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Path Related Homo-Cordial Graphs

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Abstract – Let G = (V,E) be a graph with p vertices and q edges. A Homo-Cordial Labeling of a Graph G with vertex set V is a bijection from V to {0, 1} such that each edge uv is assigned the label1if f (u) =f (v) or 0 if f (u) ≠ f (v) with the condition that the number of vertices labeled with 0 and the number of vertices labeled with 1 differ by atmost 1 and the number of edges labeled with 0 and the number of edges labeled with 1 differ by atmost 1. The graph that admits a Homo-Cordial Labeling (HoCL) is called Homo-Cordial Graph (HoCG). In this paper, we proved that path related graphs Path P_n, Comp $P_nʘK_1$, Fan P_n+K_1, Doublefan P_n+2K_1, Ladder P_n X K_2 are Homo-Cordial Graphs.

Keywords–Fan, Comp, Doublefan, Ladder, Homo-Cordial Graph, Homo-Cordial Labeling.

2000 Mathematics Subject classification 05C78.

I.INTRODUCTION

A graph G is a finite nonempty set of objects called vertices together with a set of unordered pairs of distinct vertices of G which is called edges. Each pair e= {uv} of vertices in E is called edges or a line of G. In this paper, we proved that path related graphs Path P_n, Comp $P_nʘK_1$, Fan P_n+K_1, Doublefan P_n+2K_1, Ladder P_n X K_2 are Homo-Cordial Graphs. For graph theory terminology, we follow [2].

II.PRELIMINARIES

Let G = (V,E) be a graph with p vertices and q edges. A Homo-Cordial Labeling of a Graph G with vertex set V is a bijection from V to {0, 1} such that each edge uv is assigned the label 1if f (u) =f (v) or 0 if f (u) ≠ f (v) with the condition that the number of vertices labeled with 0 and the number of vertices labeled with 1 differ by atmost 1 and the number of edges labeled with 0 and the number of edges labeled with 1 differ by atmost 1.

The graph that admits a Homo-Cordial Labeling (HoCL) is called Homo-Cordial Graph (HoCG). In this paper, we proved that path related graphs Path P_n, Comp $P_nʘK_1$, Fan P_n+K_1, Doublefan P_n+2K_1, Ladder P_n X K_2 are Homo-Cordial Graphs.

Definition:2.1

P_n is a path of length n-1.

Definition:2.2

The join of G_1 and G_2 is the graph $G=G_1+G_2$ with vertex set $V=V_1 \cup V_2$ and edge set $E=E_1 \cup E_2 \cup \{UV: u \in V_1, v \in V_2\}$. The graph P_n+K_1 is called a Fan and P_n $+2K_1$ is called the Doublefan.

Definition:2.3

The product G_1 x G_2 of two graphs G_1 and G_2 is defined to be the graph whose vertex set is V_1 X V_2 and two vertices $u=(u_1, u_2)$ and $v=(v_1 ,v_2)$ in $V=V_1$ X V_2 are adjacent in G_1 X G_2 if either $u_1=v_1$ and u_2 is adjacent to v_2 or $u_2=v_2$ and u_1 is adjacent to v_1.P_n X K_2 is called a ladder.

Definition:2.4

The corona $G_1ʘG_2$ of two graphs G_1 and G_2 is defined as the graph G obtained by taking one copy of G_1 (which has P_1 points) and P_1 copies of G_2 and joining the i^{th} point of G_1 to every point in the i^{th} copy of G_2. The graph $P_nʘK_1$ is called a comb.

III.MAIN RESULTS

Theorem: 3.1

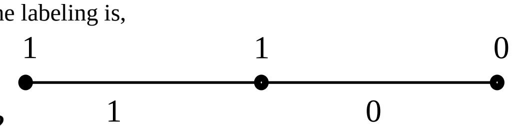
Path P_n (n-odd) is Homo-Cordial Graph.

Proof:

Let V (P_n) = $\{[u_i: 1 \le i \le n]\}$ and
E (P_n) = $\{[(u_iu_{i+1}): 1 \le i \le n-1]\}$.
Define f: $V(P_n) \to \{0, 1\}$.

Case: 1

When n=3,
The labeling is,



Case: 2

When n>3,
The vertex labeling are,

$$f(u_i) = \begin{cases} 0 & i \equiv 0,3 \bmod 4 \\ 1 & i \equiv 1,2 \bmod 4 \end{cases} \quad 1 \le i \le n$$

The induced edge labeling are,

$$f^*[(u_iu_{i+1})] = \begin{cases} 0 & i \equiv 0 \bmod 2 \\ 1 & i \equiv 1 \bmod 2 \end{cases} \quad 1 \le i \le n-1$$

Here, $v_f(1) = v_f(0)+1$ for all n and

$e_f(1) = e_f(0)$ for all n.

Therefore, Path P_n satisfies the conditions $|v_f(0)-v_f(1)| \le 1$ and $|e_f(0)-e_f(1)| \le 1$.

Hence, Path P_n (n-odd) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_5 is shown in figure 3.2

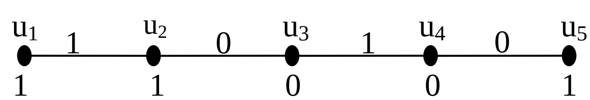


Figure 3.2:P_5

Theorem: 3.3

Path P_n (n-even) is Homo-Cordial Graph.

Proof:

Let V (P_n) = $\{[u_i: 1 \le i \le n]\}$ and
E (P_n) = $\{[(u_iu_{i+1}): 1 \le i \le n-1]\}$.
Define f: V $(P_n) \to \{0, 1\}$.

Case: 1

When n=2,
The labeling is,

Case: 2

When n>2,

The vertex labeling are ,

$$f(u_i) = \begin{cases} 0 & i \equiv 0,1 \bmod 4 \\ 1 & i \equiv 2,3 \bmod 4 \end{cases} \quad 1 \le i \le n$$

The induced edge labeling are,

$$f^*[(u_i u_{i+1})] = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \quad 1 \le i \le n-1$$

Here, $v_f(0) = v_f(1)$ for all n and

$e_f(0) = e_f(1) + 1$ for all n.

Therefore, Path P_n satisfies the conditions $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$.

Hence, Path P_n (n-even) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_6 is shown figure 3.4

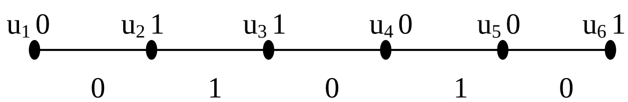


Figure 3.4:P_6

Theorem: 3.5

Comp $P_n \Theta K_1$ is Homo-Cordial Graph.

Proof:

Let $V(P_n \Theta K_1) = \{[u_i, v_i : 1 \le i \le n]\}$ and

$E(P_n \Theta K_1) = \{[(u_i u_{i+1}) : 1 \le i \le n-1] \cup [(u_i v_i) : 1 \le i \le n]\}$.

Define $f: V(P_n \Theta K_1) \rightarrow \{0, 1\}$.

The vertex labeling are ,

$f(u_i) = 0 \quad 1 \le i \le n$

$f(v_i) = 1 \quad 1 \le i \le n$

The induced edge labeling are,

$f^*[(u_i u_{i+1})] = 1 \quad 1 \le i \le n-1$

$f^*[(u_i v_i)] = 0 \quad 1 \le i \le n$

Here, $v_f(0) = v_f(1)$ for all n and

$e_f(0) = e_f(1) + 1$ for all n.

Therefore, Comp $P_n \Theta K_1$ satisfies the conditions $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$.

Hence, Comp $P_n \Theta K_1$ is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of $P_4 \Theta K_1$ and $P_3 \Theta K_1$ is shown in figure 3.6 and figure 3.7 respectively.

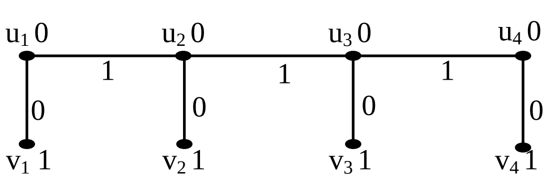


Figure 3.6: $P_4 \Theta K_1$

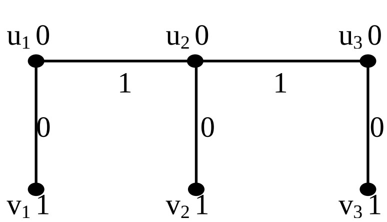


Figure 3.7:$P_3 \Theta K_1$

Theorem: 3.8

Fan $P_n + K_1$ (n-odd) is Homo-Cordial Graph.

Proof:

Let $V(P_n + K_1) = \{[u, u_i : 1 \le i \le n]\}$ and

$E(P_n + K_1) = \{[(uu_i) : 1 \le i \le n] \cup [(u_i u_{i+1}) : 1 \le i \le n-1]\}$.

Define $f: V(P_n + K_1) \rightarrow \{0, 1\}$.

The vertex labeling are ,

$f(u) = 0$

$$f(u_i) = \begin{cases} 0 & i \equiv 0,3 \bmod 4 \\ 1 & i \equiv 1,2 \bmod 4 \end{cases} \quad 1 \le i \le n$$

The induced edge labeling are,

$$f^*[(uu_i)] = \begin{cases} 0 & i \equiv 1,2 \bmod 4 \\ 1 & i \equiv 0,3 \bmod 4 \end{cases} \quad 1 \le i \le n$$

$$f^*[(u_i u_{i+1})] = \begin{cases} 0 & i \equiv 0 \bmod 2 \\ 1 & i \equiv 1 \bmod 2 \end{cases} \quad 1 \le i \le n-1$$

Here, $v_f(1) = v_f(0)$ for all n and

$e_f(0) = e_f(1) + 1$ for all n.

Therefore, Fan $P_n + K_1$(n-odd) satisfies the conditions $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$.

Hence, Fan $P_n + K_1$ (n-odd) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of $P_5 + K_1$ is shown in figure 3.9

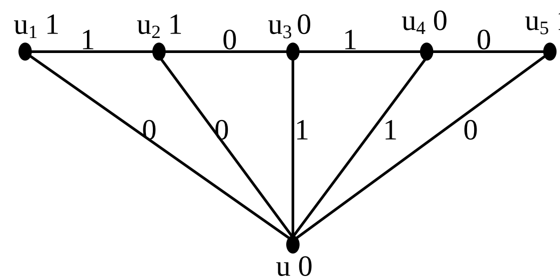


Figure 3.9:$P_5 + K_1$

Theorem: 3.10

Fan $P_n + K_1$ (n-even) is Homo-Cordial Graph.

Proof:

Let $V(P_n + K_1) = \{[u, u_i : 1 \le i \le n]\}$ and

$E(P_n + K_1) = \{[(uu_i) : 1 \le i \le n] \cup [(u_i u_{i+1}) : 1 \le i \le n-1]\}$.

Define $f: V(P_n + K_1) \rightarrow \{0, 1\}$.

The vertex labeling are ,

$f(u) = 1$

$$f(u_i) = \begin{cases} 0 & i \equiv 0,1 \bmod 4 \\ 1 & i \equiv 2,3 \bmod 4 \end{cases} \quad 1 \le i \le n$$

The induced edge labeling are,

$$f^*[(uu_i)] = \begin{cases} 0 & i \equiv 0,1 \bmod 4 \\ 1 & i \equiv 2,3 \bmod 4 \end{cases} \quad 1 \le i \le n$$

$$f^*[(u_i u_{i+1})] = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \quad 1 \le i \le n-1$$

Here, $v_f(1) = v_f(0) + 1$ for all n and

$e_f(0) = e_f(1) + 1$ for all n.

Therefore, Fan $P_n + K_1$:(n-even) satisfies the conditions $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$.

Hence, Fan $P_n + K_1$:(n-even) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_6+K_1 is shown figure 3.11

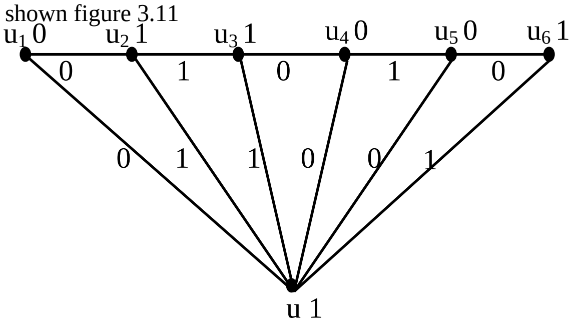


Figure 3.11: P_6+K_1

Theorem: 3.12

Ladder P_n X K_2 (n-odd) is Homo-Cordial Graph.

Proof:

Let V (P_n X K_2) = {[u_i, v_i :1≤i≤n]} and

E (P_n X K_2) = {[(u_iu_{i+1}) U (v_iv_{i+1}): 1≤i≤n-1] U [(u_iv_i):1≤i≤n}.

Define f: V (P_n X K_2) → {0, 1}.

Case 1:

When n≡1 (mod 4),

The vertex labeling are,

$f(u_i) = 0 \qquad 1 \le i \le \frac{n+1}{2}$

$f(u_i) = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \qquad \frac{n+3}{2} \le i \le n$

$f(v_i) = \begin{cases} 0 & i \equiv 0 \bmod 2 \\ 1 & i \equiv 1 \bmod 2 \end{cases} \qquad 1 \le i \le \frac{n-1}{2}$

$f(v_i) = 1 \qquad \frac{n+1}{2} \le i \le n$

The induced edge labeling are,

$f^*[(u_iu_{i+1})] = 1 \qquad 1 \le i \le \frac{n-1}{2}$

$f^*[(u_iu_{i+1})] = 0 \qquad \frac{n+1}{2} \le i \le n-1$

$f^*[(v_iv_{i+1})] = 0 \qquad 1 \le i \le \frac{n-1}{2}$

$f^*[(v_iv_{i+1})] = 1 \qquad \frac{n+1}{2} \le i \le n-1$

$f^*[(u_iv_i)] = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \qquad 1 \le i \le n$

Here, $v_f(0) = v_f(1)$ for all n and

$e_f(0) = e_f(1) + 1$ for all n.

Case 2:

When n≡3 (mod 4)

The vertex labeling are,

$f(u_i) = 0 \quad 1 \le i \le \frac{n+1}{2}$

$f(u_i) = \begin{cases} 0 & i \equiv 0 \bmod 2 \\ 1 & i \equiv 1 \bmod 2 \end{cases} \qquad \frac{n+3}{2} \le i \le n$

$f(v_i) = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \qquad 1 \le i \le \frac{n-1}{2}$

$f(v_i) = 1 \qquad \frac{n+1}{2} \le i \le n$

The induced edge labeling are,

$f^*[(u_iu_{i+1})] = 1 \qquad 1 \le i \le \frac{n-1}{2}$

$f^*[(u_iu_{i+1})] = 0 \qquad \frac{n+1}{2} \le i \le n-1$

$f^*[(v_iv_{i+1})] = 0 \qquad 1 \le i \le \frac{n-1}{2}$

$f^*[(v_iv_{i+1})] = 1 \qquad \frac{n+1}{2} \le i \le n-1$

$f^*[(u_iv_i)] = \begin{cases} 0 & i \equiv 0 \bmod 2 \\ 1 & i \equiv 1 \bmod 2 \end{cases} \qquad 1 \le i \le n$

Here, $v_f(0) = v_f(1)$ for all n and

$e_f(1) = e_f(0) + 1$ for all n.

Therefore, P_n X K_2(n-odd) satisfies the conditions $|v_f(0)-v_f(1)| \le 1$ and $|e_f(0)-e_f(1)| \le 1$.

Hence, Ladder P_n X K_2(n-odd) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_3 X K_2 and P_5 X K_1 are shown in figure 3.13 and figure 3.14 respectively.

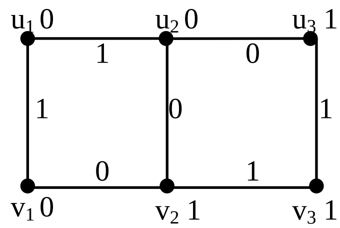


Figure 3.13: P_3 X K_2

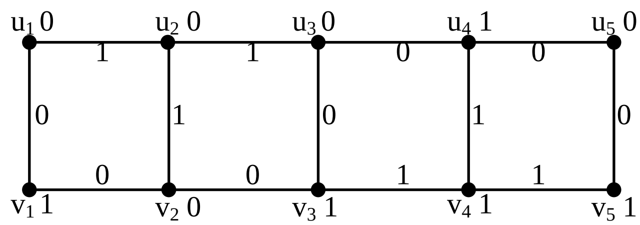


Figure 3.14: P_5 X K_2

Theorem: 3.15

Ladder P_n X K_2 (n-even) is Homo-Cordial Graph.

Proof:

Let V (P_n X K_2) = {[u_i, v_i :1≤i≤n]} and

E (P_n X K_2) = {[(u_iu_{i+1})U(v_iv_{i+1}): 1≤i≤n-1]U[(u_iv_i):1≤i≤n}.

Define f: V (P_n X K_2) → {0, 1}.

The vertex labeling are,

$f(u_i) = \begin{cases} 0 & i \equiv 3 \quad \bmod 4 \\ 1 & i \equiv 0,1,2 \bmod 4 \end{cases} \qquad 1 \le i \le n$

$f(v_i) = \begin{cases} 0 & i \equiv 1,2,3 \bmod 4 \\ 1 & i \equiv 0 \quad \bmod 4 \end{cases} \qquad 1 \le i \le n$

The induced edge labeling are,

$f^*[(u_iu_{i+1})] = \begin{cases} 0 & i \equiv 2,3 \bmod 4 \\ 1 & i \equiv 0,1 \bmod 4 \end{cases} \qquad 1 \le i \le n-1$

$f^*[(v_iv_{i+1})] = \begin{cases} 0 & i \equiv 0,3 \bmod 4 \\ 1 & i \equiv 1,2 \bmod 4 \end{cases} \qquad 1 \le i \le n-1$

$f^*[(u_iv_i)] = \begin{cases} 0 & i \equiv 1,2 \bmod 4 \\ 1 & i \equiv 0,3 \bmod 4 \end{cases} \qquad 1 \le i \le n$

Here, $v_f(0) = v_f(1)$ for all n and

$e_f(0) = e_f(1)$ for all n.

Therefore, P_n X K_2(n-even) satisfies the conditions $|v_f(0)-v_f(1)| \le 1$ and $|e_f(0)-e_f(1)| \le 1$.

Hence, Ladder P_n X K_2(n-even) is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_4 X K_2 is shown in figure 3.16

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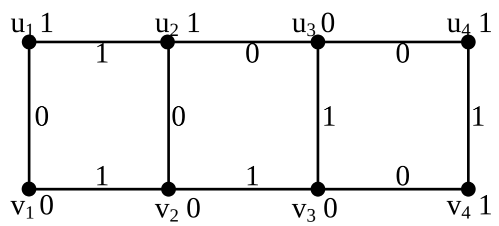
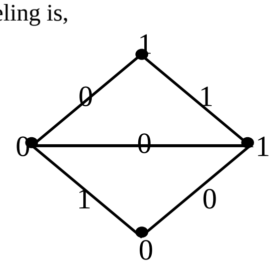
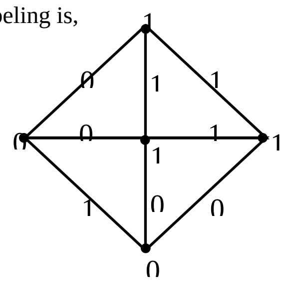


Figure 3.16: $P_4 X K_2$

Theorem: 3.17
Doublefan P_n+2K_1 is Homo-Cordial Graph.
Proof:
Case: 1
When n=2,
The labeling is,



Case: 2
When n=3,
The labeling is,



Case: 3
When n>3,
Let $V(P_n+2K_1) = \{[u, v, u_i: 1 \leq i \leq n]\}$ and
$E(P_n+2K_1) = \{[(uu_i) \cup (vu_i): 1 \leq i \leq n] \cup [(u_i u_{i+1}): 1 \leq i \leq n-1]\}$.
Define $f: V(P_n+2K_1) \rightarrow \{0, 1\}$.
The vertex labeling are,

$$f(u_i) = \begin{cases} 0 & i \equiv 0,1 \bmod 4 \\ 1 & i \equiv 2,3 \bmod 4 \end{cases} \quad 1 \leq i \leq n$$

$f(u) = 1$

$f(v) = 0$

The induced edge labeling are,

$$f^*[(u_i u_{i+1})] = \begin{cases} 0 & i \equiv 1 \bmod 2 \\ 1 & i \equiv 0 \bmod 2 \end{cases} \quad 1 \leq i \leq n-1$$

$$f^*[(uu_i)] = \begin{cases} 0 & i \equiv 0,1 \bmod 4 \\ 1 & i \equiv 2,3 \bmod 4 \end{cases} \quad 1 \leq i \leq n$$

$$f^*[(vu_i)] = \begin{cases} 0 & i \equiv 2,3 \bmod 4 \\ 1 & i \equiv 0,1 \bmod 4 \end{cases} \quad 1 \leq i \leq n$$

Here, $v_f(0) = v_f(1)$ for $n \equiv 0, 2 \bmod 4$,
$v_f(1) = v_f(0) + 1$ for $n \equiv 3 \bmod 4$,
$v_f(0) = v_f(1) + 1$ for $n \equiv 1 \bmod 4$,
$e_f(0) = e_f(1) + 1$ for $n \equiv 0, 2 \bmod 4$ and
$e_f(0) = e_f(1)$ for $n \equiv 1, 3 \bmod 4$.

Therefore, Doublefan P_n+2K_1 satisfies the conditions $|v_f(0)-v_f(1)| \leq 1$ and $|e_f(0)-e_f(1)| \leq 1$.

Hence, Doublefan P_n+2K_1 is Homo-Cordial Graph.

For example, the Homo-Cordial Labeling of P_4+2K_1 and P_5+2K_1 are shown in figure 3.17 and figure 3.18 respectively.

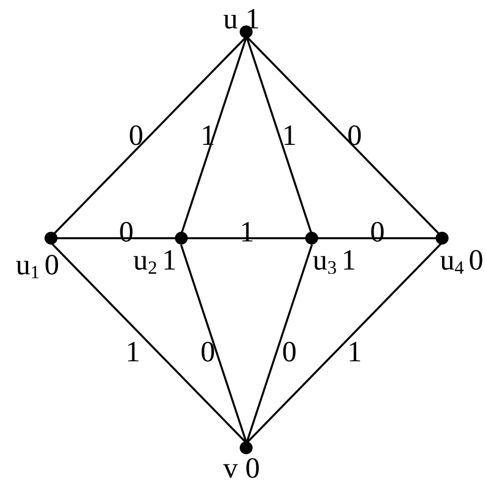


Figure 3.18:

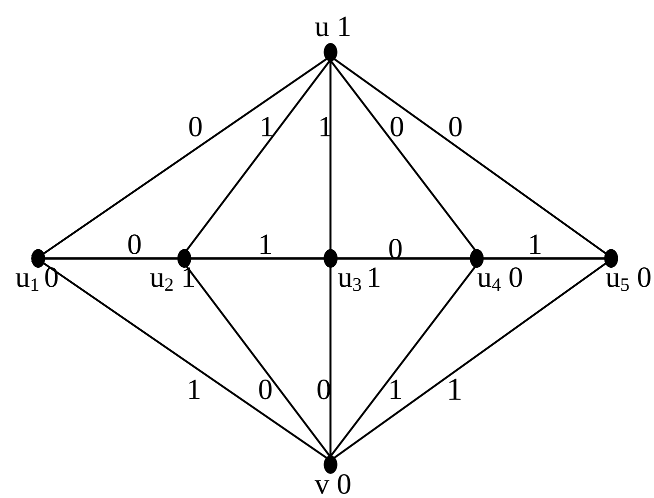


Figure 3.19: P_5+2K_1

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