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Edge Vertex Prime Labeling of Union of Graphs

M. Simaringa[1], S. Muthukumaran[2]

[1] Department of Mathematics, Thiru Kolanjiappar Govt. Arts College, Virudhachalam, Tamilnadu, India
[2] Department of Mathematics, Siga College of Management and Computer science, Villupuram, Tamilnadu, India

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Abstract

A graph $G(p,q)$ is said to be an *edge vertex prime labeling* if its vertices and edges are labeled with distinct positive numbers not exceeding $p+q$ such that for any edge $e=xy, f(x), f(y)$ and $f(xy)$ are pairwise relatively prime. A graph which admits an edge vertex prime labeling is called an *edge vertex prime graph*. We prove that some class of union of graphs such as $p+q$ is even for $G\cup K_{1,n}, G\cup P_n$ and $C_m\cup K_{1,n}, C_m\cup P_n, C_n\cup C_n$ when $n\equiv 0,2(mod\ 3), K_{2,m}\cup C_n$ and one point union of wheel and cycle related graphs are edge vertex prime.

Keywords: *edge vertex prime labeling, relatively prime, star, path, cycle, one point union of graphs*

I. INTRODUCTION

Consider only finite, simple and undirected graphs. A graph G is an ordered pair $G=(V,E)$, where $V(G)$ stands for a finite set of elements called vertices, while $E(G)$ is a finite set of unordered pairs of vertices called edges. The cardinality of the sets of vertices $V(G)$ and edges $E(G)$ is denoted by $|V(G)|$ and $|E(G)|$ respectively. For all standard notation and terminology in graph theory, we follow Balakrishnan and Ranganathan [1]. A graph of order n is *prime* if one can bijectively label its vertices with positive numbers $1,2,3,\dots,n$, so that any two adjacent vertices are relatively prime. Prime labeling is a kind of graph labeling which was first introduced by Tout, Dobboucy, Howalla [10] and later developed by Roger Entriger. There are several types of labeling for a dynamic survey of various graph labeling problems with extensive bibliography we refer to Gallian [2]. Let $G_1=(V_1,E_1)$ and $G_2=(V_2,E_2)$ be two simple graphs. The graph $G=\big(V(G),\ E(G)\big)$, where $V=V_1\cup V_2$ and $E=E_1\cup E_2$, is called the *union of* G_1 *and* G_2 is denoted by $G_1\cup G_2$. For $n\geq 2$, an $n-$*path* or simply *path* is denoted P_n, is a connected graph consisting of two vertices, with degree 1 and $n-2$ vertices of degree 2. For $n\geq 3$, an n-*Cycle* or Simply *cycle*, denoted C_n, is a connected graphconsisting of n vertices, each of degree 2. Note that both P_n and C_n have n vertices while P_n has $n-1$ edges and C_n has n edges. An $n-star$ or simply *star*, denoted S_n, is a graph consisting of one vertex of degree n, called the *centre* and n vertices of degree 1. Note that S_n consists of $n+1$ vertices and n edges. The graph W_n^m obtained from m copies of W_n by identifying their center. Prime labeling is a variant of an edge vertex prime labeling. We begin with definition of an edge vertex prime labeling. A bijective function $f: V(G)\cup E(G)\to\{1,2,3,\dots,|V(G)\cup E(G)|\}$ is an edge *vertex prime labeling* if for any edge $uv\in E(G)$, we have $gcd\big(f(u),f(v)\big)=gcd\big(f(u),f(uv)\big)=gcd\big(f(v),f(uv)\big)=1$. A graph G which admits an edge vertex prime labeling is called an *edge vertex prime graph*. The concept of an edge vertex prime labeling has been originated by Jagadesh and BaskarBabujee [3] and they proved the existence of the same paths, cycles and star $K_{1,n}$. In [4], they also proved that an edge vertex prime graph for some

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class of graphs such as generalized star, generalized cycle star, $p+q$ is even for $G\hat{O}K_{1,n}, G\hat{O}P_n, G\hat{O}C_n$. Parmer [5] investigated an edge vertex prime graph of wheel graph, fan graph, friendship graph. Also, they have [6] further determined that $K_{2,n}$, for every n and $K_{3,n}$ for $n=\{3,4,\dots,29\}$ are an edge vertex prime graph.

In [7], we proved that triangular and rectangular book, butterfly graph with shell, Drums D_n, Jahangir $J_{n,3}$, and $J_{n,4}$ are an edge vertex prime graphs. Also in [8], we determined that double star $B_{m,n}$, subdivision of $B_{m,n}$ and $K_{1,n}$, comb graph, spider, H-graph of path P_n and coconut tree are an edge vertex prime graph. We [9] have obtained some class of graphs such as $p+q$ is odd for $G\hat{O}W_n$, $G\hat{O}f_n$, $G\hat{O}F_n$, $p+q$ is even for $G\hat{O}P_n$, $C_l\hat{O}K_{1,m}\hat{O}P_n$, Umbrella graph $U(m,n)$, crown graph, union of cycles for $C_n \cup C_n \cup C_n n \equiv 0(mod\ 3)$, $C_n \cup C_n \cup C_n \cup \dots \cup C_n$, $n \equiv 0(mod\ 5)$ are an edge vertex prime graph.

In section 2, we investigate union of some graphs $p+q$ is even for $G\cup K_{1,n}, G\cup P_n$, and $C_m \cup K_{1,n}, C_m \cup P_n, C_n \cup C_n$ when $n \equiv 0,2(mod\ 3)$, $K_{2,m}\cup C_n$

$when$ m is even, $n \equiv 0(mod\ 3)$ and m is odd $n \equiv 0,1(mod\ 3)$ are an edge vertex prime.

In section 3, we prove that one point union of graphs such as W_n^m, n is even and $n=3,5,7,9$ and cycle C_n^m, $n=3,4,5,6,7,9,11$ are an edge vertex prime.

II. UNION OF GRAPHS

In this section, we now give some union of graphs are edge vertex prime.

Theorem 2.1. If $G(p,q)$ has an edge vertex prime graph with $p+q$ is even, then there exists a graph from the class $G\cup K_{1,n}, n \geq 1$ that admits an edge vertex prime graph.

Proof. Let $G(p,q)$ be an edge vertex prime graph when $p+q$ is even, with bijective function $f: V(G)\cup E(G) \to \{1,2,\dots,p+q\}$ with property that given any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Consider the graph $K_{1,n}$ with vertex set $\{u, v_i: 1 \leq i \leq n\}$ and edge set $\{uv_i: 1 \leq i \leq n\}$. We define a new graph $G_1 = G\cup K_{1,n}$ with vertex set $V_1 = V(G)\cup\{u, v_i: 1 \leq i \leq n\}$ and edge set $E_1 = E\cup\{uv_i: 1 \leq i \leq n\}$. Define a bijective function $g: V_1 \cup E_1 \to \{1,2,3,\dots,p+q,p+q+1,\dots,p+q+2n+1\}$ by $g(v)=f(v)$, for all $v \in V(G)$ and $g(uv)=f(uv)$ for all $uv \in E(G), g(u)=p$, where p is choose the largest prime number in the set $\{p+q+1, p+q+2,\dots,p+q+2n+1\}$ and label the edge set $\{uv_i: 1 \leq i \leq n\}$ by remaining even labels and label the vertex set $\{v_i: 1 \leq i \leq n\}$ by the remaining odd labels. To show that G_1 is an edge vertex prime graph. Already, G is an edge vertex prime graph, it is enough to prove that for any edge $uv \in E_1$, which is not in G, the numbers $g(u), g(v)$ and $g(uv)$ are pairwise relatively prime. It is easily verified that, for any edge $uv \in E_1, gcd\big(g(u), g(v)\big)=1$, $gcd\big(g(u), g(uv)\big)=1$, $gcd\big(g(v), g(uv)\big)=1$. Hence $G_1 = G\cup K_{1,n}, n \geq 1$ is an edge vertex prime graph.

Theorem 2.2. If $G(p,q)$ has an edge vertex prime graph with $p+q$ is even, then there exists a graph from the class $G\cup P_n$ that admits an edge vertex prime graph.

Proof. Let $G(p,q)$ be an edge vertex prime labeling graph when $p+q$ is even, with bijective function $f: V(G)\cup E(G) \to \{1,\ 2,\dots,p+q\}$ with property that given any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Consider the graph P_n with vertex set $\{u_i: 1 \leq i \leq n\}$ and edge set $\{u_iu_{i+1}: 1 \leq i \leq n-1\}$. We define a new graph $G_1 = G\cup P_n$ with vertex set $V_1 = V\cup\{u_i: 1 \leq i \leq n\}$ and $E_1 = E\cup\{u_iu_{i+1}: 1 \leq i \leq n-1\}$. Define a bijective function $g: V_1\cup E_1 \to \{1,2,3,\dots,p+q,p+q+1,\dots,p+q+2n-1\}$ by $g(v)=f(v)$ for all $v \in V(G)$ and $g(uv)=f(uv)$ for all $uv \in E(G), g(u_i)=p+q-1+2i$ for

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$1 \le i \le n, g(u_i u_{i+1}) = p + q + 2i$ for $1 \le i \le n-1$. We have to prove that G_1 is an edge vertex prime labeling. Already, G is an edge vertex prime labeling, it is enough to prove that for any edge $uv \in E_1$, which is not in G, the numbers $g(u), g(v)$ and $g(uv)$ are pairwise relatively prime. Label the vertices and edges of path P_n is consecutive positive numbers. It is easily verified that, for any edge $\in E_1, gcd(g(u), g(v)) = 1, \quad gcd(g(u), g(uv)) = 1, gcd(g(v), g(uv)) = 1$. Hence $G_1 = G \cup P_n$ is an edge vertex prime graph.**heorem 2.3.** The disconnected graph $C_m \cup K_{1,n}, m \ge 3$ is an edge vertex prime graph.

Proof. Consider the disconnected graph $G = C_m \cup K_{1,n}$. Let $V(C_m) = \{v_i: 1 \le i \le m\}$ and $V(K_{1,n}) = \{u, u_i: 1 \le i \le n\}$, where u is the centre of $K_{1,n}, E(C_m) = \{v_1 v_m, v_i v_{i+1}: 1 \le i \le m-$ *1,EK1, n=uui:1≤i≤n,* Also, *V(G)=m+n+1* and $|E(G)| = m + n$. Define a bijective function $f: V(G) \cup E(G) \to \{1, 2, \dots, 2m + 2n + 1\}$, by $f(u) = 1$, $f(u_i) = 2i + 1$ for $1 \le i \le n, f(uu_i) = 2i$ for $1 \le i \le n, f(v_1) = 2m + 2n + 1, f(v_i) = 2n + 2i - 1$ for $2 \le i \le m, f(v_i v_{i+1}) = 2n + 2i$ for $1 \le i \le m-1, f(v_1 v_m) = 2m + 2n$.

Next, we show that the property of an edge vertex prime graph.

For any $1 \le i \le n$,

$$gcd\big(f(u), f(u_i)\big) = gcd(1, 2i + 1) = 1,$$

$$gcd\big(f(u), f(uu_i)\big) = gcd(1, 2i) = 1,$$

$gcd\big(f(u_i), f(uu_i)\big) = gcd(2i + 1, 2i) = 1$,since they are consecutive positive numbers. For any $2 \le i \le n$,

$$gcd(f(v_i), f(v_{i+1})) = gcd(2n + 2i - 1, 2n + 2i + 1) = 1,$$

$$gcd\big(f(v_i), f(v_i v_{i+1})\big) = gcd(2n + 2i - 1, 2n + 2i) = 1,$$

$$gcd\big(f(v_{i+1}), f(v_i v_{i+1})\big) = gcd(2n + 2i + 1, 2n + 2i) = 1,$$

$$gcd\big(f(v_1), f(v_2)\big) = gcd(2m + 2n + 1, 2n + 3) = 1,$$

$$gcd\big(f(v_1), f(v_1 v_2)\big) = gcd(2m + 2n + 1, 2n + 2) = 1,$$

$$gcd\big(f(v_2), f(v_1 v_2)\big) = gcd(2n + 3, 2n + 2) = 1,$$

$$gcd(f(v_1), f(v_m)) = gcd(2m + 2n + 1, 2m + 2n - 1) = 1,$$

$$gcd\big(f(v_1), f(v_1 v_m)\big) = gcd(2m + 2n + 1, 2m + 2n) = 1.$$

$$gcd\big(f(v_m), f(v_1 v_m)\big) = gcd(2m + 2n - 1, 2m + 2n) = 1.$$

Therefore, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence $G = C_m \cup K_{1,n}, m \ge 3$ admits an edge vertex prime graph.

Theorem 2.4. The disconnected graph $C_m \cup P_n, m \ge 3$ is an edge vertex prime graph.

Proof. Let $u_1, u_2, \dots, u_m$ be the vertices of cycle C_m and $v_1, v_2, \dots, v_n$ be the vertices of pathP_n. Consider $G = C_m \cup P_n$ be a graph. Then $V(G) = (u_i, v_j: 1 \le i \le m, 1 \le j \le n\}$ and $E(G) = \{u_1 u_m, u_i u_{i+1}: 1 \le$ *i≤m−1Uvjvj+1:1≤i≤n−1.* Here, *V(G)=m+n* and $|E(G)| = m + n - 1$. Define a bijective function $f: V(G) \cup E(G) \to \{1, 2, \dots, 2m + 2n - 1\}$ by $f(u_i) = 2i - 1$ for $1 \le i \le m, f(u_i u_{i+1}) = 2i$ for $1 \le i \le m - 1, f(u_1 u_m) = 2m, f(v_j) = 2m + 2j - 1$ for $1 \le j \le n, f(v_j v_{j+1}) = 2m + 2j$ for $1 \le j \le n - 1$.

Next, we prove the property of an edge vertex prime graph.

For any edge $u_i u_{i+1} \in E(G)$,

$$gcd\big(f(u_i), f(u_{i+1})\big) = gcd(2i - 1, 2i + 1) = 1,$$

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$gcd\big(f(u_i), f(u_iu_{i+1})\big) = gcd(2i-1, 2i) = 1,$

$gcd\big(f(u_{i+1}), f(u_iu_{i+1})\big) = gcd(2i+1, 2i) = 1.$

For any $u_1u_m \in E(G)$,

$gcd\big(f(u_1), f(u_m)\big) = gcd(1, 2m-1) = 1,$

$gcd\big(f(u_1), f(u_1u_m)\big) = gcd(1, 2m) = 1,$

$gcd\big(f(u_m), f(u_1u_m)\big) = gcd(2m-1, 2m) = 1.$

Similarly, the other edges are pairwise relatively prime. Therefore, for any edge $uv \in E(G), gcd\big(f(u), f(v)\big) = 1,$ $gcd\big(f(u), f(uv)\big) = 1,$ $gcd\big(f(v), f(uv)\big) = 1.$ Hence $C_m \cup P_n, m \geq 3$ has an edge vertex prime graph.

Theorem 2.5. The disconnected graph $C_n \cup C_n, n \geq 3$ admits an edge vertex prime graph, where $n \equiv 0, 2(mod\ 3)$.

Proof. Let $G = C_n \cup C_n$ be a graph. Then $V(G) = \{v_i: 1 \leq i \leq 2n\}$ and $E(G) = \{v_iv_{i+1}: 1 \leq i \leq n-$ *1Uv1vnUvivi+1:n+1≤i≤2n−1Uvn+1v2n.* Also, $|V(G)| = 2n$ and $|E(G)| = 2n.$ Define a bijective function $f: V(G) \cup E(G) \to \{1, 2, \dots, 4n\}$ by $f(v_i) = 2i-1$ for $1 \leq i \leq 2n, f(v_iv_{i+1}) = 2i$ for $1 \leq i \leq n-1, f(v_1v_n) = 2n, f(v_{n+1}v_{2n}) = 4n, f(v_iv_{i+1}) = 2i$ for $n+1 \leq i \leq 2n-1.$ Clearly, for any edge $uv \in E(G), gcd\big(f(u), f(v)\big) = 1,$ $gcd\big(f(u), f(uv)\big) = 1,$ $gcd\big(f(v), f(uv)\big) = 1.$ Hence $G = C_n \cup C_n, n \geq 3$ is an edge vertex prime graph, where $n \equiv 0, 2(mod\ 3)$.

Theorem 2.6. The graph obtained by the duplication of vertex v_2 in path P_n or cycle C_n is an edge vertex prime graph.

Proof. Let G' be the graph obtained by duplicating a vertexv_2 of degree 2 in P_n. Let v_2' be the duplication of v_2 in G'. Then $V(G') = \{v_2', v_i: 1 \leq i \leq n\}$ and

$E(G') = \{v_iv_{i+1}: 1 \leq i \leq n-1\} \cup \{v_1v_2'\} \cup \{v_3v_2'\}.$ Here, $|V(G')| = n+1$ and $|E(G')| = n+1$. Define a bijective labeling $f: V(G') \cup E(G') \to \{1,2, \dots, 2n+2\}$ by $f(v_i) = 2i-1$ for $1 \leq i \leq n, f(v_iv_{i+1}) = 2i$ for $1 \leq i \leq n-1, f(v_2') = 2n+1, f(v_1v_2') = 2n, f(v_3v_2') = 2n+2.$

Next, we show that the property of an edge vertex prime graph.

For any $1 \leq i \leq n-1$,

$gcd\big(f(v_i), f(v_{i+1})\big) = gcd(2i-1, 2i+1) = 1,$

$gcd\big(f(v_i), f(v_iv_{i+1})\big) = gcd(2i-1, 2i) = 1,$

$gcd(f(v_{i+1}), f(v_iv_{i+1})) = gcd(2i+1, 2i) = 1,$

$gcd\big(f(v_1), f(v_2')\big) = gcd(1, 2n+1) = 1,$

$gcd\big(f(v_1), f(v_1v_2')\big) = gcd(1, 2n) = 1,$

$gcd\big(f(v_2'), f(v_1v_2')\big) = gcd(2n+1, 2n) = 1,$

$gcd\big(f(v_3), f(v_2')\big) = gcd(5, 2n+1) = 1,$

$gcd(f(v_3), f(v_3v_2')) = gcd(5, 2n+2) = 1,$

$gcd(f(v_2'), f(v_3v_2')) = gcd(2n+1, 2n+2) = 1.$

Therefore, for any edge $\in E(G), gcd\big(f(u), f(v)\big) = 1,$ $gcd\big(f(u), f(uv)\big) = 1,$ $gcd\big(f(v), f(uv)\big) = 1.$ Hence the graph G' is duplicating a vertex v_2 in P_n has an edge vertex prime labeling.

Let G'' be the graph obtained by duplication of v_2 of degree 2 in C_n. Let v_2'' be the duplication of v_2 in G''. Then $V(G'') = \{v_2'', v_i: 1 \leq i \leq n\}$, and $E(G'') = \{v_iv_{i+1}: 1 \leq i \leq n-1\} \cup \{v_1v_n\} \cup \{v_1v_2''\} \cup \{v_3v_2''\}.$ Here, $V(G'') = n+1$ and $E(G'') = n+2.$ Define a bijective labeling $f: V(G'') \cup E(G'') \to \{1,2, \dots, 2n+3\}$ by $f(v_i) = 2i-1$ for $1 \leq i \leq n, f(v_iv_{i+1}) = 2i$ for $1 \leq i \leq n-1, f(v_1v_n) = 2n, f(v_2'') = 2n+2, f(v_1v_2'') = 2n+1, f(v_3v_2'') = 2n+3.$ Clearly, for any edge $uv \in E(G), gcd\big(f(u), f(v)\big) = 1,$ $gcd\big(f(u), f(uv)\big) = 1,$ $gcd\big(f(v), f(uv)\big) = 1.$ Hence the graph G'' is duplication of v_2 in C_n has an edge vertex prime graph.

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Theorem 2.7 The disconnected graph $K_{2,m} \cup C_n$, $(n \geq 3, n \equiv 0(mod\ 3), m\ is\ even)$ is an edge vertex prime graph.

Proof. Consider the disconnected graph $G = K_{2,m} \cup C_n$, $(n \geq 3, n \equiv 0(mod\ 3), m\ is\ even)$. Let $V(K_{2,m}) = \{u_1, u_2\} \cup \{v_i: 1 \leq i \leq m\}$, $V(C_n) = \{w_i: 1 \leq i \leq n\}$ and $E(K_{2,m}) = \{u_1v_i, u_2v_i: 1 \leq i \leq m\}$, $E(C_n) = \{w_1w_n, w_iw_{i+1}: 1 \leq i \leq n-1\}$. Also, $|V(G)| = m + n + 2$and $|E(G)| = 2m + n$.

Define a bijective function $f: V(G) \cup E(G) \rightarrow \{1,2, \dots ,3m + 2n + 2\}$ as follows. First, consider $K_{2,m}$, we use (Parmer [6] proved that the same technique $K_{2,m}$ is an edge vertex prime graph for all m in theorem 2.1). Next, consider C_n, $f(w_i) = 3m + 2i + 1$ for $1 \leq i \leq n f(w_iw_{i+1}) = 3m + 2i + 2$ for $1 \leq i \leq n-1$.

Clearly, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence$G = K_{2,m} \cup C_n$, $(n \geq 3, n \equiv 0(mod\ 3), m\ is\ even)$ admits an edge vertex prime graph.

Theorem 2.8 The disconnected graph $K_{2,m} \cup C_n$, $(n \geq 3, n \equiv 0, 1(mod\ 3), m\ \text{is odd})$ is an edge vertex prime graph.

Proof. Similar to the even case, above theorem 2.7, only changes in first cycle, we stated the lowest label by an edge. $f(w_i) = 3m + 2i$ for $2 \leq i \leq n$,

$f(w_1) = 3m + 2n + 2$, $f(w_iw_{i+1}) = 3m + 2i + 1$ for $1 \leq i \leq n-1$,

$f(w_1w_n) = 3m + 2i + 1$. It is easily verified that, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime.

Hence $G = K_{2,m} \cup C_n$, $(n \geq 3, n \equiv 0,1(mod\ 3), m\ is\ even)$ admits an edge vertex prime graph.

III. ONE POINT UNION OF GRAPHS

In this section, we investigate one point union of some graphs are an edge vertex prime.

Theorem 3.1 One point union of $m$copies W_n, that is, W_n^m (n is even, except $n = 10n - 6, 10n - 2, m \geq 1\ and\ n \geq 1$) is an edge vertex prime graph.

Proof. Let $G = W_n^m$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \leq i \leq m, 1 \leq j \leq n\}$ and

$$E(G) = \{vv_{ij}: 1 \leq i \leq m, 1 \leq j \leq n\} \cup \{v_{ij}v_{ij+1}: 1 \leq i \leq m, 1 \leq j \leq n-1\} \cup$$

$\{v_{i1}v_{in}: 1 \leq i \leq m\}$. Also, $|V(G)| = mn + 1$and $|E(G)| = 2mn$. Define a

bijective function $f: V(G) \cup E(G) \rightarrow \{1,2, \dots ,3mn + 1\}$ by $f(v) = 1$,

$$f(v_{ij}) = \begin{cases} 3n(i-1) + 3j; & j = 1,3,5, \dots, n-1 \\ 3n(i-1) + 3j - 1; & j = 2,4,6, \dots, n \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 3n(i-1) + 3j - 1; & j = 1,3,5, \dots, n-1 \\ 3n(i-1) + 3j; & j = 2,4,6, \dots, n \end{cases}$$

$f(v_{ij}v_{ij+1}) = 3n(i-1) + 3j + 1,\ j = 1,3,5, \dots, n-1$,

$f(v_{i1}v_{ij}) = 3n(i-1) + 3j + 1,\ j = n.$

It is easily verified that, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = W_n^m$ (n is even, except $n = 10n - 6, 10n - 2, m \geq 1\ and\ n \geq 1$) admits an edge vertex prime graph.

Theorem 3.2 One point union of $W_{10n-6}^m, m \geq 1\ and\ n \geq 1$is an edge vertex prime graph.

Proof. Let $G = W_{10n-6}^m$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \leq i \leq m, 1 \leq j \leq 10n - 6\}$ and $E(G) = \{vv_{ij}: 1 \leq i \leq m, 1 \leq j \leq 10n - 6\} \cup \{v_{ij}v_{ij+1}: 1 \leq i \leq m,\ 1 \leq j \leq 10n -$

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$7\} \cup \{v_{i1}v_{i(10n-6)}: 1 \le i \le m\}$. Also, $|V(G)| = m(10n-6) + 1$ and $|E(G)| = 2m(10n-6)$. Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,3m(10n-6)+1\}$ by $f(v) = 1$,

$$f(v_{ij}) = \begin{cases} 3(10n-6)(i-1)+3j; & j = 1,3,5,\dots,10n-7 \\ 3(10n-6)(i-1)+3j-1; & j = 2,4,6,\dots,10n-6 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 3(10n-6)(i-1)+3j-1; & j = 1,3,5,\dots,10n-7 \\ 3(10n-6)(i-1)+3j; & j = 2,4,6,\dots,10n-6 \end{cases}$$

Consider the following cases.

Case 1. $m \not\equiv 2 (mod\ 5)$

$f(v_{ij}v_{ij+1}) = 3(10n-6)(i-1)+3j+1,\ j = 1,2,3,\dots,10n-7,$

$f(v_{i1}v_{ij}) = 3(10n-6)(i-1)+3j+1,\ j = 10n-6$

Case 2. $m \equiv 2 (mod\ 5)$

$$f(v_{ij}v_{ij+1}) = \begin{cases} 3(10n-6)(i-1)+3j+1; & j = 1,2,3,\dots,10n-8 \\ 3(10n-6)(i-1)+3(j+1)+1; & j = 10n-7 \end{cases}$$

$f(v_{i1}v_{ij}) = 3(10n-6)(i-1)+3(j-1)+1,\ j = 10n-6.$

Clearly, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = W_{10n-6}^m$, $m \ge 1$ and $n \ge 1$ admits an edge vertex prime.

Theorem 3.3 One point union of $W_{10n-2}^m, m \ge 1$ and $n \ge 1$ is an edge vertex prime graph.

Proof. Let $G = W_{10n-2}^m$ be a graph. Then

$V(G) = \{v, v_{ij}: 1 \le i \le m, 1 \le j \le 10n-2\}$ and $E(G) = \{vv_{ij}: 1 \le i \le m, 1 \le j \le 10n-2 \cup v_{ij}v_{ij+1}: 1 \le i \le m, 1 \le j \le 10n-3 \cup \{v_{i1}v_{i10n-2}: 1 \le i \le m\}$. Also, $|V(G)| = m(10n-2) + 1$ and $|E(G)| = 2m(10n-2)$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,3m(10n-2)+1\}$ by $f(v) = 1$,

$$f(v_{ij}) = \begin{cases} 3(10n-2)(i-1)+3j; & j = 1,3,5,\dots,10n-3 \\ 3(10n-2)(i-1)+3j-1; & j = 2,4,6,\dots,10n-4 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 3(10n-2)(i-1)+3j-1; & j = 1,3,5,\dots,10n-3 \\ 3(10n-2)(i-1)+3j; & j = 2,4,6,\dots,10n-2 \end{cases}$$

$f(v_{i(10n-2)}) = 3(10n-2)(i-1)+3j+1,\ j = 10n-2.$

Consider the following cases.

Case 1. $m \not\equiv 4 (mod\ 5)$

$f(v_{ij}v_{ij+1}) = 3(10n-2)(i-1)+3j+1,\ j = 1,2,3,\dots,10n-3,$

$f(v_{i1}v_{ij}) = 3(10n-2)(i-1)+3j+1,\ j = 10n-2$

Case 2. $m \equiv 4 (mod\ 5)$

$$f(v_{ij}v_{ij+1}) = \begin{cases} 3(10n-2)(i-1)+3j+1; & j = 1,2,3,\dots,10n-4 \\ 3(10n-2)(i-1)+3(j+1)-1; & j = 2,4,6,\dots,10n-3 \end{cases}$$

$3(10n-2)(i-1)+3(j-1)+1,\ j = 10n-2.$

Clearly, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = W_{10n-2}^m$ $m \ge 1$ and $n \ge 1$ admits an edge vertex prime graph.

Theorem 3.4 One point union of m copies W_3 is an edge vertex prime graph.

Proof. Let $G = W_3^m$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \le i \le m, 1 \le j \le 3\}$ and $E(G) = \{vv_{ij}: 1 \le i \le m, 1 \le j \le 3\} \cup \{v_{ij}v_{ij+1}: 1 \le i \le m, 1 \le j \le 2 \cup \{v_{i1}v_{i3}: 1 \le i \le m\}$. Also, $|V(G)| = 3m + 1$ and $|E(G)| = 6m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,9m+1\}$ by $f(v) = 1$.

Consider i^{th} copy of the following cases.

Case 1. Even number of copies, that is, $i = 2,4,6,\dots$

$$f(v_{ij}) = \begin{cases} 9(i-1)+3j-1; & j = 1,3 \\ 9(i-1)+3j & j = 2 \end{cases}$$

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$$f(vv_{ij}) = \begin{cases} 9(i-1)+3j; & j=1,3 \\ 9(i-1)+3j-1; & j=2 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = 9(i-1)+3j+1, \ \ j=1,2$$

$f(v_{i1}v_{ij}) = 9(i-1)+3j+1, \ \ j=3.$

Case 2.Odd number of copies, that is, $i = 1,3,5,...$

$$f(v_{ij}) = \begin{cases} 9(i-1+3j;); & j=1 \\ 9(i-1)+3j-1; & j=2 \\ 9(i-1)+3j-2; & j=3 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 9(i-1)+3j-1; & j=1,3 \\ 9(i-1)+3j & j=2 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = \begin{cases} 9(i-1)+3j+1; & j=1,2, \\ 9(i-1)+3(j+1); & j=2 \end{cases}$$

$f(v_{i1}v_{ij}) = 9(i-1)+3j+1, \ \ j=3.$

It is easily verified , for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence $G = W_3^m$ admits an edge vertex prime graph.

Theorem 3.5 One point union of m copies W_5 is an edge vertex prime graph.

Proof. Let $G = W_5^m$ be a graph. Then $V(G) = \{v, v_{ij} : 1 \le i \le m, 1 \le j \le 5\}$ and $E(G) = \{vv_{ij} : 1 \le i \le m, 1 \le j \le 5\} \cup \{v_{ij}v_{ij+1} : 1 \le i \le m, 1 \le j \le 4\} \cup \{v_{i1}v_{i5} : 1 \le i \le m\}$. Also, $|V(G)| = 5m+1$and $|E(G)| = 10m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,...,15m+1\}$by $f(v) = 1$. Consider i^{th} copy of the following cases.

Case 1. Even number of copies, that is, $i = 2,4,6,...$

$$f(v_{ij}) = \begin{cases} 15(i-1)+3j-1; & j=1,3,5 \\ 15(i-1)+3j & j=2,4 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 15(i-1)+3j; & j=1,3,5 \\ 15(i-1)+3j-1; & j=2,4 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = 15(i-1)+3j+1, \ \ j=1,2,3,4.$$

$f(v_{i1}v_{ij}) = 15(i-1)+3j+1, \ \ j=5.$

Case 2.Odd number of copies, that is, $i = 1,3,5,...$

$$f(v_{ij}) = \begin{cases} 15(i-1+3j;) & j=1,3 \\ 15(i-1)+3j-1; & j=2,4 \\ 15(i-1)+3j-2; & j=5 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 15(i-1)+3j-1; & j=1,3,5 \\ 15(i-1)+3j & j=2,4 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = \begin{cases} 15(i-1)+3j+1; & j=1,2,3 \\ 15(i-1)+3j+3; & j=4 \end{cases}$$

$f(v_{i1}v_{ij}) = 15(i-1)+3j+1, \ \ j=5.$

Therefore, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = W_5^m$ admits an edge vertex prime graph.

Theorem 3.6 One point union of m copies W_7 is an edge vertex prime graph.

Proof. Let $G = W_7^m$ be a graph. Then $V(G) = \{v, v_{ij} : 1 \le i \le m, 1 \le j \le 7\}$ and

$E(G) = \{vv_{ij} : 1 \le i \le m, 1 \le j \le 7\} \cup \{v_{ij}v_{ij+1} : 1 \le i \le m, 1 \le j \le 6\} \cup \{v_{i1}v_{i7} : 1 \le i \le m\}$. Also, $|V(G)| = 7m+1$and $|E(G)| = 14m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,...,21m+1\}$by $f(v) = 1$. Consider i^{th} copy of the following cases.

Case 1. Even number of copies, that is, $i = 2,4,6,...$

$$f(v_{ij}) = \begin{cases} 21(i-1)+3j-1; & j=1,3,5,7 \\ 21(i-1)+3j & j=2,4,6 \end{cases}$$

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$$f(vv_{ij}) = \begin{cases} 21(i-1)+3j; & j=1,3,5,7 \\ 21(i-1)+3j-1; & j=2,4,6 \end{cases}$$

Subcase 1a. $m \not\equiv 4(mod\ 10)$

$$f(v_{ij}v_{ij+1}) = 21(i-1)+3j+1,\ \ j=1,2,3,4,5,6$$

$$f(v_{i1}v_{ij}) = 21(i-1)+3(j+1)+1,\ \ j=7.$$

Subcase 1b. $m \equiv 4(mod\ 10)$

$$f(v_{ij}v_{ij+1}) = 21(i-1)+3j+1,\ \ j=1,2,3,4,5$$

$$f(v_{ij}v_{ij+1}) = 21(i-1)+3(j+1)+1,\ \ j=6$$

$$f(v_{i1}v_{ij}) = 21(i-1)+3j-2,\ \ j=7.$$

Case 2.Odd number of copies, that is, $i = 1,3,5,\ldots$

$$f(v_{ij}) = \begin{cases} 21(i-1)+3j; & j=1,3,5 \\ 21(i-1)+3j-1; & j=2,4,6 \\ 21(i-1)+3j-2; & j=7 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 21(i-1)+3j-1; & j=1,3,5,7 \\ 21(i-1)+3j & j=2,4,6 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = 21(i-1)+3j+1,\ \ j=1,2,3,4,5$$

$$f(v_{i1}v_{ij}) = 21(i-1)+3j+3,\ \ j=6.$$

$$f(v_{i1}v_{i7}) = 21(i-1)+3j+1,\ \ \text{j=7}$$

Clearly, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence $G = W_7^m$ admits an edge vertex prime graph.

Theorem 3.7 One point union of m copies W_9 is an edge vertex prime graph.

Proof. Let $G = W_9^m$ be a graph. Then $V(G) = \{v, v_{ij} : 1 \le i \le m, 1 \le j \le 9\}$ and

$E(G) = \{vv_{ij} : 1 \le i \le m, 1 \le j \le 9\} \cup \{v_{ij}v_{ij+1} : 1 \le i \le m, 1 \le j \le 8\} \cup \{v_{i1}v_{i9} : 1 \le i \le m\}$. Also, $|V(G)| = 9m + 1$and $|E(G)| = 18m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\ldots,27m+1\}$by $f(v) = 1$. Consider i^{th} copy of the following cases.

Case 1. Even number of copies, that is, $i = 2,4,6,\ldots$

$$f(v_{ij}) = \begin{cases} 27(i-1)+3j-1; & j=1,3,5,7,9 \\ 27(i-1)+3j & j=2,4,6,8 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 27(i-1)+3j; & j=1,3,5,7,9 \\ 27(i-1)+3j-1; & j=2,4,6,8 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = 27(i-1)+3j+1,\ \ j = 1,2,3,4,5,6,7,8$$

$$f(v_{i1}v_{ij}) = 27(i-1)+3j+1,\ \ j=9.$$

Case 2.Odd number of copies, that is, $i = 1,3,5,\ldots$

$$f(v_{ij}) = \begin{cases} 27(i-1)+3j; & j=1,3,5,7 \\ 27(i-1)+3j-1; & j=2,4,6,8 \\ 27(i-1)+3j-2; & j=9 \end{cases}$$

$$f(vv_{ij}) = \begin{cases} 27(i-1)+3j-1; & j=1,3,5,7 \\ 27(i-1)+3j & j=2,4,6,8 \end{cases}$$

$$f(v_{ij}v_{ij+1}) = 27(i-1)+3j+1,\ \ j = 1,2,3,4,5,6,7$$

Subcase 2a. $m \not\equiv 7(mod\ 10)$

$$f(vv_{ij}) = 27(i-1)+3j-1,\ \ j=9,$$

$$f(v_{ij}v_{ij+1}) = 27(i-1)+3j+1,\ \ j=8,$$

$$f(v_{i1}v_{ij}) = 27(i-1)+3j-2,\ \ j=9.$$

Subcase 2b. $m \equiv 7(mod\ 10)$

$$f(vv_{ij+1}) = 27(i-1)+3j+1,\ \ j=9$$

$$f(v_{ij}v_{ij+1}) = 27(i-1)+3(j+1),\ \ j=8$$

$$f(v_{i1}v_{ij}) = 27(i-1)+3j-1,\ \ j=9.$$

Clearly, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence $G = W_9^m$ admits an edge vertex prime graph.

Theorem 3.8 One point union of m copies of C_n^m, $n = 3, 5, 7, 9, 11$ is an edge vertex prime graph.

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Proof. Let $G = C_n^m$, $(n = 3, 5, 7, 9, 11)$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \le i \le m, 1 \le j \le n-1\}$ and $E(G) = \{vv_{i1}, vv_{i(n-1)}: 1 \le i \le m\} \cup \{v_{ij}v_{ij+1}: 1 \le i \le m, 1 \le j \le n-2\}$. Also, $|V(G)| = m(n-1) + 1$and $|E(G)| = mn$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,2mn - m + 1\}$by $f(v) = 1$. Consider i^{th} copy of the following cases.

Case 1.Odd number of copies, that is, $i = 1, 3, 5, \dots$

$$f(v_{ij}) = 2n(i-1) + 2(j+1) - i, \ j = 1, 2, 3, \dots, n-1.$$

$$f(v_{ij}v_{ij+1}) = 2n(i-1) + 2(j+2) - (i+1), \ j = 1,2,3, \dots, n-2.$$

$$f(vv_{i1}) = (2n-1)i - (2n-3), f(vv_{i(n-1)}) = (2n-1)i + 1.$$

Case 2. Even number of copies, that is $i = 2,4,6, \dots$

$$f(v_{ij}) = 2n(i-1) + 2(j+1) - (i+1), \ j = 1,2,3, \dots, n-1.$$

$$f(v_{ij}v_{ij+1}) = 2n(i-1) + 2(j+2) - (i+2), \ j = 1,2,3, \dots n-2.$$

Consider the following subcases.

Subcase 2a. Consider n = 3, 5, 9, if we take n= 7, then $m \not\equiv 2(mod\ 6)$ and if we take n = 11, then $m \not\equiv 4(mod\ 10)$.

$$f(vv_{i1}) = (2n-1)i + 1, f(vv_{i(n-1)}) = (2n-1)i.$$

Subcase 2b. If we take n = 7, then $m \equiv 2(mod\ 6)$ and if we take n = 11, then $m \equiv 4(mod\ 10)$.

$$f(vv_{i1}) = (2n-1)i, f(vv_{i(n-1)}) = (2n-1)i + 1.$$

Clearly, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = C_n^m$ admits an edge vertex prime graph.

Theorem 3.9 One point union of m copies of C_4 is an edge vertex prime graph.

Proof. Let $G = C_4^m$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \le i \le m, 1 \le j \le 3\}$ and

$$E(G) = \{vv_{i1}, vv_{i3}: 1 \le i \le m\} \cup \{v_{ij}v_{ij+1}: 1 \le i \le m, 1 \le j \le 2\}$$

Also, $|V(G)| = 3m + 1$and $|E(G)| = 4m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,7m + 1\}$ by $f(v) = 1$

Consider i^{th} copy of the following cases.

Case 1.Odd number of copies, that is, $i = 1,3,5, \dots$

$$f(v_{ij}) = 8(i-1) + 2(j+1) - i, \ j = 1,2,3$$

$$f(v_{ij}v_{ij+1}) = 8(i-1) + 2(j+2) - (i+1), \ j = 1, 2$$

$$f(vv_{i1}) = 7i - 5, f(vv_{i3}) = 7(i+1) + 1.$$

Case 2. Even number of copies, that is, $i = 2,4,6, \dots$

$$f(v_{ij}) = 8(i-1) + 2(j+1) - (i+1), \ j = 1,2,3$$

$$f(v_{ij}v_{ij+1}) = 8(i-1) + 2(j+2) - (i+2), \ j = 1, 2$$

$$f(vv_{i1}) = 7(i-1) + 1, f(vv_{i3}) = 7i.$$

Therefore, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence $G = C_4^m$ admits an edge vertex prime graph.

Theorem 3.10 One point union of m copies of C_6 is an edge vertex prime graph.

Proof. Let $G = C_6^m$ be a graph. Then $V(G) = \{v, v_{ij}: 1 \le i \le m, 1 \le j \le 5\}$ and

$$E(G) = \{vv_{i1}, vv_{i5}: 1 \le i \le m\} \cup \{v_{ij}v_{ij+1}: 1 \le i \le m, 1 \le j \le 4\}$$

Also, $|V(G)| = 5m + 1$and $|E(G)| = 6m$.

Define a bijective function $f: V(G) \cup E(G) \to \{1,2,\dots,11m + 1\}$by $f(v) = 1$. Consider i^{th} copy of the following cases.

Case 1.Odd number of copies, that is, $i = 1,3,5, \dots$

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$$f(v_{ij}) = 12(i-1) + 2(j+1) - i, \ \ j = 1,2,3,4,5$$

$$f(v_{ij}v_{ij+1}) = 12(i-1) + 2(j+2) - (i+1), \ \ j = 1,2,3,4$$

$$f(vv_{i1}) = 11i - 9, f(vv_{i5}) = 11i + 1.$$

Case 2. Even number of copies, that is, $i = 2,4,6,\ldots$

$$f(v_{ij}) = 12(i-1) + 2(j+1) - (i+1), \ \ j = 1,2,3,4,5$$

$$f(v_{ij}v_{ij+1}) = 12(i-1) + 2(j+2) - (i+2), \ \ j = 1,2,3,4$$

Subcase 2a. $m \not\equiv 4(mod\ 10)$

$$f(vv_{i1}) = 11i + 1, f(vv_{i5}) = 11i.$$

Subcase 2b. $m \equiv 4(mod\ 10)$

$$f(vv_{i1}) = 11i, f(vv_{i5}) = 11i + 1.$$

Therefore, for any edge $uv \in E(G)$, $gcd(f(u), f(v)) = 1$, $gcd(f(u), f(uv)) = 1$, $gcd(f(v), f(uv)) = 1$. Hence $G = C_6^m$ admits an edge vertex prime graph.

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