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Cycle Related Kth Fibonacci Prime Labeling Of Graphs

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ABSTRACT :

In this paper, we investigate the kth fibonacci prime labeling of two new families of graphs, which are a graph G is obtained by joining two cycles C_n and C_m by a path P_s and a graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s.

Keywords – fibonacci number, fibonacci prime labeling, fibonacci prime graph, triangular snake, kth fibonacci prime graph.

1. INTRODUCTION

By a graph, we mean a finite, undirected graph without loops and multiple edges, for terms not defined here, we refer to Bondy and Murthy [1]. For standard terminology and notations related to number theory we refer to Burton [2] and graph labeling, we refer to Gallian [3]. The notion of prime labeling for graphs originated with Roger Entringer and was introduced in a paper by Tout et al. [6]. In [7], Vaidya et al. introduced the concept of k-prime labeling of graph. Sekar et al. introduced the concept of Fibonacci Prime Labeling of Graphs in [5]. Periasamy et al. introduced kth Fibonacci Prime Labeling of Graphs and kth Fibonacci Prime Labeling of some standard graphs are discussed in [4]. In this paper, we present the kth Fibonacci prime labeling of a graph G is obtained by joining two cycles C_n and C_m by a path P_s and a graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s.

Definition :1.1 A graph labeling is the assignment of unique identifiers to the edges and vertices of a graph.

Definition :1.2 Let G = (V,E) be a graph with n vertices. A function $f : V(G) \rightarrow \{1,2,3,\ldots,n\}$ is said to be a prime labeling, if it is bijective and for every pair of adjacent vertices u and v, $\gcd(f(u),f(v)) = 1$. A graph which admits prime labeling is called a prime graph.

Definition : 1.3 The Fibonacci number f_n is defined recursively by the equations $f_1 = 1$, $f_2 = 1$,

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$f_{n+1} = f_n + f_{n-1}$ ($n \geq 2$). Then gcd $(f_n, f_{n-1}) = 1$ and gcd $(f_n, f_{n+1}) = 1$ for all $n \geq 1$.

Definition : 1.4 A Fibonacci prime labeling of a graph $G = (V,E)$ with $|V(G)| = n$ is an injective function $g : V(G) \rightarrow \{f_2, f_3, \ldots, f_{n+1}\}$, where f_n is the n^{th} Fibonacci number, that induces a function $g^* : E(G) \rightarrow N$ defined by $g^*(uv) = \gcd\{g(u), g(v)\} = 1$, $\forall\ uv \in E(G)$. The graph admits a Fibonacci prime labeling and is called a Fibonacci prime graph.

Definition : 1.5 A k^{th} Fibonacci prime labeling of a graph $G = (V,E)$ with $|V(G)| = n$ is an injective function $g : V(G) \rightarrow \{f_k, f_{k+1}, \ldots, f_{k+n-1}\}$, where f_k is the k^{th} Fibonacci number, that induces a function $g^* : E(G) \rightarrow N$ defined by $g^*(uv) = \gcd\{g(u), g(v)\} = 1$, $\forall\ uv \in E(G)$. The graph admits a k^{th} Fibonacci prime labeling and is called a k^{th} Fibonacci prime graph.

Remark : 1.1 A 2^{nd} Fibonacci prime graph is called Fibonacci prime graph.

2. Main Results

Theorem 2.1

The graph G is obtained by joining two cycles C_n and C_m by a path P_s is a k^{th} Fibonacci prime graph $n,m \geq 3$, $k,s \geq 2$.

Proof.

The graph G is obtained by joining two cycles C_n and C_m by a path P_s.

Let $v_1, v_2, \ldots, v_n$ be the vertices of the cycle C_n, $w_1, w_2, \ldots, w_m$ be the vertices of the cycle C_m and $u_1, u_2, \ldots, u_s$ be the vertices of the path P_s with $u_1 = v_1$ and $u_s = w_1$.

The edge set $E(G) = \{v_i v_{i+1} \mid 1 \leq i \leq n-1\} \cup \{v_n v_1\} \cup \{v_1 u_2\} \cup \{u_i u_{i+1} \mid 2 \leq i \leq s-2\} \cup \{u_{s-1} w_1\} \cup \{w_i w_{i+1} \mid 1 \leq i \leq m-1\} \cup \{w_m w_1\}$.

Then $|V(G)| = n+s+m-2$ and $|E(G)| = n+s+m-1$.

Define the mapping $g : V(G) \rightarrow \{f_k, f_{k+1}, \ldots, f_{k+n+s+m-3}\}$ as follows

Case 1 : n is odd.

$g(v_i) = f_{k+n-2i+1}$, for $1 \leq i \leq \frac{n+1}{2}$

$g(v_i) = f_{k-n+2i-2}$, for $\frac{n+3}{2} \leq i \leq n$

$g(u_i) = f_{k+n+i-2}$, for $2 \leq i \leq s-1$

Case 1(a) : m is odd.

$g(w_i) = f_{k+n+s+2i-4}$, for $1 \leq i \leq \frac{m+1}{2}$

$g(w_i) = f_{k+n+s+2m-2i-1}$, for $\frac{m+3}{2} \leq i \leq m$

Case 1(b) : m is even.

$g(w_i) = f_{k+n+s+2i-4}$, for $1 \leq i \leq \frac{m}{2}$

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$g(w_i) = f_{k+n+s+2m-2i-1}$, for $\frac{m+2}{2} \leq i \leq m$

Then the induced function $g^* : E(G) \to N$ is defined by

$$g^*(xy) = \gcd\{g(x),g(y)\} \ \forall \ xy \in E(G).$$

Now,

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+n-2i+1}, f_{k+n-2i-1}\} = 1, 1 \leq i \leq \frac{n-1}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_k, f_{k+1}\} = 1, i = \frac{n+1}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k-n+2i-2}, f_{k-n+2i}\} = 1, \frac{n+3}{2} \leq i \leq n-1$

$\gcd\{g(v_n),g(v_1)\} = \gcd\{f_{k+n-2}, f_{k+n-1}\} = 1$

$\gcd\{g(v_1),g(u_2)\} = \gcd\{f_{k+n-1}, f_{k+n}\} = 1$

$\gcd\{g(u_i),g(u_{i+1})\} = \gcd\{f_{k+n+i-2}, f_{k+n+i-1}\} = 1, 2 \leq i \leq s-1$

$\gcd\{g(u_s),g(w_1)\} = \gcd\{f_{k+n+s-3}, f_{k+n+s-2}\} = 1$

when m is odd

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2i-4}, f_{k+n+s+2i-2}\} = 1, 1 \leq i \leq \frac{m-1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+m-3}, f_{k+n+s+m-4}\} = 1, i = \frac{m+1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2m-2i-1}, f_{k+n+s+2m-2i-3}\} = 1, \frac{m+3}{2} \leq i \leq m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+s-1}, f_{k+n+s-2}\} = 1$

when m is even

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2i-4}, f_{k+n+s+2i-2}\} = 1, 1 \leq i \leq \frac{m-2}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+m-4}, f_{k+n+s+m-3}\} = 1, i = \frac{m}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2m-2i-1}, f_{k+n+s+2m-2i-3}\} = 1, \frac{m+2}{2} \leq i \leq m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+s-1}, f_{k+n+s-2}\} = 1$

Thus $g^*(xy) = \gcd\{f(x),f(y)\} = 1, \forall \ xy \in E(G)$.

Case 2 : n is even.

$g(v_i) = f_{k+n-2i+1}$, for $1 \leq i \leq \frac{n}{2}$

$g(v_i) = f_{k-n+2i-2}$, for $\frac{n+2}{2} \leq i \leq n$

$g(u_i) = f_{k+n+i-2}$, for $2 \leq i \leq s-1$

Case 2(a) : m is odd.

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$g(w_i) = f_{k+n+s+2i-4}$, for $1 \le i \le \frac{m+1}{2}$

$g(w_i) = f_{k+n+s+2m-2i-1}$, for $\frac{m+3}{2} \le i \le m$

Case 2(b) : m is even.

$g(w_i) = f_{k+n+s+2i-4}$, for $1 \le i \le \frac{m}{2}$

$g(w_i) = f_{k+n+s+2m-2i-1}$, for $\frac{m+2}{2} \le i \le m$

Then the induced function $g^* : E(G) \to N$ is defined by

$$g^*(xy) = \gcd\{g(x),g(y)\} \ \forall \ xy \in E(G).$$

Now,

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+n-2i+1}, f_{k+n-2i-1}\} = 1, 1 \le i \le \frac{n-2}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+1}, f_k\} = 1, i = \frac{n}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k-n+2i-2}, f_{k-n+2i}\} = 1, \frac{n+2}{2} \le i \le n-1$

$\gcd\{g(v_n),g(v_1)\} = \gcd\{f_{k+n-2}, f_{k+n-1}\} = 1$

$\gcd\{g(v_1),g(u_2)\} = \gcd\{f_{k+n-1}, f_{k+n}\} = 1$

$\gcd\{g(u_i),g(u_{i+1})\} = \gcd\{f_{k+n+i-2}, f_{k+n+i-1}\} = 1, 2 \le i \le s-1$

$\gcd\{g(u_s),g(w_1)\} = \gcd\{f_{k+n+s-3}, f_{k+n+s-2}\} = 1$

when m is odd

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2i-4}, f_{k+n+s+2i-2}\} = 1, 1 \le i \le \frac{m-1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+m-3}, f_{k+n+s+m-4}\} = 1, i = \frac{m+1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2m-2i-1}, f_{k+n+s+2m-2i-3}\} = 1, \frac{m+3}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+s-1}, f_{k+n+s-2}\} = 1$

when m is even

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2i-4}, f_{k+n+s+2i-2}\} = 1, 1 \le i \le \frac{m-2}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+m-4}, f_{k+n+s+m-3}\} = 1, i = \frac{m}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+s+2m-2i-1}, f_{k+n+s+2m-2i-3}\} = 1, \frac{m+2}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+s-1}, f_{k+n+s-2}\} = 1$

Thus $g^*(xy) = \gcd\{f(x),f(y)\} = 1, \forall \ xy \in E(G)$.

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Therefore, the graph G is obtained by joining two cycles C_n and C_m by a path P_s is a k^{th} Fibonacci prime graph $n,m \geq 3$, $k,s \geq 2$.

Illustration 2.1

The graph G is obtained by joining two cycles C_6 and C_7 by a path P_7 and its 3^{rd} Fibonacci prime labeling are shown in figure 2.1.

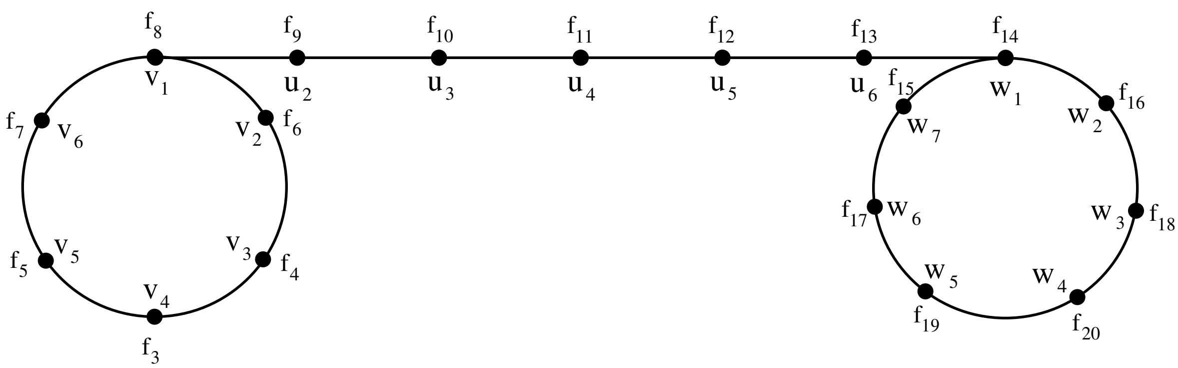

Figure 2.1 Graph G is obtained by joining two cycles C_6 and C_7 by a path P_7 is 3^{rd} Fibonacci prime graph

Theorem 2.2

The graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s is a k^{th} Fibonacci prime graph $n,m \geq 3$, $k,s \geq 2$.

Proof.

The graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s.

Let $v_1,v_2,\ldots,v_n$ be the vertices of the cycle C_n, $w_1,w_2,\ldots,w_m$ be the vertices of the cycle C_m and $x_1,x_2,\ldots,x_s,y_1,y_2,\ldots, y_{s-1}$ be the vertices of the triangular snake T_s with $x_1 = v_1$ and $x_s = w_1$.

The edge set $E(G) = \{v_iv_{i+1} \mid 1 \leq i \leq n-1\} \cup \{v_nv_1\} \cup \{v_1x_2\} \cup \{v_1y_1\} \cup \{x_ix_{i+1} \mid 2 \leq i \leq s-2\} \cup \{x_iy_i \mid 2 \leq i \leq s-1\} \cup \{y_ix_{i+1} \mid 1 \leq i \leq s-2\} \cup \{x_{s-1} w_1\} \cup \{y_{s-1} w_1\} \cup \{w_iw_{i+1} \mid 1 \leq i \leq m-1\} \cup \{w_mw_1\}$.

Then $|V(G)| = n+2s+m-3$ and $|E(G)| = n+3s+m-3$.

Define the mapping $g : V(G) \rightarrow \{ f_k,f_{k+1},\ldots, f_{k+n+2s+m-4}\}$ as follows

Case 1 : n is odd.

$g(v_i) = f_{k+n-2i+1}$, for $1 \leq i \leq \frac{n+1}{2}$

$g(v_i) = f_{k-n+2i-2}$, for $\frac{n+3}{2} \leq i \leq n$

$g(x_i) = f_{k+n+2i-3}$, for $2 \leq i \leq s-1$

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$g(y_i) = f_{k+n+2i-2}$, for $1 \le i \le s-1$

Case 1(a) : m is odd.

$g(w_i) = f_{k+n+2s+2i-5}$, for $1 \le i \le \frac{m+1}{2}$

$g(w_i) = f_{k+n+2s+2m-2i-2}$, for $\frac{m+3}{2} \le i \le m$

Case 1(b) : m is even.

$g(w_i) = f_{k+n+2s+2i-5}$, for $1 \le i \le \frac{m}{2}$

$g(w_i) = f_{k+n+2s+2m-2i-2}$, for $\frac{m+2}{2} \le i \le m$

Then the induced function $g^* : E(G) \to N$ is defined by

$$g^*(xy) = \gcd\{g(x),g(y)\}\ \forall\ xy \in E(G).$$

Now,

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+n-2i+1}, f_{k+n-2i-1}\} = 1,\ 1 \le i \le \frac{n-1}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_k, f_{k+1}\} = 1,\ i = \frac{n+1}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k-n+2i-2}, f_{k-n+2i}\} = 1,\ \frac{n+3}{2} \le i \le n-1$

$\gcd\{g(v_n),g(v_1)\} = \gcd\{f_{k+n-2}, f_{k+n-1}\} = 1$

$\gcd\{g(v_1),g(x_2)\} = \gcd\{f_{k+n-1}, f_{k+n+1}\} = 1$

$\gcd\{g(v_1),g(y_1)\} = \gcd\{f_{k+n-1}, f_{k+n}\} = 1$

$\gcd\{g(x_i),g(x_{i+1})\} = \gcd\{f_{k+n+2i-3}, f_{k+n+2i-1}\} = 1,\ 2 \le i \le s-1$

$\gcd\{g(x_i),g(y_i)\} = \gcd\{f_{k+n+2i-3}, f_{k+n+2i-2}\} = 1,\ 2 \le i \le s-1$

$\gcd\{g(y_i),g(x_{i+1})\} = \gcd\{ f_{k+n+2i-2}, f_{k+n+2i-1}\} = 1,\ 1 \le i \le s-1$

$\gcd\{g(x_{s-1}),g(w_1)\} = \gcd\{f_{k+n+s-4}, f_{k+n+2s-3}\} = 1$

$\gcd\{g(y_{s-1}),g(w_1)\} = \gcd\{f_{k+n+s-5}, f_{k+n+2s-3}\} = 1$

when m is odd

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2i-5}, f_{k+n+2s+2i-3}\} = 1,\ 1 \le i \le \frac{m-1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+m-4}, f_{k+n+2s+m-5}\} = 1,\ i = \frac{m+1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2m-2i-2}, f_{k+n+2s+2m-2i-4}\} = 1,\ \frac{m+3}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+2s-2}, f_{k+n+2s-3}\} = 1$

when m is even

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2i-5}, f_{k+n+2s+2i-3}\} = 1,\ 1 \le i \le \frac{m-2}{2}$

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$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+m-5}, f_{k+n+2s+m-4}\} = 1, i = \frac{m}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2m-2i-2}, f_{k+n+2s+2m-2i-4}\} = 1, \frac{m+2}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+2s-2}, f_{k+n+2s-3}\} = 1$

Thus $g^*(xy) = \gcd\{f(x),f(y)\} = 1, \forall\ xy \in E(G)$.

Case 2 : n is even.

$g(v_i) = f_{k+n-2i+1}$, for $1 \le i \le \frac{n}{2}$

$g(v_i) = f_{k-n+2i-2}$, for $\frac{n+2}{2} \le i \le n$

$g(x_i) = f_{k+n+2i-3}$, for $2 \le i \le s-1$

$g(y_i) = f_{k+n+2i-2}$, for $1 \le i \le s-1$

Case 2(a) : m is odd.

$g(w_i) = f_{k+n+2s+2i-5}$, for $1 \le i \le \frac{m+1}{2}$

$g(w_i) = f_{k+n+2s+2m-2i-2}$, for $\frac{m+3}{2} \le i \le m$

Case 2(b) : m is even.

$g(w_i) = f_{k+n+2s+2i-5}$, for $1 \le i \le \frac{m}{2}$

$g(w_i) = f_{k+n+2s+2m-2i-2}$, for $\frac{m+2}{2} \le i \le m$

Then the induced function $g^* : E(G) \to N$ is defined by

$$g^*(xy) = \gcd\{g(x),g(y)\}\ \forall\ xy \in E(G).$$

Now,

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+n-2i+1}, f_{k+n-2i-1}\} = 1, 1 \le i \le \frac{n-2}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k+1}, f_k\} = 1, i = \frac{n}{2}$

$\gcd\{g(v_i),g(v_{i+1})\} = \gcd\{f_{k-n+2i-2}, f_{k-n+2i}\} = 1, \frac{n+2}{2} \le i \le n-1$

$\gcd\{g(v_n),g(v_1)\} = \gcd\{f_{k+n-2}, f_{k+n-1}\} = 1$

$\gcd\{g(v_1),g(x_2)\} = \gcd\{f_{k+n-1}, f_{k+n+1}\} = 1$

$\gcd\{g(v_1),g(y_1)\} = \gcd\{f_{k+n-1}, f_{k+n}\} = 1$

$\gcd\{g(x_i),g(x_{i+1})\} = \gcd\{f_{k+n+2i-3}, f_{k+n+2i-1}\} = 1, 2 \le i \le s-1$

$\gcd\{g(x_i),g(y_i)\} = \gcd\{ f_{k+n+2i-3}, f_{k+n+2i-2}\} = 1, 2 \le i \le s-1$

$\gcd\{g(y_i),g(x_{i+1})\} = \gcd\{f_{k+n+2i-2}, f_{k+n+2i-1}\} = 1, 1 \le i \le s-1$

$\gcd\{g(x_{s-1}),g(w_1)\} = \gcd\{f_{k+n+s-4}, f_{k+n+2s-3}\} = 1$

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$\gcd\{g(y_{s-1}),g(w_1)\} = \gcd\{f_{k+n+s-5}, f_{k+n+2s-3}\} = 1$

when m is odd

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2i-5}, f_{k+n+2s+2i-3}\} = 1,\ 1 \le i \le \frac{m-1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+m-4}, f_{k+n+2s+m-5}\} = 1,\ i = \frac{m+1}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2m-2i-2}, f_{k+n+2s+2m-2i-4}\} = 1,\ \frac{m+3}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+2s-2}, f_{k+n+2s-3}\} = 1$

when m is even

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2i-5}, f_{k+n+2s+2i-3}\} = 1,\ 1 \le i \le \frac{m-2}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+m-5}, f_{k+n+2s+m-4}\} = 1,\ i = \frac{m}{2}$

$\gcd\{g(w_i),g(w_{i+1})\} = \gcd\{f_{k+n+2s+2m-2i-2}, f_{k+n+2s+2m-2i-4}\} = 1,\ \frac{m+2}{2} \le i \le m-1$

$\gcd\{g(w_n),g(w_1)\} = \gcd\{f_{k+n+2s-2}, f_{k+n+2s-3}\} = 1$

Thus $g^*(xy) = \gcd\{f(x),f(y)\} = 1,\ \forall\ xy \in E(G)$.

Therefore, the graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s is a k^{th} Fibonacci prime graph $n,m \ge 3$, $k,s \ge 2$.

Illustration 2.2

The graph G is obtained by joining two cycles C_7 and C_6 by a triangular snake T_5 and its 5^{th} Fibonacci prime labeling are shown in figure 2.2.

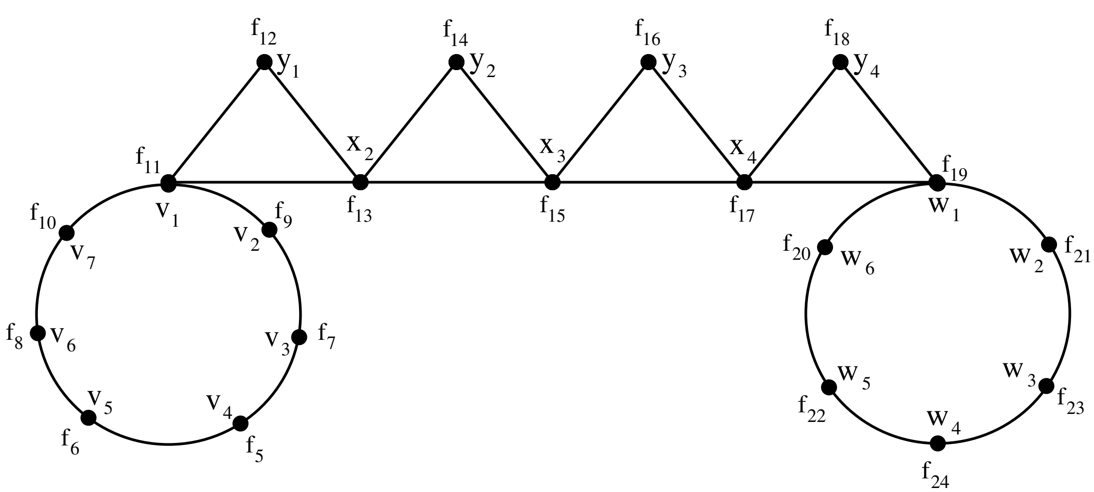

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Figure 2.2 Graph G is obtained by joining two cycles C_7 and C_6 by a triangular snake T_5 is 5^{th} Fibonacci prime graph

3. CONCLUSION

In this paper, the k^{th} Fibonacci prime labeling of a graph G is obtained by joining two cycles C_n and C_m by a path P_s and a graph G is obtained by joining two cycles C_n and C_m by a triangular snake T_s are presented.

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