

# Even-odd Harmonious Labeling of Some Graphs

Dhvanik Zala, Narendra Chotaliya, Michal Chaurasiya



**Abstract:** Let  $G = (V, E)$  be a graph, with  $n = |V(G)|$  and  $m = |E(G)|$ . An injective mapping  $f: V(G) \rightarrow \{1, 2, 3, \dots, 2m-1\}$  is called an even-odd harmonious labeling of the graph  $G$ , if  $\tau$  is an induced edge mapping  $f^*: E(G) \rightarrow \{0, 2, 4, \dots, 2(m-1)\}$  such that (i)  $f^*$  is bijective mapping (ii)  $f^*(e = pq) = (f(p) + f(q)) \pmod{2m}$ . The graph acquired from this labeling is called even-odd harmonious graph. In this paper, we discovered some interesting results like H-graph, comb graph, bistar graph and  $\langle K_{2n}^{(2)}, K_{2n}^{(2)}, K_{2n}^{(2)} \rangle$  graph for even-odd harmonious labeling.

**Keywords:** Comb graph, Even-odd harmonious labeling, H-graph, Injective mapping

## I. INTRODUCTION

Graph labeling is an engrossing and shirable research in the arena of graph theory. It trades in how vertices and edges of a graph are labelled corresponding to certain mathematical condition[1]. From Gallian[5], the meiotic research development in the sphere of graph labeling is taken. The pioneer of graph labeling was A. Rosa[10]. Books of Harary[2] and D.B.west[8] are being used for the ideas and basic knowledge. The harmonious graph have instigated [3] in 1980. Z.liang et al[8] set forth the odd harmonious graphs in 2009 and in 2011 P.B.sarasija et al [10] investigated the even harmonious graphs. Further Adalin Beatress and Sarasija in [2] set forth the even odd harmonious graphs. We have manifested distinct graphs, as we have collected distinct types of graphs in forms of even - odd harmonious labeling.

## II. BASIC TERMINOLOGY

**Definition[16] 2.1:** A graph  $G = (V(G), E(G))$  with  $n$  edges is called a harmonious, if there is an injective function  $f: V(G) \rightarrow \mathbb{Z}_n$  such that when each edge  $uv$  is allotted the label  $(f(u) + f(v)) \pmod{n}$ , the resulting edge labels are different. When the graph  $G$  is tree, exactly one edge label may be used on two vertices.

**Definition[7] 2.2:** Let  $G = (V, E)$  be a graph, with  $n = |V(G)|$  and  $m = |E(G)|$ ,  $f: V(G) \rightarrow \{1, 2, 3, \dots, 2m-1\}$  is said to be an even-odd harmonious labeling of the graph  $G$  if

$\tau$  an induced edge mapping  $f^*: E(G) \rightarrow \{0, 2, 4, \dots, 2(m-1)\}$  such that (i)  $f^*$  is bijective mapping (ii)  $f^*(e = pq) = (f(p) + f(q)) \pmod{2m}$ . The graph acquired from this labeling is called even-odd harmonious graph.

**Definition[8] 2.3:** The H-graph of a path  $P_n$  is the graph secured from two copies of path  $P_n$  with vertices  $v_1, v_2, v_3, \dots, v_n$  and  $v_{n+1}, v_{n+2}, v_{n+3}, \dots, v_{2n}$  by attaching the vertices  $v_{2i-1}$  and  $v_{2i}$  if  $n$  is odd and the vertices  $v_{2i-2}$  and  $v_{2i}$  if  $n$  is even.

**Definition[8] 2.4:** A comb graph is a graph obtained by attaching a single pendant edge to each vertex of a path. The comb graph is defined as  $P_n \odot K_1$ . Where  $P_n = \{v_1, \dots, v_n\}$  be the path with  $n$  vertices which contains  $n$  vertices and  $n-1$  edges.

**Definition[9] 2.5:** The bistar graph  $B_{n,p}$  is a graph acquired from a path  $P_n$  by attaching the root of stars  $S_n$  and  $S_m$  at the terminal vertices of  $P_n$ , the bistar graph is denoted by  $B_{n,m}$ .

**Remark:** In this paper, we use "EOHL" instead of "even-odd harmonious labeling", for the simplicity.

## III. EVEN-ODD HARMONIOUS LABELING OF ACYCLIC GRAPH

**Theorem 3.1:** The H-graph of path  $P_n$  is an even-odd harmonious graph.

**Proof:** Let  $G = H_n$  be the H-graph. Let  $v_1, v_2, v_3, \dots, v_n, v_{n+1}, v_{n+2}, v_{n+3}, \dots, v_{2n}$  be the vertices of graph  $G$  and  $E(G) = \{v_1v_2, v_2v_3, \dots, v_{n-1}v_n, v_1v_{n+1}, v_2v_{n+2}, \dots, v_nv_{2n}\}$   
 $(\text{assign } f: V(G) \rightarrow \mathbb{Z}_{2m})$   
 $f(v_i) = \begin{cases} i & i = 1, 2, \dots, n \\ 2m + i - 1 & i = n+1, n+2, \dots, 2n \end{cases}$   
 and

Note that,  $p = |V(G)| = 2n$  and  $q = |E(G)| = 2n - 1$ . Define an injective function  $f: V(G) \rightarrow \{1, 2, 3, \dots, 4n - 1\}$  such that

**Case-1:** - When  $n \equiv 1 \pmod{2}$

$$f(v_i) = \begin{cases} i & i = 1 \pmod{2} \\ 2m + i - 1 & i = 0 \pmod{2} \end{cases} \quad \text{and}$$

$$f(v_i) = \begin{cases} 3n + i - 1 & i \equiv 1 \pmod{2} \\ n + i & i \equiv 0 \pmod{2} \end{cases}$$

**Case-2:** - When  $n \equiv 0 \pmod{2}$

$$f(v_i) = \begin{cases} i & i = 1 \pmod{2} \\ 2m + i - 1 & i = 0 \pmod{2} \end{cases} \quad \text{and}$$

$$f(v_i) = \begin{cases} 2n + i - 1 & i = 1 \pmod{2} \\ 4n - i + 1 & i = 0 \pmod{2} \end{cases}$$

and an induced edge function  $f^*: E(G) \rightarrow \{0, 2, 4, \dots, 4n - 4\}$  such that

**Case-1:** - When  $n \equiv 1 \pmod{2}$

$$f^*(v_i) = f^*(v_{i+1}, v_{i+2}) = (2n + 2i) \pmod{2q}, 1 \leq i \leq n - 1$$

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