; \quad 1 \leq i \leq n$$

$$f(v_i) = k + 13i - 4; \quad 1 \leq i \leq n$$

$$f(w_i) = k + 13i - 1; \quad 1 \leq i \leq n$$

$$f(w'_i) = k + 13i - 3; \quad 1 \leq i \leq n$$

Now the induced edge labels are

$$f^*(e_i) = k + 13i - 8; \quad 1 \leq i \leq n$$

$$f^*(e'_i) = k + 13i - 5; \quad 1 \leq i \leq n$$

$$f^*(e''_i) = k + 13i - 2; \quad 1 \leq i \leq n$$

$$f^*(e'''_i) = k + 13i - 10; \quad 1 \leq i \leq n$$

$$f^*(e^{iv}_i) = k + 13i - 12; \quad 1 \leq i \leq n$$

$$f^*(e^v_i) = k + 13i - 6; \quad 1 \leq i \leq n$$

Here $p = 7n, q = 6n$.

Clearly, $f(V) \cup \{f^*(e) : e \in E(n(S(S_3)))\} = \{k, k + 1, \dots, k + 13n - 1\}$. So f is a k -Super mean labeling.

Hence $n(S(S_3))$ is a k -Super mean graph.

J. Example 2.10

10 – Super mean labeling of $6(S(S_3))$ is given in figure 1:

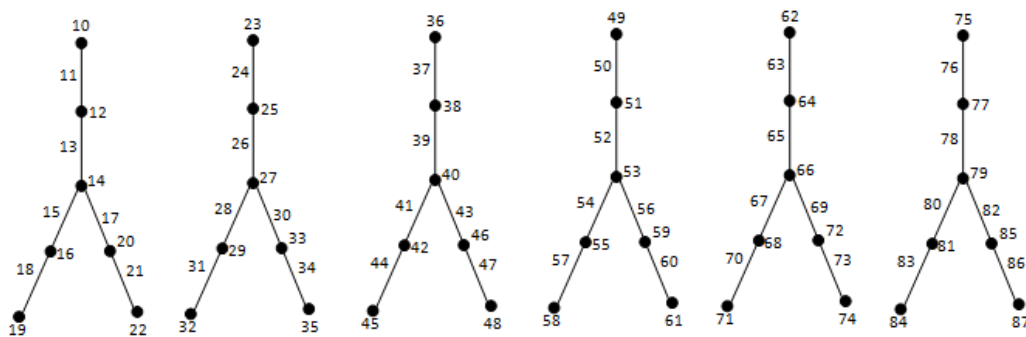


Figure 1: 10 – Super mean labeling of $6(S(S_3))$

K. Definition 2.11

Let G be a graph with fixed vertex v and let $(P_m; G)$ be the graph obtained from m copies of G and the path $P_m: u_1, u_2, \dots, u_m$ by joining u_i with the vertex v of the i^{th} copy of G by means of an edge, for $1 \leq i \leq m$.

L. Theorem 2.1

The graph $(P_n; S_2)$ is a k -Super mean graph for all $n \geq 1$.

Proof:

Let $V((P_n; S_2)) = \{u_i, v_i, w_i, w'_i; 1 \leq i \leq n\}$ and $E((P_n; S_2)) = \{e_i = (u_i, u_{i+1}), 1 \leq i \leq n-1\} \cup \{e'_i = (u_i, v_i), e''_i = (w_i, v_i), e'''_i = (v_i, w'_i); 1 \leq i \leq n\}$ be the vertices and edges of $(P_n; S_2)$ respectively.

Define $f: V((P_n; S_2)) \rightarrow \{k, k+1, k+2, \dots, k+8n-1\}$ by

$$f(u_i) = \begin{cases} k+8i-8; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-2; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(v_i) = \begin{cases} k+8i-6; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-4; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(w_i) = \begin{cases} k+8i-4; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-10; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(w'_i) = \begin{cases} k+8i; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-6; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

Now the induced edge labels are

$$f^*(e_i) = k+8i-1; \quad 1 \leq i \leq n-1$$

$$f^*(e'_i) = \begin{cases} k+8i-7; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-3; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e''_i) = \begin{cases} k+8i-5; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-7; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e'''_i) = \begin{cases} k+8i-3; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k+8i-5; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

Here $p = 4n, q = 4n-1$.

Clearly, $f(V) \cup \{f^*(e) : e \in E((P_n; S_2))\} = \{k, k+1, \dots, k+8n-1\}$. So f is a k -Super mean labeling.

Hence $(P_n; S_2)$ is a k -Super mean graph.

M. Example 2.13

40 – Super mean labeling of $(P_4; S_2)$ is given in figure 2:

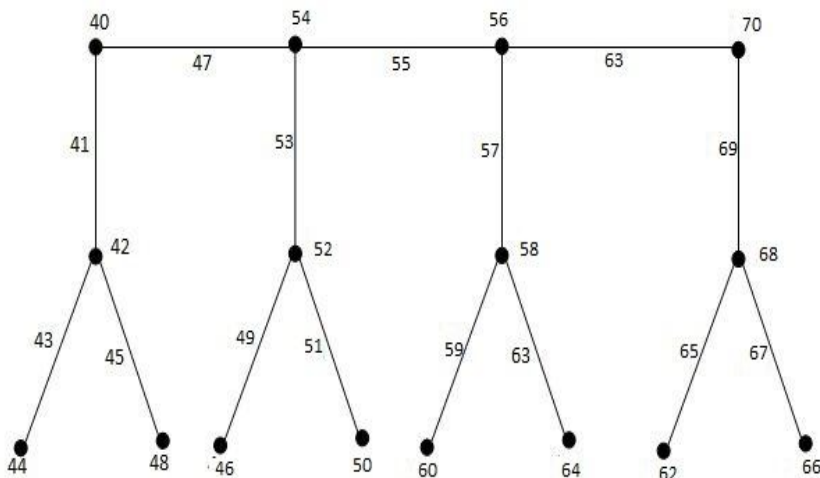


Figure 2: 40 – Super mean labeling of $(P_4; S_2)$

N. Definition 2.14

Let G be a graph with fixed vertex v , and let $[P_m; G]$ be the graph obtained from m copies of G by joining v_i and v_{i+1} by means of an edge for some j and $1 \leq i \leq m - 1$.

O. Theorem 2.15

The graph $[P_n; Q_3]$ is a k -Super mean graph for all $n \geq 1$.

Proof:

Let $V([P_n; Q_3]) = \{u_i, v_i, w_i, x_i, u'_i, v'_i, w'_i, x'_i; 1 \leq i \leq n\}$ and $E([P_n; Q_3]) = \{e_i = (u_i, u_{i+1}), 1 \leq i \leq n - 1\} \cup \{e'_i = (u_i, v_i), e''_i = (w_i, v_i), e'''_i = (w_i, x_i), 1 \leq i \leq n\} \cup \{e^{iv}_i = (u_i, x_i), e^v_i = (u_i, u'_i), e^{vi}_i = (v_i, v'_i); 1 \leq i \leq n\} \cup \{e^{vii}_i = (w_i, w'_i), e^{viii}_i = (x_i, x'_i), e^{ix}_i = (u'_i, x'_i); 1 \leq i \leq n\} \cup \{e^{xi}_i = (u'_i, v'_i), e^{xi}_i = (v'_i, w'_i), e^{xii}_i = (w'_i, x'_i); 1 \leq i \leq n\}$

be the vertices and edges of $[P_n; Q_3]$ respectively.

Define $f: V([P_n; Q_3]) \rightarrow \{k, k + 1, k + 2, \dots, k + 21n - 2\}$ by

$$f(u_i) = \begin{cases} k + 21i - 21; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 2; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(u'_i) = \begin{cases} k + 21i - 11; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 13; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(v'_i) = \begin{cases} k + 21i - 17; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 6; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(w'_i) = \begin{cases} k + 21i - 13; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 11; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(x'_i) = \begin{cases} k + 21i - 6; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 17; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(v_i) = \begin{cases} k + 21i - 19; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 4; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(w_i) = \begin{cases} k + 21i - 2; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 21; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f(x_i) = \begin{cases} k + 21i - 4; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 19; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

Now the induced edge labels are

$$f^*(e_i) = k + 21i - 1; \quad 1 \leq i \leq n - 1$$

$$f^*(e'_i) = \begin{cases} k + 21i - 20; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 3; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e''_i) = \begin{cases} k + 21i - 10; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 12; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e'''_i) = \begin{cases} k + 21i - 3; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 20; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{iv}_i) = \begin{cases} k + 21i - 12; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 10; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^v_i) = \begin{cases} k + 21i - 16; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 7; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{vi}_i) = \begin{cases} k + 21i - 18; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 5; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{vii}_i) = \begin{cases} k + 21i - 7; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 16; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{viii}_i) = \begin{cases} k + 21i - 5; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 18; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{ix}_i) = \begin{cases} k + 21i - 8; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 15; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^x_i) = \begin{cases} k + 21i - 14; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 9; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e^{xi}_i) = \begin{cases} k + 21i - 15; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 8; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

$$f^*(e_i^{xii}) = \begin{cases} k + 21i - 9; & 1 \leq i \leq n; \text{ if } n \text{ is odd} \\ k + 21i - 14; & 1 \leq i \leq n; \text{ if } n \text{ is even} \end{cases}$$

Here $p = 8n, q = 13n-1$.

Clearly, $f(V) \cup \{f^*(e) : e \in E([P_n; Q_3])\} = \{k, k + 1, \dots, k + 21n - 2\}$. So f is a k – Super mean labeling.

Hence $[P_n; Q_3]$ is a k – Super mean graph. .

P. Example 2.16

50 – Super mean labeling of $[P_2; Q_3]$ is given in figure 2.3:

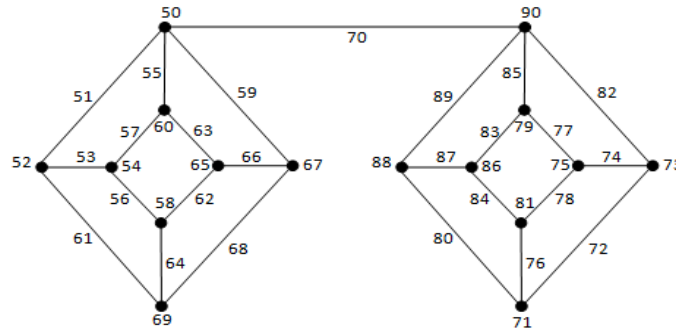


Figure 3: 50 – Super mean labeling of $[P_2; Q_3]$

Q. Theorem 2.17

The graph $T_n \cup T(L_m)$ is a k -Super mean graph for all $n, m \geq 2$.

Proof:

Let $V(T_n \cup T(L_m)) = \{u_i, v_i; 1 \leq i \leq n\} \cup \{w_i, w'_i; 1 \leq i \leq m\}$ and $E(T_n \cup T(L_m)) = \{e_i = (u_i, u_{i+1}), e'_i = (v_i, u_i); 1 \leq i \leq n - 1\} \cup \{e''_i = (v_i, u_{i+1}), e'''_i = (w_i, w_{i+1}); 1 \leq i \leq n - 1\} \cup \{e^v_i = (w_{i+1}, w'_i), e^{vi}_i = (w'_i, w'_{i+1}); 1 \leq i \leq n - 1\} \cup \{e^{iv}_i = (w_i, w'_i); 1 \leq i \leq n\}$ be the vertices and edges of $T_n \cup T(L_m)$ respectively.

Define $f: V(T_n \cup T(L_m)) \rightarrow \{k, k + 1, k + 2, \dots, k + 5n + 6m - 8\}$ by

$$f(u_i) = k + 5i - 5; \quad 1 \leq i \leq n$$

$$f(v_i) = k + 5i - 3; \quad 1 \leq i \leq n - 1$$

$$f(w_i) = f(u_n) + 6i - 5; \quad 1 \leq i \leq m$$

$$f(w'_i) = f(u_n) + 6i - 3; \quad 1 \leq i \leq m$$

Now the induced edge labels are

$$f^*(e_i) = k + 5i - 2; \quad 1 \leq i \leq n - 1$$

$$f^*(e'_i) = k + 5i - 4; \quad 1 \leq i \leq n - 1$$

$$f^*(e''_i) = k + 5i - 1; \quad 1 \leq i \leq n - 1$$

$$f^*(e'''_i) = f(u_n) + 6i - 2; \quad 1 \leq i \leq m$$

$$f^*(e^{iv}_i) = f(u_n) + 6i - 4; \quad 1 \leq i \leq m - 1$$

$$f^*(e^v_i) = f(u_n) + 6i - 1; \quad 1 \leq i \leq m - 1$$

$$f^*(e^{vi}_i) = f(u_n) + 6i; \quad 1 \leq i \leq m - 1$$

Here $p = 2(m+n)-1, q = 3n+4m-6$.

Clearly, $f(V) \cup \{f^*(e) : e \in E(T_n \cup T(L_m))\} = \{k, k + 1, \dots, k + 5n + 6m - 8\}$.

So f is a k – Super mean labeling.

Hence $(T_n \cup T(L_m))$ is a k – Super mean graph.

R. Example 2.18

200 – Super mean labeling of $(T_4 \cup T(L_4))$ is given in figure 4:

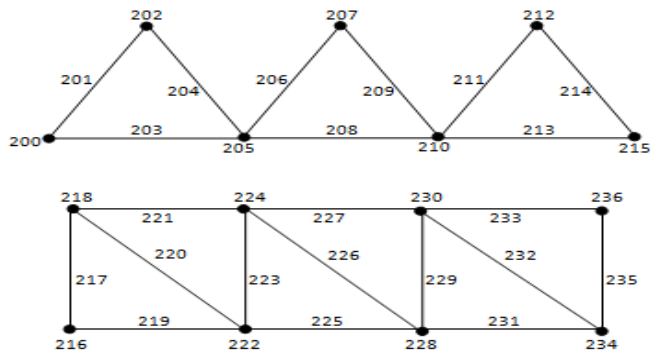


Figure 4: 200 – Super mean labeling of $(T_4 \cup T(L_4))$

S. Definition 2.19:

Double $D(F_n)$ is obtained by P_n+2K_1 .

T. Theorem 2.20

The graph $D(F_n)$ is a k-Super mean graph for all $n \geq 1$.

Proof:

Let $V(D(F_n)) = \{u, v\} \cup \{u_i; 1 \leq i \leq n\}$ and $E(D(F_n)) = \{e_i = (u_i, u_{i+1}); 1 \leq i \leq n-1\} \cup \{e'_i = (u_i, u); 1 \leq i \leq n\} \cup \{e''_i = (u_i, v); n+1 \leq i \leq 2n, 1 \leq j \leq n\}$ be the vertices and edges of $D(F_n)$ respectively.

Define $f: V(D(F_n)) \rightarrow \{k, k+1, k+2, \dots, k+4n-2\}$ by

$$f(u) = k$$

$$f(v) = k + 4n$$

$$f(u_i) = k + 4i - 2; 1 \leq i \leq n$$

Now the induced edge labels are

$$f^*(e_i) = k + 4i; 1 \leq i \leq n-1$$

$$f^*(e'_i) = k + 2i - 1; 1 \leq i \leq 2n$$

Here $p = n+2, q = 3n-1$.

Clearly, $f(V) \cup \{f^*(e); e \in E(D(F_n))\} = \{k, k+1, \dots, k+4n-2\}$.

So f is a k – Super mean labeling.

Hence $D(F_n)$ is a k – Super mean graph.

U. Example 2.21:

100 – Super mean labeling of $D(F_7)$ is given in figure 5:

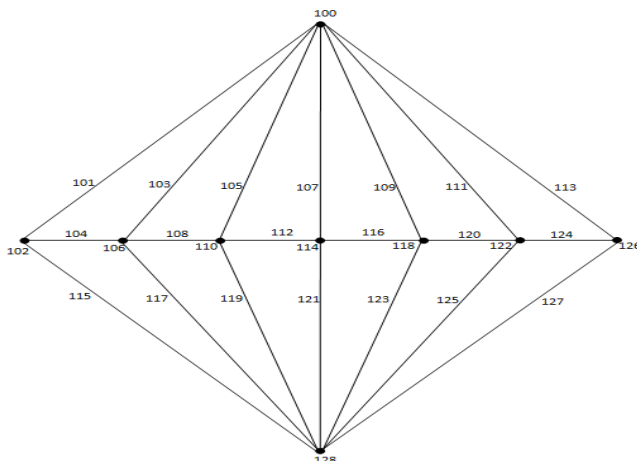


Figure 5: 100 – Super mean labeling of $D(F_7)$

III. CONCLUSIONS

Graph labeling has its own applications in communication networks and astronomy. so, enormous types of labeling have grown. Towards this, k-super mean labeling is also a kind of labeling which is an extension of super mean labeling. we discussed k-super mean labeling of the graphs $n(S(S_3))$, $(P_n; S_2)$, $[P_n; Q_3]$, $T_n \cup T(L_m)$, $D(F_n)$.

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