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Certain class of graph with odd and even ratio edge antimagic Labeling

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ABSTRACT

In this paper the existence of odd and even ratio edge antimagic labeling for double triangular snakes ($2\Delta_k$-snake), $2m\Delta_1$-snake, $2m\Delta_k$-snake and kC_4-snake are proved.

Introduction

The graphs considered here are finite, undirected and simple. The symbols $V(G)$ and $E(G)$ will denote the vertex set and edge set of a graph G respectively. Also p and q denote the number of vertices and edges of G respectively. Rosa [7] defined a triangular snake (or Δ-snake) as a connected graph in which all blocks are triangles and the block-cut-point graph is a path. Let Δ_k-snake be a Δ-snake with k blocks while k $n\Delta$-snake is a Δ-snake with k blocks and every block has n number of triangles with one common edge.

Max-min edge antimagic labeling was first introduced by J.Jayapriya and.D.Muruganandam in the year 2012, seeking application in Welding Technology [4]. In the year 2013[5] Jayapriya showed the existences of Max-min edge antimagic labeling for the graphs path, cycle, star, sunflower etc. Max-min edge antimagic labeling was renamed as ratio edge antimagic labeling [6]. In this paper the existence of odd and even ratio edge antimagic labeling, for double triangular snakes, $2m\Delta_k$-snake and kC_4-snake graphs are shown.

Definition 1.1 [4]: Let $G(V, E)$ be a simple graph with p vertices and q edges. A bijective function $f : V(G) \to \{1, 3, 5, ..., 2p-1\}$ is said to be odd ratio edge antimagic labeling if for every edge uv in E, the edge weights

$\lambda(uv) = \dfrac{\max\{f(u), f(v)\}}{\min\{f(u), f(v)\}}$ are distinct.

Definition 1.2 [4]: Let $G(V, E)$ be a simple graph with p vertices and q edges.

A bijective function $f : V(G) \to \{2, 4, 6, ..., 2p\}$ is said to be even ratio edge antimagic labeling if for every edge uv in E,

$\lambda(uv) = \dfrac{\max\{f(u), f(v)\}}{\min\{f(u), f(v)\}}$ are distinct.

2. Some Class of Triangular Snake Graph with Odd and Even Ratio Edge Antimagic Labeling

Theorem 2.1: The double triangular snake ($2\Delta_k$-snake) graph admits odd and even ratio edge antimagic labeling.

Proof: Let $G(V, E)$ be a $2\Delta_k$-snake graph. The graph G consists of the vertices $V = \{u_1, u_2, ..., u_k\} \cup \{v_1, v_2, ..., v_{k+1}\} \cup \{w_1, w_2, ..., w_k\}$ and the edges $E = \{u_iv_i ; 1 \le i \le k\} \cup \{u_iv_{i+1} ; 1 \le i \le k\} \cup \{v_iw_i ; 1 \le i \le k\} \cup \{w_iv_{i+1} ; 1 \le i \le k\}$.

Let us consider the function $f : V(G) \to \{1, 3, 5, ..., 2p-1\}$, such that $f(u_i) = 2i-1$; $1 \le i \le k$.

$f(v_i) = 4k + (2i-1)$; $1 \le i \le k+1$.$f(w_i) = 2k + (2i-1)$; $1 \le i \le k$.Now the edge weights are calculated as follows.

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For $1 \le i \le k$, $\lambda(u_i v_i) = \dfrac{4k+2i-1}{2i-1}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(u_i v_i) \ne \lambda(u_j v_j)$, if $\lambda(u_i w_i) = \lambda(u_j w_j)$ then

$\dfrac{4k+2i-1}{2i-1} = \dfrac{4k+2j-1}{2j-1}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$,

$\lambda(u_i v_{i+1}) = \dfrac{4k+(2i+1)}{(2i-1)}$. Clearly for $1 \le i, j \le k$, $\lambda(u_i v_{i+1}) \ne \lambda(u_j v_{j+1})$, if $\lambda(u_i v_{i+1}) = \lambda(u_j v_{j+1})$ then

$\dfrac{4k+(2i+1)}{(2i-1)} = \dfrac{4k+(2j+1)}{(2j-1)}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct. For $1 \le i \le k$,

$\lambda(u_i w_i) = \dfrac{4k+2i-1}{2k+2i-1}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(u_i w_i) \ne \lambda(u_j w_j)$, if $\lambda(u_i w_i) = \lambda(u_j w_j)$ then

$\dfrac{4k+2i-1}{2k+2i-1} = \dfrac{4k+2j-1}{2k+2j-1}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct. For $1 \le i \le k$,

$\lambda(w_i v_{i+1}) = \dfrac{4k+(2i+1)}{2k+(2i-1)}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(w_i v_{i+1}) \ne \lambda(w_j v_{j+1})$, if $\lambda(w_i v_{i+1}) = \lambda(w_j v_{j+1})$ then $\dfrac{4k+(2i+1)}{2k+(2i-1)} = \dfrac{4k+(2j+1)}{2k+(2j-1)}$

which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$, $\lambda(v_i v_{i+1}) = \dfrac{4k+(2i+1)}{4k+(2i-1)}$.

Suppose $\lambda(v_i v_{i+1}) = \lambda(v_j v_{j+1})$ then $\dfrac{4k+(2i+1)}{4k+(2i-1)} = \dfrac{4k+(2j+1)}{4k+(2j-1)}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct. Thus the double triangular snake ($2\Delta_k$-snake) graph admits odd ratio edge antimagic labeling.

To prove the existences of even ratio edge antimagic labeling, let us define

$f : V(G) \to \{2, 4, 6, ..., 2p\}$, such that $f(u_i) = 2i$; $1 \le i \le k$.

$f(v_i) = 4k + 2i$; $1 \le i \le k+1$.

$f(w_i) = 2k + 2i$; $1 \le i \le k$.

Now the edge weights are calculated as follows.

For $1 \le i \le k$, $\lambda(u_i v_i) = \dfrac{4k+2i}{2i}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(u_i v_i) \ne \lambda(u_j v_j)$, if $\lambda(u_i w_i) = \lambda(u_j w_j)$ then $\dfrac{4k+2i}{2i} = \dfrac{4k+2j}{2j}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$, $\lambda(u_i v_{i+1}) = \dfrac{4k+2i+2}{2i}$. Clearly for $1 \le i, j \le k$, $\lambda(u_i v_{i+1}) \ne \lambda(u_j v_{j+1})$, if $\lambda(u_i v_{i+1}) = \lambda(u_j v_{j+1})$ then $\dfrac{4k+2i+2}{2i} = \dfrac{4k+2j+2}{2j}$

which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$, $\lambda(u_i w_i) = \dfrac{4k+2i}{2k+2i}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(v_i w_i) \ne \lambda(v_j w_j)$, if $\lambda(v_i w_i) = \lambda(v_j w_j)$ then $\dfrac{4k+2i}{2k+2i} = \dfrac{4k+2j}{2k+2j}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$, $\lambda(w_i v_{i+1}) = \dfrac{4k+2i+2}{2k+2i}$. Clearly for $1 \le i, j \le k$, $i \ne j$, $\lambda(w_i v_{i+1}) \ne \lambda(w_j v_{j+1})$, if $\lambda(w_i v_{i+1}) = \lambda(w_j v_{j+1})$ then

$\dfrac{4k+2i+2}{2k+2i} = \dfrac{4k+2j+2}{2k+2j}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct.

For $1 \le i \le k$, $\lambda(v_i v_{i+1}) = \dfrac{4k+(2i+2)}{2k+(2i)}$.

For $1 \le i \le k$, if $i \ne j$, $\lambda(v_iv_{i+1}) \ne \lambda(v_jv_{j+1})$. Suppose $\lambda(v_iv_{i+1}) = \lambda(v_jv_{j+1})$ then $\frac{4k+(2i+2)}{2k+(2i)} = \frac{4k+(2j+2)}{2k+(2j)}$ which implies $i = j$, which is a contradiction. Therefore all edge labels are distinct. Thus the double triangular snakes ($2\Delta_k$-snake) graph admits even ratio edge antimagic labeling.

Theorem 2.2: $2m\Delta_1$-snake graph admits odd and even ratio edge antimagic labeling for $m \ge 1$.

Proof: Let $G\,(V, E)$ be a $2m\Delta_1$-snake graph.

The graph G consists of the vertex $V = \{u_1, u_2\} \cup \{v_1^1, v_1^2, \ldots, v_1^m\} \cup \{w_1^1, w_1^2, \ldots, w_1^m\}$ and the edges E = $\{u_1u_2\} \cup \{u_1v_1^i;\ 1 \le i \le m\} \cup \{u_2v_1^i;\ 1 \le i \le m\} \cup \{u_1w_1^i;\ 1 \le i \le m\} \cup \{u_2w_1^i\}$.

Let us consider the function $f: V(G) \to \{1, 3, 5, ..., 2p-1\}$, such that $f(w_1^i) = 2i-1;\ 1 \le i \le m$.

$f(v_1^i) = 2m + (2i-1);\ 1 \le i \le m$.

$f(u_i) = 4m + 1$ and $f(u_2) = 4m+3$.

Now the edge weights are calculated as follows.

For $1 \le i \le m$, $\lambda(u_1w_1^i) = \frac{4m+1}{2i-1}$.

$$\lambda(u_2w_1^i) = \frac{4m+3}{2i-1}.$$

$$\lambda(u_1v_1^i) = \frac{4m+1}{2m+(2i-1)}.$$

$$\lambda(u_2v_1^i) = \frac{4m+3}{2m+(2i-1)}.$$

Thus all edge labels are distinct. Hence $2m\Delta_1$-snake are odd ratio edge antimagic for $m \ge 1$.

To prove the existence of even ratio edge antimagic labeling, let us define

$f: V(G) \to \{2, 4, 6, ..., 2p\}$, such that $f(w_1^i) = 2i;\ 1 \le i \le m$.

$f(v_1^i) = 2m + 2i;\ 1 \le i \le m$.

$f(u_1) = 4m + 2$ and $f(u_2) = 4m + 4$.

Now the edge weights are calculated as follows.

For $1 \le i \le m$, $\lambda(u_1w_1^i) = \frac{4m+2}{2i}$.

$$\lambda(u_2w_1^i) = \frac{4m+4}{2i}.$$

$$\lambda(u_1v_1^i) = \frac{4m+2}{2m+2i}.$$

$$\lambda(u_2v_1^i) = \frac{4m+4}{2m+2i}.$$

Thus all edge labels are distinct. Hence $2m\Delta_1$-snake are even ratio edge antimagic for $m \ge 1$.

Theorem 2.3:.The $2m\Delta_k$-snake admits odd and even ratio edge antimagic labeling.

Proof. Let *G (V,E)* be a $2m\Delta_k$-snake graph. The graph *G(V,E)* consists of $k(2m+1)+1$ vertices. Let $V(G) = \{u_1, u_2, \ldots, u_{k+1}\} \cup \{v_1^1, v_1^2, \ldots, v_1^m\} \cup \{v_2^1, v_2^2, \ldots, v_2^m\} \cup \ldots \{v_k^1, v_k^2, \ldots, v_k^m\} \cup \{w_1^1, w_1^2, \ldots, w_1^m\} \cup \{w_2^1, w_2^2, \ldots, w_2^m\} \cup \ldots, \{w_k^1, w_k^2, \ldots, w_k^m\}$ and edges as

$E(G)=\{v_ku_i{:}1 \le i \le m, 2 \le k \le m\} \cup \{v_k^iu_{i+1}{:}1 \le i \le m, 2 \le k \le m\} \cup \{w_k^iu_i{:}1 \le i \le m, 2 \le k \le m\} \cup \{w_k^iu_{i+1}{:}1 \le i \le m, 2 \le k \le m\}$

To prove that $2m\Delta_k$-snake admits odd ratio edge antimagic labeling let us define, $f: V(G) \to \{1,3,5,\ldots, 4km+2k+1\}$, such that

$f(v_j^i) = 2m(j-1)+(2i-1)$; $1 \le j \le k$, $1 \le i \le m$.

$f(w_j^i) = 2m(k+j-1)+(2i-1)$; $1 \le j \le k$, $1 \le i \le m$.

$f(u_j) = 4km+(2j-1)$; $1 \le j \le k+1$.

The edge weights are calculated as follows:

For $1 \le j \le k-1$, $1 \le i \le m$,$\lambda(u_jv_j^i)= \dfrac{4km+2j-1}{2m(j-1)+(2i-1)}$.

Clearly $\lambda(u_jv_j^i) \neq \lambda(u_{j+1}v_j^i)$, if $\lambda(u_jv_j^i) = \lambda(u_{j+1}v_j^i)$ then , $\dfrac{4km+2j-1}{2m(j-1)+(2i-1)} = \dfrac{4km+2j+1}{2m(j-1)+(2i-1)}$.

This implies $2 = 0$, which is a contradiction.Thus edge labels are distinct.

For $1 \le j \le k, 1 \le i \le m$,$\lambda(u_jw_j^i) = \dfrac{4km+2j-1}{2m(k+j-1)+(2i-1)}$.

Clearly $\lambda(u_jw_j^i) \neq \lambda(u_{j+1}w_j^i)$.

If $\lambda(u_jv_j^i) = \lambda(u_{j+1}v_j^i)$, then $\dfrac{4km+2j-1}{2m(k+j-1)+(2i-1)} = \dfrac{4km+2j+1}{2m(k+j-1)+(2i-1)}$.

This implies 2 = 0, which is a contradiction. Thus edge labels are distinct.

For $1 \le j, l \le k$, clearly for $l \neq j$, $\lambda(u_ju_{j+1}) \neq \lambda(u_lu_{l+1})$.

If $\lambda(u_ju_{j+1}) = \lambda(u_lu_{l+1})$ then $\dfrac{4km+2j+1}{4km+2j-1} = \dfrac{4km+2l+1}{4km+2l-1}$.

This implies $l = j$, which is a contradiction. Thus edge labels are distinct.

Therefore $2m\Delta_k$-snake graph admits odd ratio edge antimagic labeling.

To prove the existence of even ratio edge antimagic labeling, let us define $g : V(G) \to \{2,4,6,\ldots, 4km+2k+2\}$, such that $g(v_1^i)=2i$; $1 \le i \le m$

$g(v_j^i) = 2m(j-1)+ 2i$; $1 \le j \le k, 1 \le i \le m$.

$g(w_j^i) = 2m(k+ j-1)+2i$; $1 \le j \le k, 1 \le i \le m$.

$g(u_j) = 4km+2j$; $1 \le j \le k+1$.

The edge weights are calculated as follows:

For $1 \le j \le k$, $1 \le i \le m$, $\lambda(u_j^iv_j^i) = \dfrac{4km+2j}{2m(j-1)+2i}$.

Clearly $\lambda(u_jv_j^i) \neq \lambda(u_{j+1}^iv_j^i)$,

if $\lambda(u_jv_j^i) = \lambda(u_{j+1}v_j^i)$ then $\dfrac{4km+2j}{2m(j-1)+2i} = \dfrac{4km+2j+2}{2m(j-1)+2i}$.

This implies 2 = 0, which is a contradiction. Thus edge labels are distinct.

For $1 \le j \le k$, $1 \le i \le m$, $\lambda(u_jw_j^i) = \dfrac{4km+2j}{2m(k+j-1)+2i}$.

Clearly $\lambda(u_jw_j^i) \neq \lambda(u_{j+1}w_j^i)$,

if $\lambda(u_jv_j^i) = \lambda(u_{j+1}v_j^i)$ then $\dfrac{4km+2j}{2m(k+j-1)+2i} = \dfrac{4km+2j+2}{2m(k+j-1)+2i}$.

This implies 2 = 0, which is a contradiction. Thus edge labels are distinct.

For $1 \le j, l \le k$, clearly for $l \neq j$, $\lambda(u_ju_{j+1}) \neq \lambda(u_lu_{l+1})$.

If $\lambda(u_ju_{j+1}) = \lambda(u_lu_{l+1})$ then $\dfrac{4km+2j}{4km+2j} = \dfrac{4km+2l}{4km+2l}$. This implies $l = j$, which is a contradiction. Thus edge labels are distinct. Therefore $2m\Delta_k$-snake graph admits even ratio edge antimagic labeling.

Theorem 2.4: The kC_4-snake graphs are odd and even ratio edge antimagic labeling.

Proof. Let $G(V, E)$ be a kC_4-snake graph where $k \geq 1$. This graph has $3k+1$ vertices and $4k$ edges. Let

$V(G) = \{w_i\,;\ 1 \leq i \leq k+1\} \cup \{u_i;\ 1 \leq i \leq k\} \cup \{v_i\,;\ 1 \leq\ i \leq k\}$,

$E(G)=\{\ w_iv_i;\ 1 \leq\ i \leq k\ \} \cup \{\ w_iu_i;\ 1 \leq\ i \leq k\ \} \cup \{\ w_{i+1}v_i;\ 1 \leq\ i \leq k\ \} \cup$

$\{\ w_{i+1}u_i;\ 1 \leq\ i \leq k\ \}$.

To prove that kC_4-snake admits ratio edge antimagic labeling let us define,

$f : V(G) \to \{1, 3, 5, \ldots, 6k+1\}$ such that $f(v_i) = 2i-1;\ 1 \leq i \leq k$,

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

The edge weights are calculated as follows:

For, $1 \leq\ i \leq k$, $\lambda(w_iv_i) = \dfrac{4k+2i-1}{2i-1}$.

For $1 \leq\ i, j \leq k$, clearly $\lambda(w_iv_i) \neq \lambda(w_jv_j)$ and $i \neq j$.

If $\lambda(w_iv_i) = \lambda(w_jv_j)$, then $\dfrac{4k+2i-1}{2i-1} = \dfrac{4k+2j-1}{2j-1}$.

This implies $i = j$, which is a contradiction.

For $1 \leq\ i, j \leq k$, $\lambda(w_iu_i) = \dfrac{4k+2i-1}{2k+2i-1}$.

For $1 \leq\ i, j \leq k$, clearly $\lambda(w_iu_i) \neq \lambda(w_ju_j)$ and $i \neq j$.

If $\lambda(w_iu_i) = \lambda(w_ju_j)$ then $\dfrac{4k+2i-1}{2k+2i-1} = \dfrac{4k+2j-1}{2k+2j-1}$. This implies $i = j$,

which is a contradiction.

For $1 \leq\ i, j \leq k$, $\lambda(w_{i+1}v_i) = \dfrac{4k+1+2i}{2i-1}$.

For $1 \leq\ i, j \leq k$, clearly $\lambda(w_{i+1}v_i) \neq \lambda(w_{j+1}v_j)$ and $i \neq j$.

If $\lambda(w_{i+1}v_i) = \lambda(w_{j+1}v_j)$ then $\dfrac{4k+1+2i}{2i-1} = \dfrac{4k+1+2j}{2j-1}$.

This implies $i = j$, which is a contradiction.

For $1 \leq\ i, j \leq k$, $\lambda(w_{i+1}u_i) = \dfrac{4k+2i+1}{2k+2i-1}$.

For $1 \leq\ i, j \leq k$, clearly $\lambda(w_{i+1}u_i) \neq \lambda(w_{j+1}u_j)$ and $i \neq j$.

If $\lambda(w_{i+1}u_i) = \lambda(w_{j+1}u_j)$ then $\dfrac{4k+2i+1}{2k+2i-1} = \dfrac{4k+2j+1}{2k+2j-1}$.

This implies $i = j$, which is a contradiction. Thus all edge labels are distinct

For $1 \leq\ i, j \leq k$, clearly $\lambda(w_iv_i) \neq \lambda(w_{i+1}v_i)$ and $i \neq j$.

If $\lambda(w_iv_i) = \lambda(w_{i+1}v_i)$ then $\dfrac{4k+2i-1}{2i-1} = \dfrac{4k+2i+1}{2i-1}$ implies $2 = 0$, which is a contradiction.

Also $\lambda(w_iu_i) \neq \lambda(w_{i+1}u_i)$, if $\lambda(w_iu_i) = \lambda(w_{i+1}u_i)$ then $\dfrac{4k+2i-1}{2k+2i-1} = \dfrac{4k+2i+1}{2k+2i-1}$ implies $2 = 0$, which leads to contradiction.

Thus all edge labels are distinct. Therefore kC_4-snake graph admits odd ratio edge antimagic labeling.

To prove the existence of even ratio edge antimagic labeling, let us define

$g : V(G) \to \{2, 4, 6, \ldots, 6k+2)\}$, such that

$g(v_i) = 2i\ ;\ 1 \leq i \leq k$,

$g(u_i) = 2k+2i\ ;\ 1 \leq i \leq k$,

$g(w_i) = 4k+2i$; $1 \le i \le k+1$.

The edge weights are calculated as follows:

For $1 \le i \le k$, $\lambda(w_iv_i) = \frac{4k+2i}{2i}$.

For $1 \le i, j \le k$, clearly $\lambda(w_iv_i) \ne \lambda(w_jv_j)$ and $i \ne j$.

If $\lambda(w_iv_i) = \lambda(w_jv_j)$, then $\frac{4k+2i}{2i} = \frac{4k+2j}{2j}$. This implies $i = j$, which is a contradiction. Thus all edge labels are distinct.

For $1 \le i \le k$, $\lambda(w_iv_{i+1}) = \frac{4k+2i}{2i+2}$.

For $1 \le i, j \le k$, clearly $\lambda(w_iv_{i+1}) \ne \lambda(w_jv_{j+1})$. If $\lambda(w_iv_{i+1}) \ne \lambda(w_jv_{j+1})$ then $\frac{4k+2i}{2i+2} = \frac{4k+2j}{2j+2}$. This implies $i = j$, which is a contradiction. Thus all edge labels are distinct.

For $1 \le i \le k$, $\lambda(w_iu_i) = \frac{4k+2i}{2k+2i}$.

For $1 \le i, j \le k$, clearly $\lambda(w_iu_i) \ne \lambda(w_ju_j)$ and $i \ne j$.

If $\lambda(w_iu_i) = \lambda(w_ju_j)$ then $\frac{4k+2i}{2k+2i} = \frac{4k+2j}{2k+2j}$.

This implies $i = j$, which is a contradiction.

Thus all edge labels are distinct.

For $1 \le i \le k$, $\lambda(w_iu_{j+1}) = \frac{4k+2i}{2k+2i+2}$. Clearly $\lambda(w_iv_i) \ne \lambda(w_{i+1}v_i)$, if $\lambda(w_iv_i) = \lambda(w_{i+1}v_i)$ then $\frac{4k+2i}{2i} = \frac{4k+2i+2}{2i}$ implies $2 = 0$, which leads to a contradiction. Thus edge labels are distinct.

Clearly $\lambda(w_iu_i) \ne \lambda(w_{i+1}u_i)$, if $\lambda(w_iu_i) \ne \lambda(w_{i+1}u_i)$ then $\frac{4k+2i}{2k+2i} = \frac{4k+2i+2}{2k+2i}$ implies $2=0$, which leads to a contradiction. Thus edge labels are distinct. Therefore kC_4-snake graph admits even ratio edge antimagic labeling.

Conclusion

Thus existence of odd and even ratio edge antimagic labeling, for some class of graph is proved.

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