International Journal of Mathematics And its Applications
Volume 5, Issue 4–E (2017), 655–662.
ISSN: 2347-1557
Available Online: http://ijmaa.in/

International Journal of Mathematics And its Applications

k-cordial Labeling of Triangular Belt, Alternate Triangular Belt, Braid Graph and Z-P_n

Research Article

N.B. Rathod[1]* and K.K. Kanani[2]

1 School of Science, R.K. University, Rajkot, Gujarat, India.

2 Department of Mathematics, Government Engineering College, Rajkot, Gujarat, India.

Abstract: In this research paper, we find k-cordial labeling of some special graphs. We prove that Triangular Belt $TB(n)(\downarrow^n)$, Alternate Triangular Belt $ATB(n)(\downarrow\uparrow\downarrow\uparrow ...)$ and Braid Graph $B(n)$ are k-cordial. Moreover, the graph Z-P_n is k-cordial for all odd k.

MSC: 05C78.

Keywords: Abelian Group, k-cordial Labeling, Triangular Belt, Alternate Triangular Belt, Braid graph, Z-P_n.

1. Introduction

In this research work we consider only finite, connected, undirected and simple graph $G = (V(G), E(G))$. We denote $|V(G)|$ = total number of vertices of graph G and $|E(G)|$ = total number of edges of graph G respectively. A *graph labeling* is an assignment of numbers to the vertices or edges or both subject to certain condition(s). To understand more about graph labeling as well as bibliographic references we refer Gallian [1].

1.1. Preliminaries

Definition 1.1. *Let $< A, * >$ be any Abelian group. A graph $G = (V(G), E(G))$ is said to be* A-cordial *if there is a mapping $f : V(G) \to A$ which satisfies the following two conditions when the edge $e = uv$ is labeled as $f(u) * f(v)$*

(i). $|v_f(a) - v_f(b)| \leq 1$; for all $a, b \in A$,

(ii). $|e_f(a) - e_f(b)| \leq 1$; for all $a, b \in A$.

Where

$v_f(a)$=the number of vertices with label a;

$v_f(b)$=the number of vertices with label b;

$e_f(a)$=the number of edges with label a;

$e_f(b)$=the number of edges with label b.

We note that if $A =< Z_k, +_k >$, that is additive group of modulo k then the labeling is known as k-cordial labeling.

* *E-mail: rathodneha005@gmail.com*

The concept of A-cordial labeling was introduced by Hovey [2] and proved the following results:

- All the Connected graphs are 3-cordial.
- All the Trees are 3-cordial and 4-cordial.
- Cycles are k-cordial for all odd k.

Youssef [3] proved the following results:

- The Complete Graph K_n is 4-cordial $\iff n \leq 6$.
- The Complete Bipartite Graph $K_{m,n}$ is 4-cordial $\iff m$ or $n \not\equiv 2(mod\ 4)$.

Modha and Kanani [4] proved the following result:

- The Fan f_n is k-cordial for all k.

Modha and Kanani [5] proved the following results:

- The Bistar $B_{m,n}$ is k-cordial for all k.
- The Restricted Square Graph $B^2_{n,n}$ of bistar is k-cordial for odd k.
- The One Point Union of cycle C_3 with star graph $K_{1,n}$ is k-cordial for all k.
- The Comb Graph $P_n \bigodot K_1$ is k-cordial for all k.

Modha and Kanani [6] proved the following results:

- The Wheel W_n is k-cordial for all odd k and for all $n = mk + j$, $m \geq 0$, $1 \leq j \leq k - 1$ except for $j = \frac{k-1}{2}$.
- The Total Graph $T(P_n)$ of path P_n is k-cordial for all k.
- The Square Graph C^2_n of cycle C_n is k-cordial for all odd k and $n \geq k$.
- The Path Union of n Copies of cycle C_k is k-cordial graph for odd k.

Rathod and Kanani [7] proved the following results:

- The Square Graph P^2_n of path P_n is k-cordial.
- The Pan Graph C^{+1}_n is k-cordial for all even k and $n = k + j$, $0 \leq j \leq k - 1$.
- The Pan Graph C^{+1}_n is k-cordial for all even k and $n = 2tk + j$, where $t \in N \cup \{0\}$ and $0 \leq j \leq k - 1$.
- The Pan Graph C^{+1}_n is k-cordial for all even k and $n = 2tk + k + j$, where $t \in N$ and $0 \leq j \leq k - 1$.

Rathod and Kanani [8] proved the following results:

- The Triangular Book $B(3, n)$ with n-pages is k-cordial.
- The Triangular Book with Book Mark $TB_n(u, v)(v, w)$ is k-cordial.
- The Jewel Graph J_n is k-cordial.

We consider the following useful definitions to understand the results of this research paper.

Definition 1.2. *Let L_n=$P_n \times P_2$ $(n \geq 2)$ be the ladder graph with vertex set u_i and v_i, $i = 1, 2, ..., n$. The* Triangular Belt *is obtained from the ladder by adding the edges $u_i v_{i+1}$ for all $1 \leq i \leq n-1$. This graph is denoted by $TB(n)(\downarrow^n)$.*

Definition 1.3. *Let L_n=$P_n \times P_2$ $(n \geq 2)$ be the ladder graph with vertex set u_i and v_i, $i = 1, 2, ..., n$. The* Alternate Triangular Belt *is obtained from the ladder by adding the edges $u_{2i+1}v_{2i+2}$ for all $i = 0, 1, 2, ..., n-1$ and $v_{2i}u_{2i+1}$ for all $i = 1, 2, ..., n-1$. This graph is denoted by $ATB(n)(\downarrow\uparrow\downarrow\uparrow ...)$.*

Definition 1.4. *The* Braid Graph *$B(n)$ is obtained from a pair of paths ${P_n}'$ and ${P_n}''$. Let $v_1, v_2, ..., v_n$ be the vertices of path ${P_n}'$ and $u_1, u_2, ..., u_n$ are the vertices of path ${P_n}''$. To obtain braid graph $B(n)$ join i^{th} vertex of path ${P_n}'$ with $(i+1)^{th}$ vertex of path ${P_n}''$ and i^{th} vertex of path ${P_n}''$ with $(i+2)^{th}$ vertex of path ${P_n}'$ with the new edges for all $1 \leq i \leq n-2$.*

Definition 1.5. *The graph Z-P_n is obtained from a pair of paths ${P_n}'$ and ${P_n}''$. Let $v_1, v_2, ..., v_n$ be the vertices of path ${P_n}'$ and $u_1, u_2, ..., u_n$ are the vertices of path ${P_n}''$. To obtain Z-P_n join i^{th} vertex of path ${P_n}'$ with $(i+1)^{th}$ vertex of path ${P_n}''$ for all $1 \leq i \leq n-1$.*

Here, all terminologies are considered from Gross and Yellen [9].

2. Main Results

Theorem 2.1. *The Triangular Belt $TB(n)(\downarrow^n)$ is k-cordial for all n.*

Proof. Let $G = TB(n)$ be the triangular belt. Let L_n=$P_n \times P_2$ $(n \geq 2)$ be the ladder graph with vertex set u_i and v_i, $i = 1, 2, ..., n$. The triangular belt is obtained from the ladder by adding the edges $u_i v_{i+1}$ for all $1 \leq i \leq n-1$. Let $n = mk + j$, where $m \geq 0$ and $1 \leq j \leq k-1$. We divide n vertices into two blocks of mk and j, which are denoted by $u_1, u_2, ..., u_{mk}$ and $u'_1, u'_2, ..., u'_j$ also $v_1, v_2, ..., v_{mk}$ and $v'_1, v'_2, ..., v'_j$. We note that $|V(G)| = 2n$ and $|E(G)| = 4n-3$.
To define k-cordial labeling $f : V(G) \rightarrow Z_k$ we consider the following cases.

Case 1: $m > 0$ and $j = 0$.

The labeling pattern of mk vertices is defined as follows:

Subcase 1: $k \equiv 0 (mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq k$,

Subcase 2: $k \equiv 1 (mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i (\text{mod } k+1)$; $\quad \frac{k-1}{2} + 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k+1)$; $\quad \frac{k-1}{2} + 2 \leq i \leq k$,

Case 2: $m \geq 0$ and $1 \leq j \leq k-1$.

Subcase 1: $k \equiv 0 (mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \leq i \leq k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $\quad 1 \leq j \leq k-1$,

$f(v'_j) = 2j - 2$; $\quad 1 \leq j \leq k-1$.

Subcase 2: $k \equiv 1(mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $i \equiv p_i(\text{mod } k)$; $1 \le i \le \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $i \equiv p_i(\text{mod } k+1)$; $\frac{k-1}{2} + 1 \le i \le k$,

$f(v_i) = 2p_i - 2$; $i \equiv p_i(\text{mod } k)$; $1 \le i \le \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $i \equiv p_i(\text{mod } k+1)$; $\frac{k-1}{2} + 2 \le i \le k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $1 \le j \le \frac{k-1}{2}$,

$f(u'_j) = 2j$; $\frac{k-1}{2} + 1 \le j \le k-1$,

$f(v'_j) = 2j - 2$; $1 \le j \le \frac{k-1}{2} + 1$,

$f(v'_j) = 2j - 1$; $\frac{k-1}{2} + 2 \le j \le k-1$.

In each possibility the graph under consideration satisfies the vertex conditions and edge conditions for k-cordial labeling. Hence, triangular belt $TB(n)(\downarrow^n)$ is k-cordial for all n. □

Example 2.2.

1. *The Triangular Belt* $TB(9)(\downarrow^9)$ *and its* 8*-cordial labeling is shown in* Figure 1.

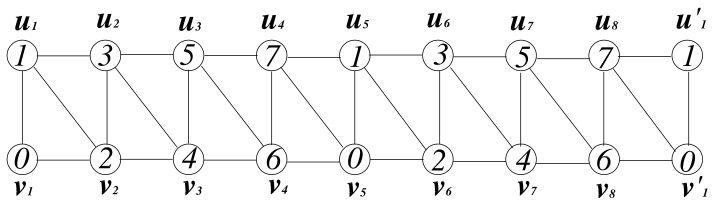

Figure 1. **8-cordial labeling of Triangular Belt** $TB(9)(\downarrow^n)$

2. *The Triangular Belt* $TB(10)(\downarrow^{10})$ *and its* 7*-cordial labeling is shown in* Figure 2.

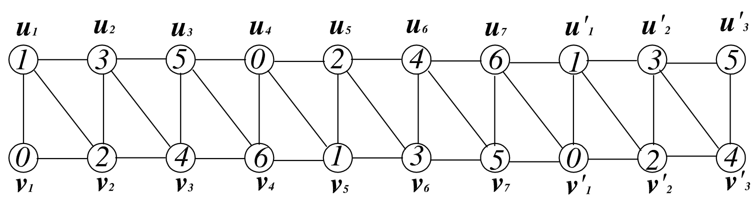

Figure 2. **7-cordial labeling of Triangular Belt** $TB(10)(\downarrow^{10})$

Theorem 2.3. *The Alternate Triangular Belt* $ATB(n)(\downarrow\uparrow\downarrow\uparrow \ldots)$ *is* k*-cordial for all* n.

Proof. Let $G = ATB(n)$ be the alternate triangular belt. Let $L_n = P_n \times P_2$ $(n \ge 2)$ be the ladder graph with vertex set u_i and v_i, $i = 1, 2, ..., n$. The alternate triangular belt is obtained from the ladder by adding the edges $u_{2i+1}v_{2i+2}$ for all $i = 0, 1, 2, ..., n-1$ and $v_{2i}u_{2i+1}$ for all $i = 1, 2, ..., n-1$. Let $n = mk + j$, where $m \ge 0$ and $1 \le j \le k-1$. We divide n vertices into two blocks of mk and j, which are denoted by $u_1, u_2, ..., u_{mk}$ and $u'_1, u'_2, ..., u'_j$ also $v_1, v_2, ..., v_{mk}$ and $v'_1, v'_2, ..., v'_j$. We note that $|V(G)| = 2n$ and $|E(G)| = 4n - 3$.

To define k-cordial labeling $f : V(G) \to Z_k$ we consider the following cases.

Case 1: $m > 0$ and $j = 0$.

The labeling pattern of mk vertices is defined as follows:

Subcase 1: $k \equiv 0(mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

Subcase 2: $k \equiv 1(mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 2 \leq i \leq k$,

Case 2: $m \geq 0$ and $1 \leq j \leq k - 1$.

Subcase 1: $k \equiv 0(mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $\quad 1 \leq j \leq k - 1$,

$f(v'_j) = 2j - 2$; $\quad 1 \leq j \leq k - 1$.

Subcase 2: $k \equiv 1(mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 2 \leq i \leq k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $\quad 1 \leq j \leq \frac{k-1}{2}$,

$f(u'_j) = 2j$; $\quad \frac{k-1}{2} + 1 \leq j \leq k - 1$,

$f(v'_j) = 2j - 2$; $\quad 1 \leq j \leq \frac{k-1}{2} + 1$,

$f(v'_j) = 2j - 1$; $\quad \frac{k-1}{2} + 2 \leq j \leq k - 1$.

In each possibility the graph under consideration satisfies the vertex conditions and edge conditions for k-cordial labeling. Hence, alternate triangular belt $ATB(n)(\downarrow\uparrow\downarrow\uparrow\ ...)$ is k-cordial for all n. □

Example 2.4.

1. *The Alternate Triangular Belt* $ATB(6)$ *and its* 8*-cordial labeling is shown in* Figure 3.

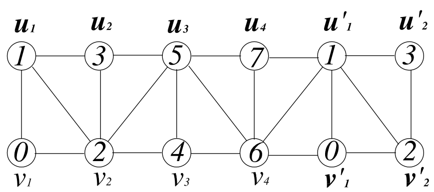

Figure 3. **8-cordial labeling of Alternate Triangular Belt** $ATB(6)$

2. The Alternate Triangular Belt $ATB(8)$ *and its* 7*-cordial labeling is shown in* Figure 4.

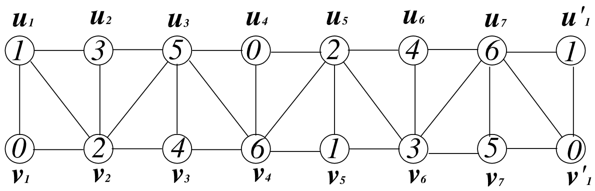

Figure 4. **7-cordial labeling of Alternate Triangular Belt** $ATB(8)$

Theorem 2.5. *The Braid graph* $B(n)$ *is* k*-cordial for all* n*.*

Proof. Let $G = B(n)$ be the braid graph. The braid graph is obtained from a pair of paths $P_n{}'$ and $P_n{}''$. Let $u_1, u_2, ..., u_n$ be the vertices of path $P_n{}'$ and $v_1, v_2, ..., v_n$ are the vertices of path $P_n{}''$. To find braid graph join i^{th} vertex of path $P_n{}'$ with $(i+1)^{th}$ vertex of path $P_n{}''$ and i^{th} vertex of path $P_n{}''$ with $(i+2)^{th}$ vertex of path $P_n{}'$ with the new edges for all $1 \leq i \leq n-2$. Let $n = mk + j$, where $m \geq 0$ and $1 \leq j \leq k-1$. We divide n vertices into two blocks of mk and j, which are denoted by $u_1, u_2, ..., u_{mk}$ and $u'_1, u'_2, ..., u'_j$ also $v_1, v_2, ..., v_{mk}$ and $v'_1, v'_2, ..., v'_j$. We note that $|V(G)| = 2n$ and $|E(G)| = 4n - 5$.

To define k-cordial labeling $f : V(G) \to Z_k$ we consider the following cases.

Case 1: $m > 0$ and $j = 0$.

The labeling pattern of mk vertices is defined as follows:

Subcase 1: $k \equiv 0(mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

Subcase 2: $k \equiv 1(mod\ 2)$, $1 \leq i \leq mk$.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 2 \leq i \leq k$,

Case 2: $m \geq 0$ and $1 \leq j \leq k-1$.

Subcase 1: $k \equiv 0(mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $\quad 1 \leq j \leq k-1$,

$f(v'_j) = 2j - 2$; $\quad 1 \leq j \leq k-1$.

Subcase 2: $k \equiv 1(mod\ 2)$.

The labeling pattern of first block of mk vertices is defined as follows:

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 1 \leq i \leq k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i(\text{mod } k)$; $\quad 1 \leq i \leq \frac{k-1}{2} + 1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i(\text{mod } k+1)$; $\quad \frac{k-1}{2} + 2 \leq i \leq k$, The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j-1$; $\quad 1 \le j \le \frac{k-1}{2}$,

$f(u'_j) = 2j$; $\quad \frac{k-1}{2}+1 \le j \le k-1$,

$f(v'_j) = 2j-2$; $\quad 1 \le j \le \frac{k-1}{2}+1$,

$f(v'_j) = 2j-1$; $\quad \frac{k-1}{2}+2 \le j \le k-1$.

In each possibility the graph under consideration satisfies the vertex conditions and edge conditions for k-cordial labeling. Hence, the braid graph $B(n)$ is k-cordial for all n. □

Example 2.6.

1. *The Braid graph* $B(9)$ *and its* 10*-cordial labeling is shown in* Figure 5.

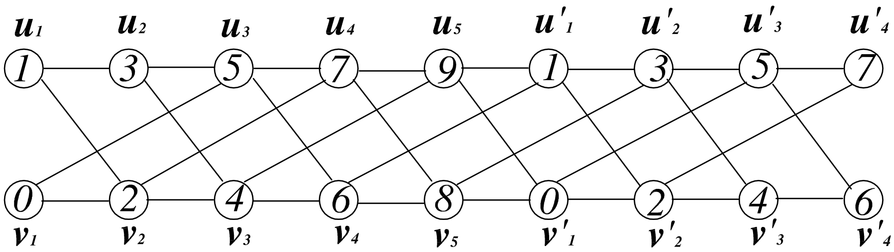

Figure 5. **10-cordial labeling of Braid graph** $B(9)$

2. *The Braid graph* $B(10)$ *and its* 9*-cordial labeling is shown in* Figure 6.

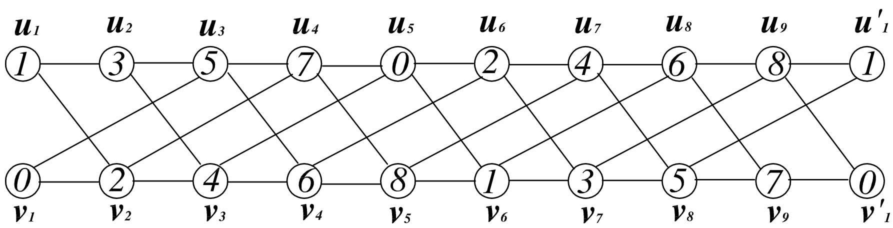

Figure 6. **9-cordial labeling of Braid graph** $B(10)$

Theorem 2.7. *The graph* Z-P_n *is* k*-cordial for all odd* k *and for all* n.

Proof. Let G=Z-P_n be the graph obtained from a pair of paths $P_n{}'$ and $P_n{}''$. Let $v_1, v_2, ..., v_n$ be the vertices of path $P_n{}'$ and $u_1, u_2, ..., u_n$ are the vertices of path $P_n{}''$. To find Z-P_n join i^{th} vertex of path $P_n{}'$ with $(i+1)^{th}$ vertex of path $P_n{}''$ for all $1 \le i \le n-1$. Let $n = mk + j$, where $m \ge 0$ and $1 \le j \le k-1$. We divide n vertices into two blocks of mk and j, which are denoted by $u_1, u_2, ..., u_{mk}$ and $u'_1, u'_2, ..., u'_j$ also $v_1, v_2, ..., v_{mk}$ and $v'_1, v'_2, ..., v'_j$. We note that $|V(G)| = 2n$ and $|E(G)| = 3n-3$.

The labeling pattern of first block of mk vertices is defined as follows.

$f(u_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \le i \le \frac{k-1}{2}$,

$f(u_i) = 2p_i$; $\quad i \equiv p_i (\text{mod } k+1)$; $\quad \frac{k-1}{2}+1 \le i \le k$,

$f(v_i) = 2p_i - 2$; $\quad i \equiv p_i (\text{mod } k)$; $\quad 1 \le i \le \frac{k-1}{2}+1$,

$f(v_i) = 2p_i - 1$; $\quad i \equiv p_i (\text{mod } k+1)$; $\quad \frac{k-1}{2}+2 \le i \le k$,

The labeling pattern of second block of j vertices is defined as follows:

$f(u'_j) = 2j - 1$; $\quad 1 \leq j \leq \frac{k-1}{2}$,

$f(u'_j) = 2j$; $\quad \frac{k-1}{2} + 1 \leq j \leq k - 1$,

$f(v'_j) = 2j - 2$; $\quad 1 \leq j \leq \frac{k-1}{2} + 1$,

$f(v'_j) = 2j - 1$; $\quad \frac{k-1}{2} + 2 \leq j \leq k - 1$.

In each possibility the graph under consideration satisfies the vertex conditions and edge conditions for k-cordial labeling. Hence, the graph Z-P_n is k-cordial for all odd k and for all n. □

Example 2.8. *The graph Z-P_{10} and its 5-cordial labeling is shown in* Figure 7.

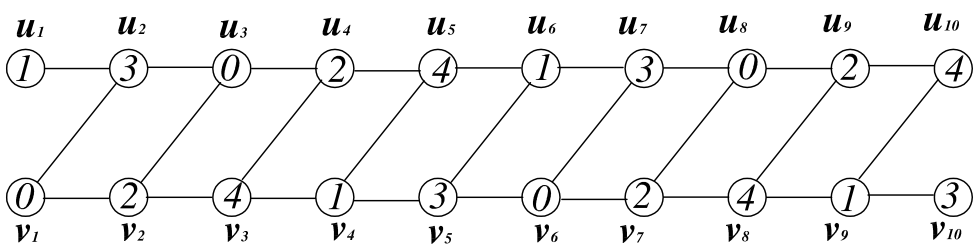

Figure 7. **5-cordial labeling of Z-P_{10}**

3. Concluding Remarks

Graph labeling technique is a wide area of research. To investigate more graph families which admit k-cordial labeling for even and odd k is an open area of research.

References

[1] J.A.Gallian, *A dynamic survey of graph labeling*, The Electronics Journal of Combinatorics, 19(2016).

[2] M.Hovey, *A-cordial graphs*, Discrete Math., 93(1991), 183-194.

[3] M.Z.Youssef, *On k-cordial labeling*, Australas. J. Combin., 43(2009), 31-37.

[4] M.V.Modha and K.K.Kanani, *k-cordial labeling of fan and double fan*, Int. J. of Appl. Math. Res., 4(2)(2015), 362-369.

[5] M.V.Modha and K.K.Kanani, *On k-cordial labeling of some graphs*, British. J. of Math. and Com. Sci., 13(3)(2016), 1-7.

[6] M.V.Modha and K.K.Kanani, *k-cordiality of Wheel, Path Related and Cycle Related Graphs*, Int. J. of Math. and Scientific Computing, 5(2)(2015), 79-82.

[7] N.B.Rathod and K.K.Kanani, *k-cordiality of Path and Cycle Related Graphs*, Int. J. of Math. and Comp. Appl. Res., 5(3)(2015), 81-92.

[8] N.B.Rathod and K.K.Kanani, *k-cordial Labeling of Triangular Book, Triangular Book with Book Mark and Jewel Graph*, Global J. of Pure and Appl. Math., 13(10)(2017), 6979-6989.

[9] J.Gross and J.Yellen, *Handbook of graph theory*, CRC Press, (2004).

[10] R.Tao, *On k-cordiality of cycles, crowns and wheels*, Systems Sci. Math. Sci., 11(1998), 227-229.