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Lucky Edge Labeling of P_n, C_n and Corona of P_n, C_n

Dr. A. Nellai Murugan
Department of Mathematics,
V.O.Chidambaram College,
Tuticorin, Tamilnadu(INDIA)
anellai.vocc@gmail.com

R. Maria Irudhaya Aspin Chitra
Department of Mathematics,
V.O.Chidambaram College,
Tuticorin, Tamilnadu(INDIA)
aspinvjs@gmail.com

Abstract: *Let G be a Simple Graph with Vertex set V(G) and Edge set E(G) respectively. Vertex set V(G) is labeled arbitrary by positive integers and let E(e) denote the edge label such that it is the sum of labels of vertices incident with edge e. The labeling is said to be lucky edge labeling if the edge set E(G) is a proper coloring of G, that is, if we have $E(e_1) \neq E(e_2)$ whenever e_1 and e_2 are adjacent edges. The least integer k for which a graph G has a lucky edge labeling from the set {1, 2,….,k} is the lucky number of G denoted by η(G).*

A graph which admits lucky edge labeling is the lucky edge labeled graph.In this paper, it is proved that Path P_n, Comb P_n^+, Cycle C_n, Crown C_n^+ are lucky edge labeled graphs.

Keywords: *Lucky Edge Labeled Graph, Lucky Edge Labeling, Lucky Number, 2010 Mathematics subject classification Number: 05C78.*

1. INTRODUCTION

A graph G is a finite non empty set of objects called vertices together with a set of pairs of distinct vertices of G which is called edges. Each e={uv} of vertices in E is called an edge or a line of G. For Graph Theoretical Terminology, [2].

2. PRELIMINARIES

Definition: 2.1

Let G be a Simple Graph with Vertex set V(G) and Edge set E(G) respectively. Vertex set V(G) are labeled arbitrary by positive integers and let E(e) denote the edge label such that it is the sum of labels of vertices incident with edge e. The labeling is said to be **lucky edge labeling** if the edge set E(G) is a proper coloring of G,that is, if we have $E(e_1) \neq E(e_2)$ whenever e_1 and e_2 are adjacent edges. The least integer k for which a graph G has a lucky edge labeling from the set {1, 2,….,k} is the **lucky number** of G denoted by **η(G)**.

A graph which admits lucky edge labeling is the **lucky edge labeled graph**.

Definition: 2.2

A **Walk** of a graph G is an alternating sequence of vertices and edges v_1, e_1, v_2, e_2,…..v_{n-1}, e_n, v_n beginning and ending with vertices such that each edge e_i is incident with v_{i-1} and v_i.

Definition: 2.3

If all the vertices in a walk are distinct, then it is called a **Path** and a path of length n is denoted by $\mathbf{P_{n+1}}$.

Definition: 2.4

A graph obtained by joining each $u_i$to a vertex v_i is called a **Comb** and denoted by $\mathbf{P_n^+}$. The Vetex set and Edge set of P_n^+ is $V[P_n^+] = \{u_i,v_i: 1 \le i \le n\}$ and $E[P_n^+] = \{(u_iu_{i+1}): 1 \le i \le n-1\} \cup \{(u_iv_i): 1 \le i \le n\}$ respectively. P_n^+ has 2n vertices and 2n-1 edges.

Definition: 2.5

A closed path is called a **Cycle** and a cycle of length n is denoted by $\mathbf{C_n}$.

Definition: 2.6

C_n^+ is a graph obtained from G by attaching a pendent vertex from each vertex of the graph Cn is called **Crown**.

3. Main Results

Theorem: 3.1

P_n has {a, b} lucky edge labeling graph for any a, b ∈ $\boldsymbol{N}$.

Proof:

Let $V[P_n] = \{ u_i : 1 \leq i \leq n \}$ and $E[P_n] = \{ (u_iu_{i+1}): 1 \leq i \leq n-1 \}$.

Let f: $V[P_n] \rightarrow \{1, 2\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}$$

and $1 \leq i \leq (n-1)/2$, for n is odd and $1 \leq i \leq n/2$, for n is even.

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}$$

and $1 \leq i \leq (n+1)/2$, for n is odd and $1 \leq i \leq n/2$, for n is even.

Then the induced edge coloring are

whenn is odd, $1 \leq i \leq (n-1)/2$ and when n is even, $1 \leq i \leq (n/2) - 1$

$$f^*(u_{2i}u_{2i+1}) = 3$$

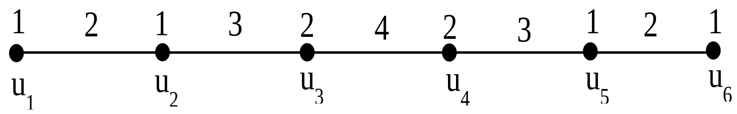
whenn is odd, $1 \leq i \leq (n-1)/2$and when n is even, $1 \leq i \leq n/2$

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}$$

It is clear that lucky edge labeling of P_n is {2, 3, 4}.

Hence,P_n has lucky edge labeling graph.

For example, lucky edge labeling of $P_6$is shown in figure 1 and $\eta(P_n) = 4$.



Theorem: 3.2

P_n^+ has {a, b, c} lucky edge labeling graph for any a, b, c ∈ $\boldsymbol{N}$.

Proof:

Let $V[P_n^+] = \{\{u_i : 1 \leq i \leq n\}, \{v_i : 1 \leq i \leq n\}\}$and $E[P_n^+] = \{(u_iu_{i+1}): 1 \leq i \leq n-1\} \cup \{(u_iv_i): 1 \leq i \leq n\}$.

Let f: $V[P_n^+] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}$$

and $1 \leq i \leq (n-1)/2$, for n is odd and $1 \leq i \leq n/2$, for n is even.

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}$$

and $1 \leq i \leq (n+1)/2$, for n is odd and $1 \leq i \leq n/2$, for n is even.

$f(v_1) = 2$

$f(v_i) = 3,\ 2 \le i \le n-1$

$f(v_n) = \begin{cases} 1 & n \equiv 0, 1 \bmod 4 \\ 2 & n \equiv 2, 3 \bmod 4 \end{cases}$.

Then the induced edge coloring are

whenn is odd, $1 \le i \le (n-1)/2$ and when n is even, $1 \le i \le (n/2) - 1$

$f^*(u_{2i}u_{2i+1}) = 3$

whenn is odd, $1 \le i \le (n-1)/2$and when n is even, $1 \le i \le n/2$

$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}$

$f^*(u_1v_1) = 3$

$f^*(u_iv_i) = \begin{cases} 4 & i \equiv 1, 2 \bmod 4 \\ 5 & i \equiv 0, 3 \bmod 4 \end{cases}$ for $2 \le i \le n-1$.

$f^*(u_nv_n) = \begin{cases} 3 & n \equiv 0 \bmod 2 \\ 2 & n \equiv 1 \bmod 4 \\ 4 & n \equiv 3 \bmod 4 \end{cases}$.

It is clear that lucky edge labeling of P_n^+ is {2, 3, 4, 5}.

Hence,P_n^+ hasluky edge labeling graph.

For example, lucky edge labeling of P_5^+ and P_6^+ are given in the figure 2a and figure 2b and $\eta(P_n^+) = 5$.

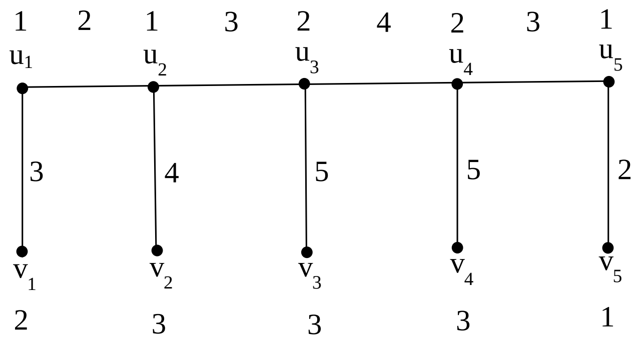


Figure 2a and $\eta(P_n^+) = 5$

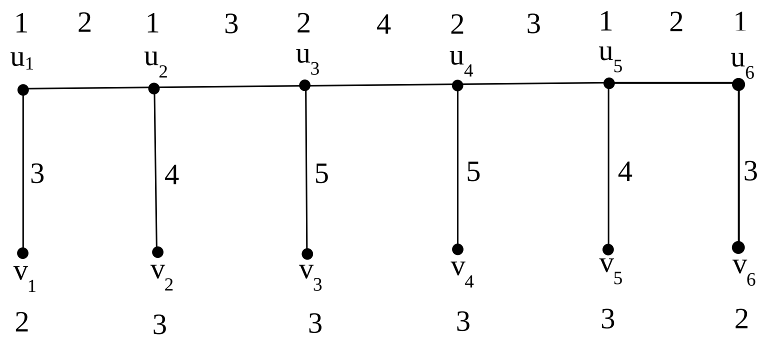


Figure 2b and $\eta(P_n^+) = 5$

Theorem 3.3:

C_n : $n \equiv 1, 2, 3 \pmod 4$ has {a, b, c} lucky edge labeling and

C_n : $n \equiv 0 \pmod 4$ has {a, b} lucky edge labeling for any a, b, c $\in \boldsymbol{N}$.

Proof:

Let $V[C_n] = \{ u_i : 1 \leq i \leq n \}$and $E[C_n] = \{\{(u_iu_{i+1}): 1 \leq i \leq n-1\}\cup\{(u_n\, u_1)\}\}$.

Case 1:

Let C_n be the graph whenn $\equiv 0 \pmod 4$.

Let f: $V[C_n] \rightarrow \{1, 2\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases},\ 1 \leq i \leq n/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases},\ 1 \leq i \leq n/2.$$

Then the induced edge coloring are

when$1 \leq i \leq (n/2) - 1$,

$f^*(u_{2i}u_{2i+1}) = 3$,

$f^*(u_nu_1) = 3$.

when$1 \leq i \leq n/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

It is clear that the lucky edge labeling of C_n : $n \equiv 0 \pmod 4$ is $\{2, 3, 4\}$.

For example, Lucky edge labeling ofC_4 is given in the figure 3a and $\eta(C_n) = 4$.

Case 2:

Let C_n be the graph when $n \equiv 1 \pmod 4$.

Let f: $V[C_n] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases},\ 1 \leq i \leq n/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases},\ 1 \leq i \leq n/2.$$

$f(u_i)=3$, $i \equiv 1 \pmod 4$ and $i = n$.

Then the induced edge coloring are

when$1 \leq i \leq (n - 3)/2$,

$f^*(u_{2i}u_{2i+1}) = 3$.

when $1 \leq i \leq (n - 1)/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

when i=n,

$f^*(u_iu_1) = 4$ and $f^*(u_{i-1}u_i) = 5$.

It is clear that the lucky edge labeling of C_n : $n \equiv 1 \pmod 4$ is clearly $\{2, 3, 4, 5\}$.

For example, Lucky edge labeling of C_5 is shown in the figure 3b and $\eta(C_n) = 5$.

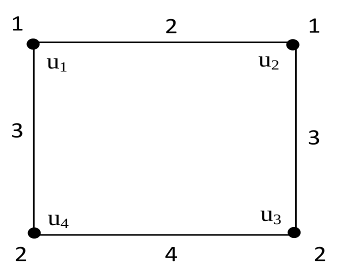


Figure 3a and $\eta(C_n) = 4$

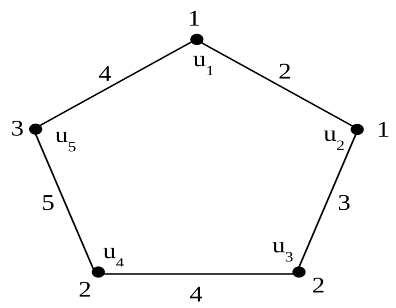


Figure 3b and $\eta(C_n) = 5$

Case 3:

Let C_n be the graph when n ≡ 2 (mod 4).

Let f: V[C_n] → {1, 2, 3} defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, \ 1 \le i \le (n/2) - 1.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, \ 1 \le i \le (n/2) - 1.$$

$$f(u_i) = 3, \begin{cases} i \equiv 1 \ (\text{mod } 4) \\ i \equiv 2 \ (\text{mod } 4) \end{cases} \text{ and } i = n, n\text{-}1.$$

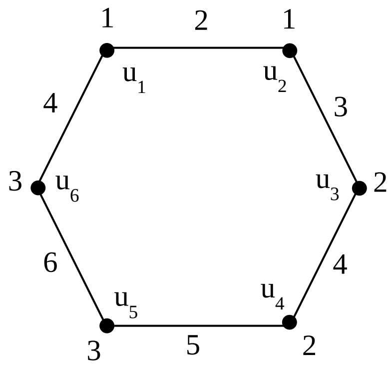


Figure 3c and η(C_n) = 6

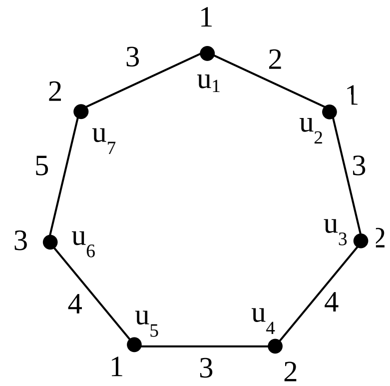


Figure 3d and η(C_n) = 5

Then the induced edge coloring are

when $1 \le i \le (n/2) - 2$,

$$f^*(u_{2i}u_{2i+1}) = 3.$$

when $1 \le i \le (n/2) - 1$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

when i= n-1 and n-2,

$$f^*(u_iu_{i+1}) = \begin{cases} 5 & i \equiv 0 \bmod 4 \\ 6 & i \equiv 1 \bmod 4 \end{cases}.$$

$$f^*(u_nu_1) = 4.$$

It is clear that the lucky edge labeling of C_n : n ≡ 2 (mod 4) is clearly {2, 3, 4, 5, 6}.

For example, Lucky edge labeling of C_6 is shown in the figure 3c and η(C_n) = 6.

Case 4:

Let C_n be the graph when n ≡ 3 (mod 4).

Let f: V[C_n] → {1, 2, 3} defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, \ 1 \le i \le (n-3)/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, \ 1 \le i \le (n+1)/2 \text{ and } i = n-1$$

$$f(u_i) = 3, \ i \equiv 2 \ (\text{mod } 4).$$

Then the induced edge coloring is

when $1 \le i \le (n-3)/2$,

$$f^*(u_{2i}u_{2i+1}) = 3.$$

when $1 \le i \le (n-3)/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

$$f^*(u_{i-1}u_i) = \begin{cases} 4 & \text{when } i = n-1 \\ 5 & \text{when } i = 1 \end{cases} \text{ and } f^*(u_nu_1) = 3.$$

It is clear that the lucky edge labeling of C_n : n ≡ 3 (mod 4)is clearly {2, 3, 4, 5}.
For example, Lucky edge labeling of C_7 is shown in the figure 3d and $\eta(C_n) = 5$.
Hence,C_n has lucky edge labeling graph.

Theorem 3.4:

C_n^+ : n ≡ 0, 1, 2, 3 (mod 4) has {a, b, c} lucky edge labeling for any a, b, c ∈ $\boldsymbol{N}$.

Proof:

Let $V[C_n^+] = \{u_i: 1 \leq i \leq n\}$ and $\{v_i : 1 \leq i \leq n\}$ and
$E[C_n^+] = \{\{(u_iu_{i+1}): 1 \leq i \leq n\text{-}1\} \cup \{(u_n\, u_1)\} \cup \{(u_iv_i): 1 \leq i \leq n\}\}$.

Case 1:

Let C_n^+ be the graph whenn ≡ 0 (mod 4).
Let f: $V[C_n] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, 1 \leq i \leq n/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, 1 \leq i \leq n/2.$$

$$f(v_i) = 3, 1 \leq i \leq n.$$

Then the induced edge coloring are
when $1 \leq i \leq (n/2) - 1$,

$$f^*(u_{2i}u_{2i+1}) = 3.$$

$$f^*(u_nu_1) = 3.$$

when $1 \leq i \leq n/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

when $1 \leq i \leq n$,

$$f^*(u_iv_i) = \begin{cases} 4 & i \equiv 1,2 \bmod 4 \\ 5 & i \equiv 0,3 \bmod 4 \end{cases}.$$

It is clear that the lucky edge labeling of C_n^+ : n ≡ 0(mod 4) is {2, 3, 4, 5}.
For example, Lucky edge labeling ofC_4^+ is shown in the figure 4a and $\eta(C_n^+) = 5$.

Case 2:

Let C_n^+ be the graph when n ≡ 1 (mod 4).

Let f: $V[C_n^+] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, 1 \leq i \leq n/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \bmod 2 \\ 2 & i \equiv 0 \bmod 2 \end{cases}, 1 \leq i \leq n/2.$$

$f(u_i)=3$, i ≡ 1 (mod 4) and i = n.

$f(v_1) = 2$, $f(v_{n-1}) = 1$

$f(v_i) = 3$, $2 \leq i \leq n$.

Then the induced edge coloring are

when$1 \leq i \leq (n-3)/2$,

$$f^*(u_{2i}u_{2i+1}) = 3.$$

when $1 \leq i \leq (n-1)/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

when i=n,

$f^*(u_iu_1) = 4$ and $f^*(u_{i-1}u_i) = 5$.

whenn-2 ≤ i ≤ n,

$$f^*(u_iv_i) = \begin{cases} 5 & i \equiv 3 \ mod\ 4 \\ 3 & i \equiv 0 \ mod\ 4. \\ 6 & i \equiv 1 \ mod\ 4 \end{cases}$$

$f^*(u_1v_1) = 3$.

when 2 ≤ i ≤ n-3,

$$f^*(u_iv_i) = \begin{cases} 4 & i \equiv 1,2 \ mod\ 4 \\ 5 & i \equiv 0,3 \ mod\ 4 \end{cases}.$$

It is clear that the lucky edge labeling of C_n^+ :n ≡ 1 (mod 4) is {2, 3, 4, 5, 6}.

For example, Lucky edge labeling of C_5^+ is shown in the figure 4b and $\eta(C_n^+) = 6$.

Case 3:

Let C_n^+ be the graph when n ≡ 2 (mod 4).

Let f: $V[C_n^+] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \ mod\ 2 \\ 2 & i \equiv 0 \ mod\ 2 \end{cases}, 1 \le i \le (n/2) - 1.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \ mod\ 2 \\ 2 & i \equiv 0 \ mod\ 2 \end{cases}, 1 \le i \le (n/2) - 1.$$

$f(u_i)=3$, $\begin{matrix} i \equiv 1 \ (\text{mod } 4) \\ i \equiv 2 \ (\text{mod } 4) \end{matrix}$ and i = n, n-1.

$f(v_1) = 1$, i = n-1, n-2 and $f(v_i) = 2$, i = 1, n.

$f(v_i) = 3$, 2 ≤ i ≤ n-3.

Then the induced edge coloring are

when1 ≤ i ≤$(n/2) - 2$,

$f^*(u_{2i}u_{2i+1}) = 3$.

when1 ≤ i ≤ $(n/2) - 1$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \ mod\ 2 \\ 4 & i \equiv 0 \ mod\ 2 \end{cases}.$$

when i= n-1, n-2,

$$f^*(u_iu_{i+1}) = \begin{cases} 5 & i \equiv 0 \ mod\ 4 \\ 6 & i \equiv 1 \ mod\ 4 \end{cases}.$$

$f^*(u_nu_1) = 4$.

when i = 1, n-2,

$f^*(u_iv_i) = 3$.

when 2 ≤ i ≤ n-1,

$$f^*(u_iv_i) = \begin{cases} 4 & i \equiv 1,2 \ mod\ 4 \\ 5 & i \equiv 0,3 \ mod\ 4 \end{cases}.$$

$f^*(u_iv_i) = 5$, i = n.

It is clear that the lucky edge labeling of C_n^+ :n ≡ 2 (mod 4) is {2, 3, 4, 5, 6}.

For example, Lucky edge labeling of C_6^+ is shown in the figure 4c and $\eta(C_n^+) = 6$.

Case 4:

Let C_n^+ be the graph when n ≡ 3 (mod 4).

Let f: $V[C_n^+] \rightarrow \{1, 2, 3\}$ defined by

$$f(u_{2i}) = \begin{cases} 1 & i \equiv 1 \ mod\ 2 \\ 2 & i \equiv 0 \ mod\ 2 \end{cases}, 1 \le i \le (n-3)/2.$$

$$f(u_{2i-1}) = \begin{cases} 1 & i \equiv 1 \ mod\ 2 \\ 2 & i \equiv 0 \ mod\ 2 \end{cases}, 1 \le i \le (n+1)/2 \text{ and } i= n-1$$

$f(u_i)=3$, i ≡ 2 (mod 4).

$$f(v_i) = \begin{cases} 2 & i \equiv 3 \ mod\ 4 \\ 3 & i \equiv 2 \ mod\ 4 \\ 1 & i \equiv 1 \ mod\ 4 \end{cases}, n-2 \le i \le n.$$

$f(v_i) = 3$, 1 ≤ i ≤ n-3.

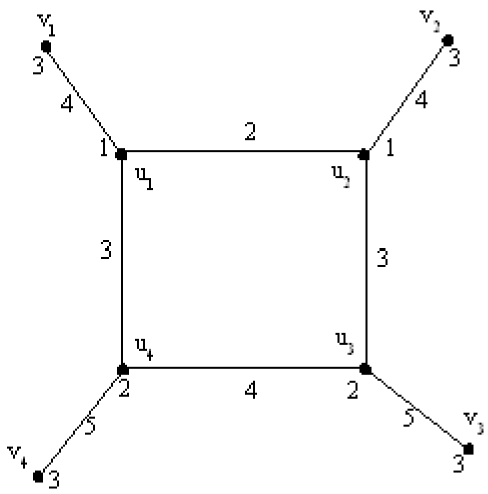


Figure 4a and $\eta(C_n^+) = 5$

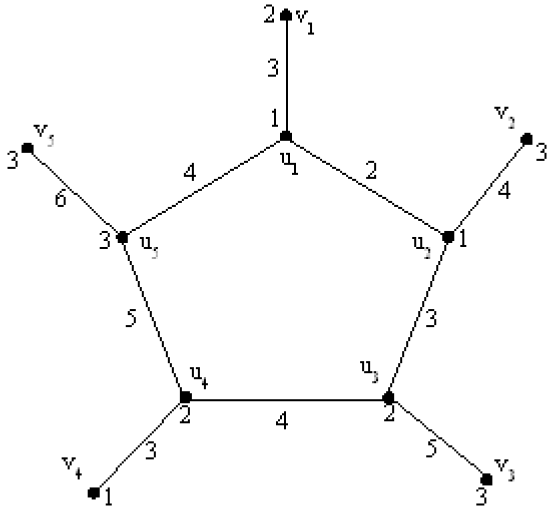


Figure 4b and $\eta(C_n^+) = 6$

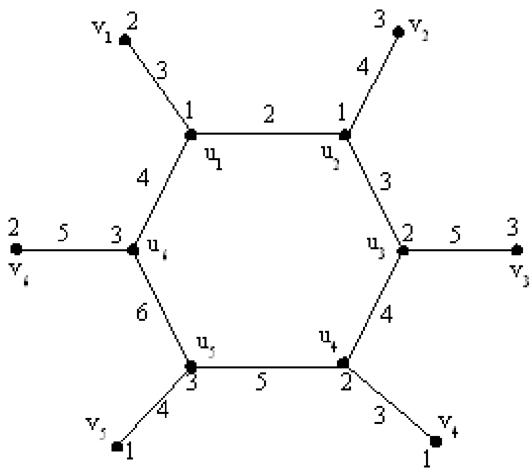


Figure 4c and $\eta(C_n^+) = 6$

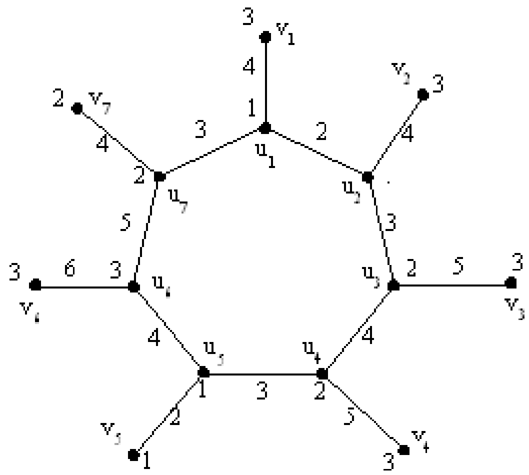


Figure 4d and $\eta(C_n^+) = 6$

Then the induced edge coloring are

when $1 \le i \le (n-3)/2$,

$$f^*(u_{2i}u_{2i+1}) = 3.$$

when $1 \le i \le (n-3)/2$,

$$f^*(u_{2i-1}u_{2i}) = \begin{cases} 2 & i \equiv 1 \bmod 2 \\ 4 & i \equiv 0 \bmod 2 \end{cases}.$$

$$f^*(u_{i-1}u_i) = \begin{cases} 4 & when\ i = n-1 \\ 5 & when\ \ i = 1 \end{cases}.$$

$$f^*(u_nu_1) = 3.$$

whenn-2 $\le i \le n$,

$$f^*(u_iv_i) = \begin{cases} 2 & i \equiv 1 \bmod 3 \\ 6 & i \equiv 2 \bmod 3. \\ 4 & i \equiv 0 \bmod 3 \end{cases}$$

when $1 \le i \le n-3$,

$$f^*(u_iv_i) = \begin{cases} 4 & i \equiv 1,2 \bmod 4 \\ 5 & i \equiv 0,3 \bmod 4 \end{cases}.$$

It is clear that the lucky edge labeling of C_n^+ :$n \equiv 3 \pmod 4$ is {2, 3, 4, 5, 6}.

For example, Lucky edge labeling of C_7^+ is shown in the figure 4d and $\eta(C_n^+) = 6$.

Hence,C_n^+ has lucky edge labeling graph.

4. CONCLUSION

Among all labelling lucky edge labelling has a special importance because it is incorporated with coloring of graphs

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[3] NELLAIMURUGAN.*A- STUDIES IN GRAPH THEORY –SOME LABELING PROBLEMS IN GRAPHS AND RELATED TOPICS,*Ph.D, Thesis September 2011...

AUTHORS' BIOGRAPHY

Dr. A. Nellai Murugan is working as a Associate Professor in theDepartment of Mathematics, V.O. ChidambaramCollege, Tuticorin. He has 30 years of teachingexperience and 10 years of research experience. Hehas participated in number of conferences/seminar atnational and international level. He has publishedmore than 40 research article in the reputed research journals. He is guiding 6 Ph.D research scholars.

R.Maria Irudhaya Aspin Chitra is a full time Ph.D Research Scholar working in Graph theory at Department of Mathematics, V.O. ChidambaramCollege, Tuticorin. She has communicated 3 more research articles