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Cordial Labeling on Few Graphs of Subdividedshell Graphs

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Abstract

In 1987, Cahit[1]implemented cordial labeling. Cordial labeling[1] is defined as a function $h: V(\theta) \to \{0,1\}$in which each edge ab is assigned the label $|h(a) - h(b)|$ with the conditions$|v_h(0) - v_h(1)| \leq 1$ and $|e_h(0) - e_h(1)| \leq 1$ where $v_h(0)$ and $v_h(1)$signify the number of vertices with 0's and 1's, similarly $e_h(0)$ and$e_h(1)$signify the number of edges with 0's and 1's. We want to show that the graphssuch as uniform sub-divided shell bow graph, uniform sub-divided shell flower graph, one point union of multiple sub-divided shell graph, sub-divided shell Graph with star graphs coupled to the apex and path vertices are cordial.

Keywords: Cordial labeling, Sub-divided Shell Graph, Sub-divided shell bow graph, Sub-divided shell flower graph, Multiplesub-divided shell graph.
2010 Mathematics Subject Classification: 05C78

1. Introduction

Graph labeling is one among the most exciting areas of study. Labeling is the process of assigning values to edges or vertices. Alexander Rosa [7] pioneered the notion of graceful labeling. A few labeling

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approaches were introduced later. Cahit [1] suggested cordial labeling as one such kind of labeling. Cordial labeling[1] is defined as a function $h: V(\theta) \to \{0,1\}$ in which each edge ab is assigned the label $|h(a) - h(b)|$ with the conditions $|v_h(0) - v_h(1)| \leq 1$ and $|e_h(0) - e_h(1)| \leq 1$ where $v_h(0)$ and $v_h(1)$ signify the number of vertices with 0's and 1's, similarly $e_h(0)$ and$e_h(1)$ signify the number of edges with 0's and 1's.Cahit [2] demonstrated the cordiality for the complete graph iff $n \leq 3$, ladders, friendship graphs, paths, wheels and pinwheels.The shell graph was first introduced by Deb and Limaye [3], followed by subdivided shell graphs and subdivided shell flower graphs by Jeba Jesintha and Hilda [4][6]. For further information, refer Gallian's dynamic survey [5]. Shell graphs are used in a variety of fieldsincluding X-ray crystallography, radar communication and networks, coding theory and other domains [4].

We prove that the following graphs are cordial: uniform sub-divided shell bow graph, uniform sub-divided shell flower graph, one point union of multiple sub-divided shell graph, sub-divided shell graph with star graphs coupled to the apex and the path vertices of shell graphs.

2. Definitions

As in the literature [5], this section contains few definitions.

Definition 2. 1

Create a cycle. The apex of C_n with $(n-3)$ chords with a shared end point is defined to be the shell graph [3]. C is used to represent shell graphs $(n, n-3)$. Fan graphs are another name for shell graphs.

Definition 2. 2

In each path in the shell graph is divided, we get a sub-divided shell graph [6].We denote sub-divided shell graph as SSG.

Definition 2. 3

A double sub-divided shell graph of the same order is defined as sub-divided shell bow graph [6].

Definition 2. 4

One vertex union of t copies of sub-divided shell graph and t copies of the complete graph K_2 is defined as a subdivided shell flower graph [4].

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3. Main Results

We prove few theorems about sub-divided shell graphs in this section.

Theorem 3.1

The graph of a uniform sub-divided shell bow graph is cordial.

Proof.

The uniform sub-divided shell bow graph, indicated as G, is created by joining two copies of a sub-divided shell graph with a as an apex vertex. The vertices of the first copy of the shell graph are $c_1, c_2, c_3, \ldots\ c_n$. The vertices of the first copy of the SSG are $c_1', c_2', c_3', \ldots,\ c_{n-1}'$. The vertices of the second copy of the shell graph are $d_1, d_2, d_3, \ldots,\ d_n$. The vertices of the second copy of the SSG are $d_1', d_2', d_3', \ldots,\ d_{n-1}'$. Figure 1 illustrates the graph G. The graph $G's$ vertices and edges are specified as $|V(G)| = 4n-1$, $|E(G)| = 6n-4$. The graph vertex labeling is defined as μ is from $V(G)$ to $\{0,1\}$.

Case 1: When n is even

$$\mu(a) = 1$$

$$\mu(c_j) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n$$

$$\mu(c_j') = \begin{cases} 0; & j \equiv 1 (mod\ 2) \\ 1; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1$$

$$\mu(d_j) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n$$

$$\mu(d_j') = \begin{cases} 0; & j \equiv 1 (mod\ 2) \\ 1; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1$$

Case 2: When n is odd

$$\mu(a) = 0$$

$$\mu(c_j) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n$$

$$\mu(c_j') = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1$$

$$\mu(d_j) = \begin{cases} 0; & j \equiv 1 (mod\ 2) \\ 1; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n$$

$$\mu(d_j') = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1$$

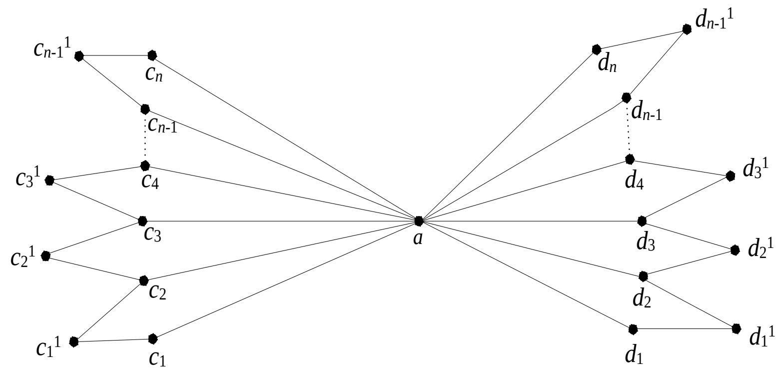

Figure 1: A graph of a uniform subdivided shell bow graph

The volume of vertices with identifiers 0's and 1's expressed as $v_\mu(0)$ and $v_\mu(1)$.

$$v_\mu(0) = 2n$$

$$v_\mu(1) = 2n - 1$$

The volume of edges with identifiers 0's and 1's expressed as $e_\mu(0)$ and $e_\mu(1)$.

$$e_\mu(0) = 3n - 2 = e_\mu(1)$$

As a result, the above labeling pattern meets both the requirements $\left|v_\mu(0) - v_\mu(1)\right| \leq 1$ and $\left|e_\mu(0) - e_\mu(1)\right| \leq 1$. Thus,sub-divided shell bow graph admits cordiality.

Theorem 3.2

The graph of a uniform sub-divided shell flower graph is cordial.

Proof.

Let *H*stand for the sub-divided shell flower graph,which is defined as the union of t copies of the sub-divided shell graph with t pendent edges at a single point. The end vertices of the pendent edges attached to the apex vertex$u$ are$k_1, k_2, \dots, k_t$. Let $l_1^1, l_2^1, l_3^1, \dots,\ l_n^1$become the path vertices of the initial copy of the SSG's shell graph. Let the path vertices of the sub-divided shell network of the first copy of the SSG be$m_1^1, m_2^1, m_3^1, \dots,\ m_{n-1}^1$. Similarly, let $l_1^2, l_2^2, l_3^2, \dots,\ l_n^2$ be the path vertices of the second copy of SSG's shell graph and let the path vertices of the sub-divided shell network of the second copy

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of the SSG be $m_1^2, m_2^2, m_3^2, \dots, m_{n-1}^2$. In general, let $l_1^t, l_2^t, l_3^t, \dots, l_n^t$ become the path vertices of the t^{th} copy of the SSG's shell graph. Let the path vertices of the sub-divided shell network of the t^{th} copy of the SSG be $m_1^t, m_2^t, m_3^t, \dots, m_{n-1}^t$. Figure 2 depicts the graph for H. The graph H's vertices and edges be defined as $|V(H)| = t(2n-1)+1+k$, $|E(H)| = t(3n-2)+k$. The graph H's vertex labeling is specified as f is from $V(H)$ to $\{0,1\}$.

Case 1. When n is an even number

$$f(u) = 0$$

$$f(l_j^s) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n,\ 1 \le s \le t$$

$$f(m_j^s) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1,\ 1 \le s \le t \quad when\ f(t_j) \equiv 1 (mod\ 2)$$

$$f(m_j^s) = \begin{cases} 0; & j \equiv 1 (mod\ 2) \\ 1; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n,\ 2 \le s \le t-1 \quad when f(t_j) \equiv 0 (mod\ 2)$$

$$f(k_j) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le t$$

Case 2. When n is an odd number

$$f(u) = 0$$

$$f(l_j^s) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n,\ 1 \le s \le t$$

$$f(m_j^s) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le n-1,\ 1 \le s \le t$$

$$f(k_j) = \begin{cases} 1; & j \equiv 1 (mod\ 2) \\ 0; & j \equiv 0 (mod\ 2) \end{cases} \quad for\ 1 \le j \le t$$

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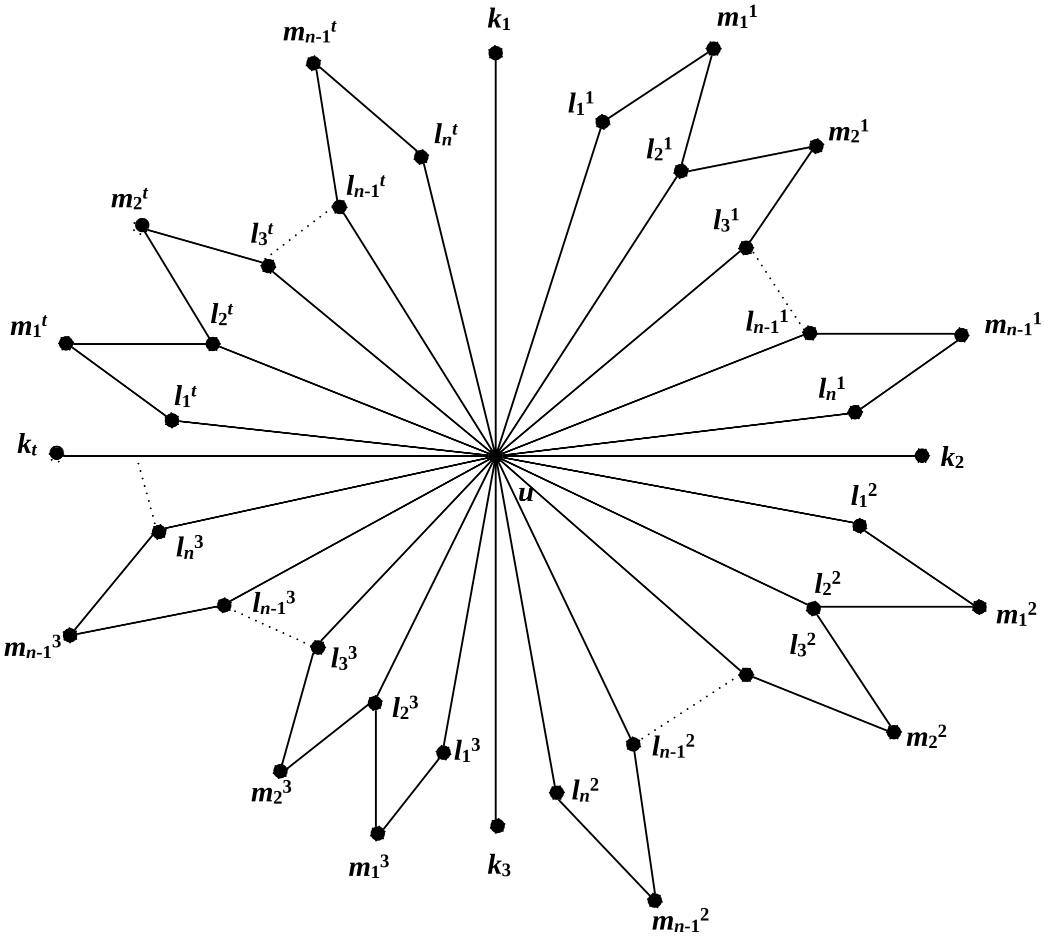

Figure 2: Subdivided shell flower graph

Label the number of vertices and edges as follows:

Case a. When n, t even; n odd and t even

$$v_f(0) = (n-1)t + \frac{t}{2} + 1$$

$$v_f(1) = (n-1)t + \frac{t}{2}$$

$$e_f(0) = (3n-2)\frac{t}{2} = e_f(1)$$

Case b. When n is even$t$is odd

$$v_f(0) = (n-1)t + \left\lfloor\frac{t}{2}\right\rfloor + 1 = v_f(1)$$

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$$e_f(0) = (3n-2)\,\frac{t}{2} = e_f(1)$$

Case c. When n, t is odd

$$v_f(0) = (n-1)t + \left\lfloor \frac{t}{2} \right\rfloor + 1 = v_f(1)$$

$$e_f(0) = \left\lfloor \frac{3n-2}{2} \right\rfloor t + \left\lfloor \frac{t}{2} \right\rfloor$$

$$e_f(1) = \left\lfloor \frac{3n-2}{2} \right\rfloor t + \left\lfloor \frac{t}{2} \right\rfloor + 1$$

As a result, the above labeling pattern meets the conditions $|v_f(0) - v_f1 \le 1$ and $ef0 - ef1 \le 1$. Thus, Sub-divided shell flower graph admits cordial labeling.

Theorem 3.3

One point union of multiple sub-divided shell graph of same order is cordial.

Proof.

Joining m number of SSG to the apex u yields a multiple sub-divided shell graph$G$. Let $a_1^1, a_2^1, a_3^1, \dots, a_n^1$become the path vertices of the initial copy of the SSG's shell graph. Let $b_1^1, b_2^1, b_3^1, \dots, b_{n-1}^1$ become the path vertices of the sub-divided shell graph of initial copy of the SSG. Similarly, let $a_1^2, a_2^2, a_3^2, \dots, a_n^2$ become the path vertices of the second copy of the SSG's shell graph and let$b_1^2, b_2^2, b_3^2, \dots, b_{n-1}^2$ be the path vertices of the sub-divided shell graph of second copy of the SSG. In general, let $a_1^m, a_2^m, a_3^m, \dots, a_n^m$ be the path vertices of the shell graph of$m^{\text{th}}$of the SSG. Let $b_1^m, b_2^m, b_3^m, \dots, b_{n-1}^m$ be the path vertices of the sub-divided shell graph of m^{th} of the SSG. Figure 3 illustrates the for G.Number of vertices and edges should be calculated as follows:$|V(G)| = m(2n-1)+1$, $|E(G)| = m(3n-2)$.

The graph's vertexlabeling is defined as$g$is from$V(G)$ to $\{0,1\}$.

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$$g(u) = \begin{cases} 1\,; & when\ n, m\ even;\ n, m\ odd;\ n\ odd\ and\ m\ even \\ 0\,; & otherwise \end{cases}$$

$$g(a_k^h) = \begin{cases} 1; & k \equiv 1(mod\ 2) \\ 0; & k \equiv 0(mod\ 2) \end{cases} \quad for\ \ 1 \le k \le n, 1 \le h \le m, \quad when\ g(a_k^h) \equiv 1(mod\ 2)$$

$$g(a_k^h) = \begin{cases} 0; & k \equiv 1(mod\ 2) \\ 1; & k \equiv 0(mod\ 2) \end{cases} \quad for\ \ 1 \le k \le n-1, 2 \le h \le m-1, \quad when\ g(a_k^h) \equiv 0(mod\ 2)$$

$$g(b_k^h) = \begin{cases} 0; & k \equiv 1(mod\ 2) \\ 1; & k \equiv 0(mod\ 2) \end{cases} \quad for\ \ 1 \le k \le n, 1 \le h \le m, \quad g(a_k^h) \equiv 1(mod\ 2)$$

$$g(b_k^h) = \begin{cases} 1; & k \equiv 1(mod\ 2) \\ 0; & k \equiv 0(mod\ 2) \end{cases} \quad for\ \ 1 \le k \le n-1, 2 \le h \le m-1, \quad g(a_k^h) \equiv 0(mod\ 2)$$

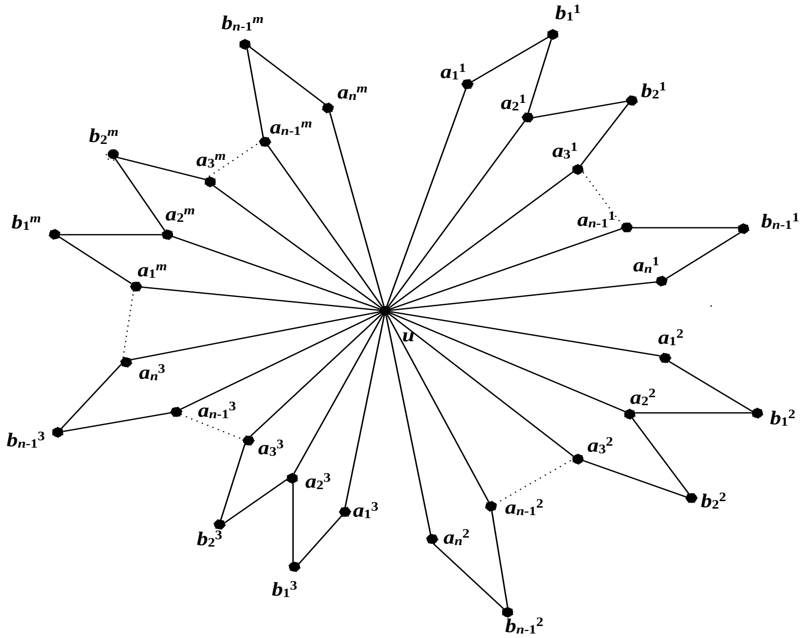

Figure 3: One point union of multiple sub-divided shell graph

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Labeling the quantity of vertices and edges be

Case 1. When n, m is odd

$$v_g(0) = n(m+1) - \left\lfloor\frac{n}{2}\right\rfloor = v_g(1)$$

$$e_g(0) = \left\lfloor\frac{n}{2}\right\rfloor(3m+1) = e_g(1)$$

Case 2. When n, m is even; When $n is even$, $m is odd$

$$v_g(0) = n(m+1)$$

$$v_g(1) = n(m+1) - 1$$

$$e_g(0) = \frac{n}{2}\ (3m+1)\ = e_g(1)$$

Case 3. When $n is odd$, m is even

$$v_g(0) = n(m+1) - \left\lfloor\frac{n}{2}\right\rfloor = v_g(1)$$

$$e_g(0) = \left\lfloor\frac{n(3m+1)}{2}\right\rfloor$$

$$e_g(1) = \left\lfloor\frac{n(3m+1)}{2}\right\rfloor + 1$$

As a result, the above labeling pattern meets the conditions $|v_g(0) - v_g(1)| \leq 1$ and $|e_g(0) - e_g(1)| \leq 1$. Thus, Cordial labeling is possible with the multiple sub-divided shell graph.

Theorem 3.4

Sub-divided shell Graph with uniform star graphs coupled to the apex and path vertices admits cordiality.

Proof.

Let X be the graph formed byconnecting the apex and path vertices of the shell graph with uniform star graphs [8]. The following is a description of the graph X.Let $v$represent the graph's apex.Let $c_1, c_2, \dots, c_n$denote the path vertices of the SSG's shell graph, and let $d_1, d_2, \dots, d_{n-1}$denote the path vertices of the SSG's split shell graph.The star graph associated to the vertex c_1 is $s_1^1, s_2^1, s_3^1, \dots, s_r^1$. Similarly, the star graph associated to the vertexc_2 is $s_1^2, s_2^2, s_3^2, \dots, s_r^2$. In general, the star associated to the vertex c_n is $s_1^n, s_2^n, s_3^n, \dots, s_r^n$.The star graph associated to the apex vertex v is$t_1, t_2, \dots, t_r$.The graph$X$ has $|V(X)| = 2n + r(n+1)$,

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$|E(X)| = 3n + r(n+1) - 2$.The graph's vertexlabelingis definedas $\emptyset$ is from $V(X)$ to $\{0,1\}$.

Case 1. When n, r is even and n odd, r even

$$\emptyset(v) = \begin{cases} 1; if\ n, s\ is\ even \\ 0\ ;\ otherwise \end{cases}$$

$$\emptyset(c_k) = \begin{cases} 1;\ k \equiv 1(mod\ 2) \\ 0;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le n$$

$$\emptyset(d_k) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le n - 1$$

When $i \equiv 1(mod\ 2)$

$$\emptyset(s_k^i) = \begin{cases} 1;\ k \equiv 1(mod\ 2) \\ 0;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le r$$

When $i \equiv 0(mod\ 2)$

$$\emptyset(s_k^i) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 2 \le k \le r - 1$$

$$\emptyset(t_k) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le i \le r$$

Case 2. When n, s is odd and n even, r odd

$$\emptyset(v) = 0$$

$$\emptyset(c_k) = \begin{cases} 1;\ k \equiv 1(mod\ 2) \\ 0;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le n$$

$$\emptyset(d_k) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le n - 1$$

When $i \equiv 1,2(mod\ 4)$

$$\emptyset(s_k^i) = \begin{cases} 1;\ k \equiv 1(mod\ 2) \\ 0;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le r - 1$$

When $i \equiv 0,3(mod\ 4)$

$$\emptyset(s_k^i) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 2 \le k \le r$$

$$\emptyset(t_k) = \begin{cases} 0;\ k \equiv 1(mod\ 2) \\ 1;\ k \equiv 0(mod\ 2) \end{cases} \quad for\ 1 \le k \le r$$

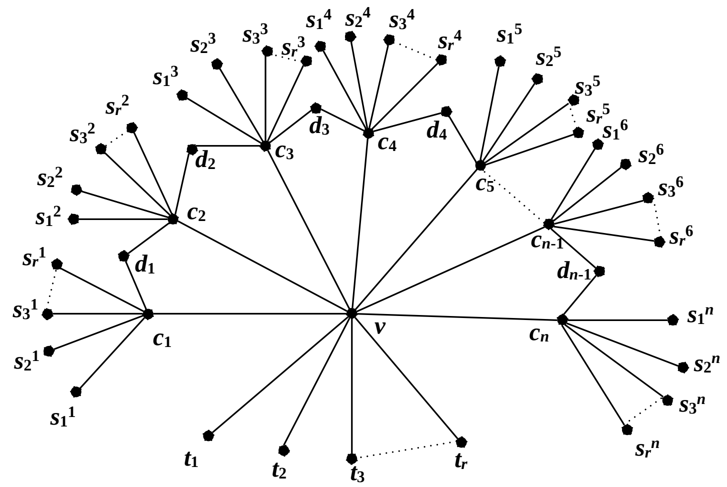

Figure 4. Sub-divided shell graph with star attached coupled at the apex and path vertices.

Label the number of vertices and edges as follows:

Case a. When n, r is even

$$v_\emptyset(0) = n + \frac{r}{2}(n+1) = v_\emptyset(1)$$

$$e_\emptyset(0) = \frac{3n}{2} + \frac{r}{2}(n+1) - 1 = e_\emptyset(1)$$

Case b. When n, r is odd

$$v_\emptyset(0) = n + \frac{r}{2}(n+1) = v_\emptyset(1)$$

Subcase:1When $n = 5$ and $r = 2i - 1$

$$e_\emptyset(0) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1)$$

$$e_\emptyset(1) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1) - 1$$

Subcase:2When $n \geq 3$

$$e_\emptyset(0) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1) - 1$$

$$e_\emptyset(1) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1)$$

Case c. When $nisodd$, r is even

$$v_\emptyset(0) = n + \frac{r}{2}(n+1) = v_\emptyset(1)$$

$$e_\emptyset(0) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1) - 1$$

$$e_\emptyset(1) = \left\lfloor \frac{3n}{2} \right\rfloor + \frac{r}{2}(n+1)$$

Case d. When $niseven$, $risodd$

$$v_\emptyset(0) = n + \left\lfloor \frac{r(n+1)}{2} \right\rfloor + 1$$

$$v_\emptyset(1) = n + \left\lfloor \frac{r(n+1)}{2} \right\rfloor$$

$$e_\emptyset(0) = \frac{3n}{2} + \left\lfloor \frac{r(n+1)}{2} \right\rfloor$$

$$e_\emptyset(1) = \frac{3n}{2} + \left\lfloor \frac{r(n+1)}{2} \right\rfloor - 1$$

As a result, the above labeling pattern meets the requirements$|v_\emptyset(0) -$ *vØ1≤1* and *eØ0−eØ1≤*1. Thus, sub-divided shell graph with uniform star graphs coupled to the apex and path vertices admits cordiality.

4. Conclusion

We showed that the uniform sub-divided shell bow graphs, uniform sub-divided shell flower graphs, one point union of multiple sub-divided shell graphs, sub-divided shell graphs with star graphs coupled to the apex and path vertices are cordial in this work.

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