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More Results on k-Super Mean Labeling

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***Abstract:** Let G be a (p, q) graph and $f: V(G) \to \{k, k+1, k+2, \dots, p+q+k-1\}$ 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. 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, $n(S(S_3))$, $(P_n; S_2)$, $[P_n; Q_3]$, $T_n \cup T(L_m)$, $D(F_n)$.*
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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 $f: V(G) \to \{1,2,3, \dots, p+q\}$ 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 $f: V(G) \to \{k, k+1, k+2, \dots, p+q+k-1\}$ 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,…,n-1and to a new vertices u_i for i =1,2,…,n-1.

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

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

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

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

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

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

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

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

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

Now the induced edge labels are

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

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

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

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

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

$f^*(e_i^{v}) = k + 13i - 6;\ \ 1 \leq i \leq n$

Here p = 7n, q = 6n.

Clearly, $f(V) \cup \left\{f^*(e): e \in E\left(n(S(S_3))\right)\right\} = \{k, k+1, \dots, k+13n-1\}$. 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:

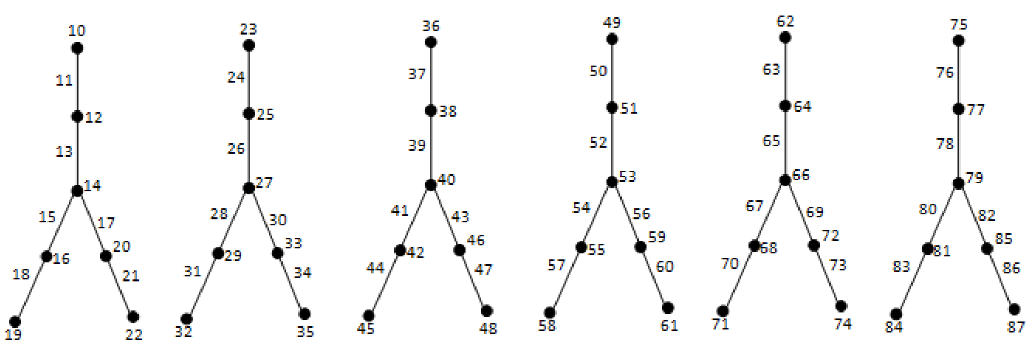

Figure 1: 10 – Super mean labeling of $6(S(S_3))$

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 ith copy of G by means of an edge, for $1 \le i \le m$.

L. Theorem 2.1

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

Proof:

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

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

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

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

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

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

Now the induced edge labels are

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

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

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

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

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:

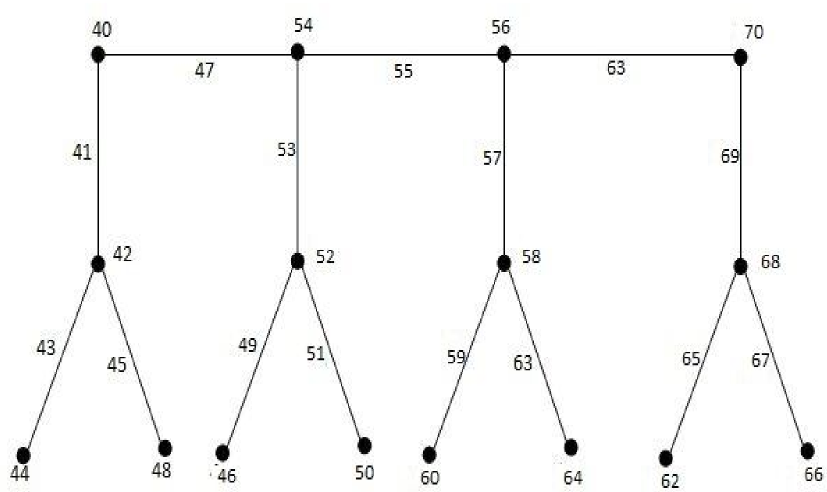

Figure 2: 40 – Super mean labeling of $(P_4; S_2)$

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 $1 \le i \le m-1$.

O. Theorem 2.15

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

Proof:

Let $V([P_n;Q_3]) = \{u_i, v_i, w_i, x_i, u_i', v_i', w_i', x_i'; 1 \le i \le n\}$ and $E([P_n;Q_3]) = \{e_i = (u_i, u_{i+1}), 1 \le i \le n-1\} \cup \{e_i' = (u_i, v_i), e_i'' = (w_i, v_i), e_i''' = (w_i, x_i), ; 1 \le i \le n\} \cup \{e_i^{iv} = (u_i, x_i), e_i^{v} = (u_i, u_i'), e_i^{vi} = (v_i, v_i'); 1 \le i \le n\} \cup \{e_i^{vii} = (w_i, w_i'), e_i^{viii} = (x_i, x_i'), e_i^{ix} = (u_i', x_i'); 1 \le i \le n\} \cup \{e_i^{x} = (u_i', v_i'), e_i^{xi} = (v_i', w_i'), e_i^{xii} = (w_i', x_i'); 1 \le i \le n\}$ be the vertices and edges of $[P_n;Q_3]$ respectively.

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

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

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

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

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

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

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

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

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

Now the induced edge labels are

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Clearly, $f(V) \cup \{f^*(e): e \in E([P_n; Q_3])\} = \{k, k+1, \ldots, k+21n-2\}$. 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:

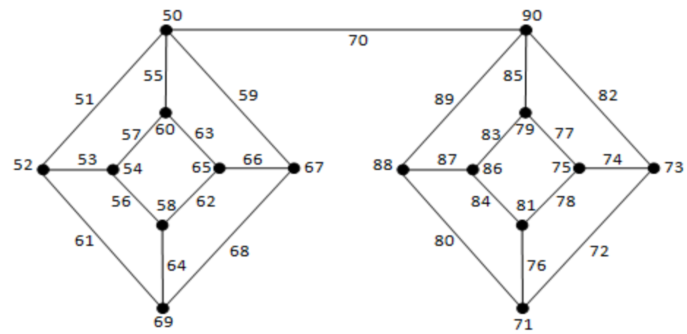

Figure 3: 50 – Super mean labeling of $[P_2; Q_3]$

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

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

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

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

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

$f(w_i') = f(u_n) + 6i - 3;\ \ 1 \le i \le m$

Now the induced edge labels are

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

$f^*(e_i') = k + 5i - 4;\ \ 1 \le i \le n-1$

$f^*(e_i'') = k + 5i - 1;\ \ 1 \le i \le n-1$

$f^*(e_i''') = f(u_n) + 6i - 2;\ \ 1 \le i \le m$

$f^*(e_i^{iv}) = f(u_n) + 6i - 4;\ \ 1 \le i \le m-1$

$f^*(e_i^{v}) = f(u_n) + 6i - 1;\ \ 1 \le i \le m-1$

$f^*(e_i^{vi}) = f(u_n) + 6i;\ \ 1 \le i \le m-1$

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

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

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:

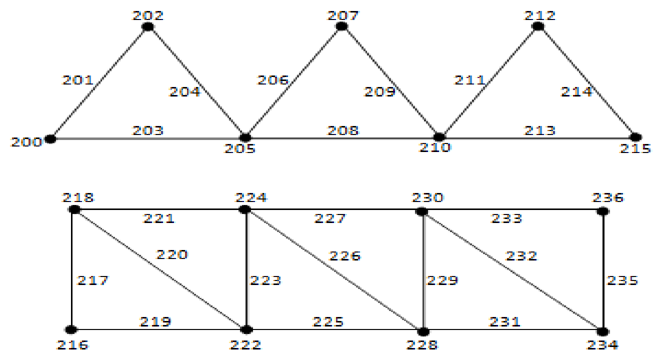

Figure 4: 200 – Super mean labeling of $(T_4 \cup T(L_4))$

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

Define $f: V(D(F_n)) \rightarrow \{k, k+1, k+2, \ldots, k+4n-2\}$ 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, $f(V) \cup \{f^*(e): e \in E(D(F_n))\} = \{k, k+1, \ldots, k+4n-2\}$.

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:

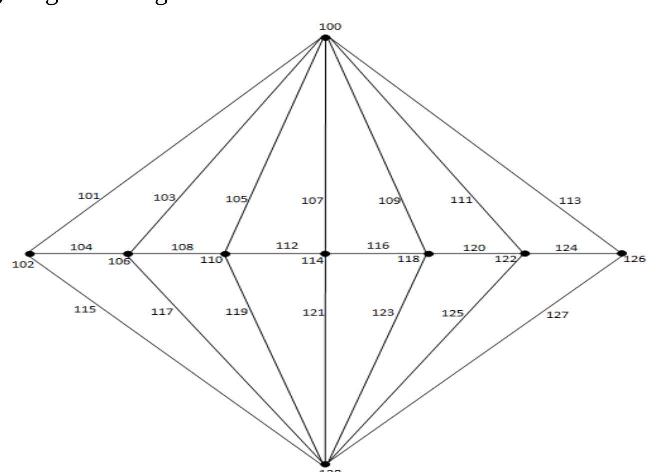

Figure 5: 100 – Super mean labeling of $D(F_7)$

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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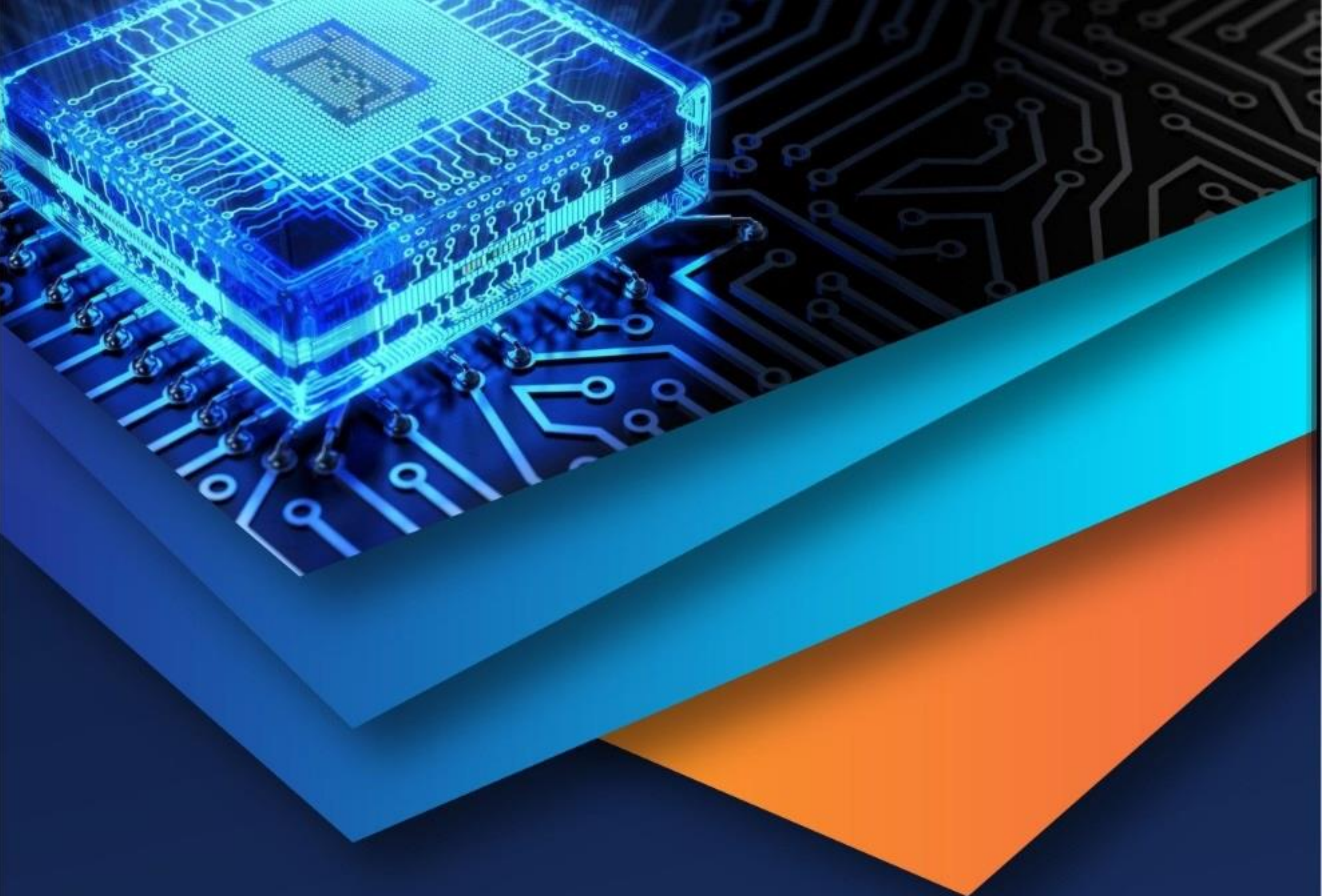

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