Malaya Journal of Matematik, Vol. 9, No. 1, 765-769, 2021

https://doi.org/10.26637/MJM0901/0135

On the upper open detour monophonic number of a graph

K. Krishna Kumari[1]*, S. Kavitha[2] and D. Nidha[3]

Abstract

An open detour monophonic set M in a connected graph G is called a minimal open detour monophonic set if no proper subset of M is an open detour monophonic set of G. The upper open detour monophonic number $odm^{+}(G)$ of G is the maximum cardinality of a minimal open detour monophonic set of G. Some general properties satisfied by this concept are studied. The upper open detour monophonic number of some standard graphs are determined. Connected graphs of order n with upper open detour monophonic number 2 or 3 or n are characterized. It is shown that for every pair a and b of integers a and b with $2 \leq a \leq b$, there exists a connected graph G such that $odm(G) = a$ and $odm^{+}(G) = b$, where $odm(G)$ is the open detour monophonic number of a graph.

Keywords

detour number, open detour number, monophonic number, open monophonic number, upper open detour monophonic number.

AMS Subject Classification

05C12, 05C38.

[1,3] *Department of Mathematics, Nesamony Memorial Christian College, Marthandam – 629165,Tamil Nadu, India.*

[2] *Department of Mathematics, Gobi Arts and Science College, Gobichettipalayam-638474, Tamil Nadu, India.*

[1,2,3] Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli-627012, Tamil Nadu, India.

***Corresponding author**: [1] krishnakumarikr@yahoo.com;[2] kavithaashmi@gmail.com; [3] nidhamaths@gmail.com

Article History: Received **24** December **2020**; Accepted **09** March **2021**

Contents

1 **Introduction** 765

2 **On The Upper Open Detour Monophonic Number of a Graph** 766

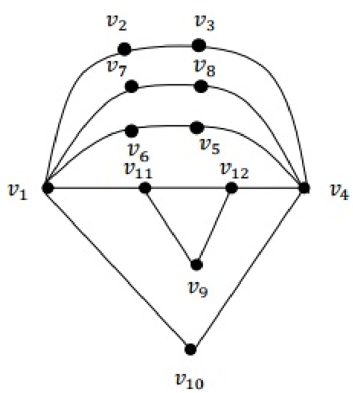
3 **Some Results On The Upper Open Detour Monophonic Number of a Graph** 767

References 769

1. Introduction

By a graph $G = (V, E)$, we mean a finite undirected graph without loops or multiple edges. The order and size of G are denoted by n and m, respectively. For basic graph theoretic terminology, we refer to [1]. The neighborhood of a vertex v is the set $N(v)$ consisting of all vertices u which are adjacent with v. A vertex v is an extreme vertex if the subgraph induced by its neighbors is *complete*. A *chord* of a path P in G is an edge connecting two non adjacent vertices of P. For two vertices u and v in a connected graph G, a u-v path P is called a *monophonic path* P is a chordless path [2-11]. A longest u-v monophonic path is called an u-v *detour monophonic path*. A u-v monophonic path with its length equal to $d_m(u,v)$ is known as a uv monophonic. For any vertex v in a connected graph G, the monophonic eccentricity of v is $e_m(v) = max\{d_m(u,v) : u \in V\}$. A vertex u of G such that $d_m(u,v) = e_m(v)$ is called a *monophonic eccentric vertex* of v. The monophonic radius and monophonic diameter of G are defined by $rad_m G = min\{e_m(v) : v \in V\}$ and $diam_m G = max\{e_m(v) : v \in V\}$, respectively. We denote $rad_m G$ by r_m and $diam_m G$ by d_m. Two vertices u and v are said to be detour antipodal if $d_m(u,v) = d_m$.The monophonic distance of a graph was studied in [16]. For two vertices $u, v \in V$, let $J_{dm}[u,v]$ denotes the set of all vertices that lies in u-v detour monophonic path including u and v, and $J_{dm}(u,v)$ denotes the set of all internal vertices that lies in u-v detour monophonic path. For $M \subseteq V$, let $J_{dm}[M] = \cup_{(u,v \in M)} J_{dm}[u,v]$. A set $M \subseteq V$ is a *detour monophonic set* if $J_{dm}[M] = V$. The minimum cardinality of a detour monophonic set of G is the detour monophonic number of G and is denoted by $d_m(G)$. The detour monophonic set of cardinality $d_m(G)$ is called d_m-set. The detour monophonic number of a graph was studied

in [16].
A vertex x of a connected graph G is said to be a *detour simplicial vertex* of G if x is not an internal vertex of any u-v detour monophonic path for every $u, v \in V$. Each extreme vertex of G is a detour monophonic simplicial vertex of G. Infact there are detour monophonic simplicial vertices which are not extreme vertices of G [12,14]. For the graph G given in the Figure 1.1, v_9 and v_{10} are the only two detour monophonic simplicial vertices of G. Every extreme vertex of G is a detour monophonic simplicial vertex of G. In fact there are detour monophonic simplicial vertices which are not extreme vertices of G. For the graph G given Figure 1.1, v_{10} is a detour monophonic simplicial vertex of G, which is not an extreme vertex of G. A set $M \subseteq V$ is called an *open detour monophonic set* of G if for each vertex x in G, (1) either x is a detour monophonic simplicial vertex of G and $x \in M$ or (2) $x \in J_{dm}(u,v)$ for some $u, v \in M$. An open detour monophonic set of minimum cardinality is called a minimum open detour monophonic set and this cardinality is the open detour monophonic number of G, denoted by $odm(G)$. An open detour set of cardinality $odm(G)$ is called an odm-set of G. The open detour monophonic number of a graph was studied in [13]. Throughout the following G denotes a connected graph with at least two vertices. The following Theorems are used in the sequel.



G
Figure 1.1

Theorem 1.1. [**8**] *Every open detour monophonic set of G contains its detour monophonic simplicial vertices. Also, if the set M of all detour monophonic simplicial vertices is an open detour monophonic set of G, then M is the unique minimum open detour monophonic set of G.*

Theorem 1.2. [**8**] *Let G be a connected graph of order $n \geq 4$. If G contains no detour monophonic simplicial vertices, then $odm(G) \leq 4$.*

2. On The Upper Open Detour Monophonic Number of a Graph

Definition 2.1. *An open detour monophonic set M in a connected graph G is called a minimal open detour monophonic set if no proper subset of M is an open detour monophonic set of G. The upper open detour monophonic number $odm^+(G)$ of G is the maximum cardinality of a minimal open detour monophonic set of G.*

Example 2.2. *For the graph G given in Figure 1.1, $M_1 = \{v_1, v_9, v_{10}\}$, $M_2 = \{v_4, v_9, v_{10}\}$,$M_3 = \{v_1, v_4, v_9, v_{10}\}$, $M_4 = \{v_5,$
$v_6, v_9, v_{10}\}$ and $M_5 = \{v_7, v_8, v_9, v_{10}\}$, $M_6 = \{v_2, v_3, v_9, v_{10}\}$ are the only minimal open detour monophonic sets of G so that $odm(G) = 3$ and $odm^+(G) = 4$.*

Remark 2.3. *Every minimum open detour monophonic set of G is a minimal open detour monophonic set of G and the converse is not true. For the graph G given in Figure 2.1, $\{v_1, v_4, v_9, v_{10}\}$ is a minimal open detour monophonic set of G but not a minimum open detour monophonic set of G. Here, $M_1 = \{v_1, v_9, v_{10}\}$ is a minimum open detour monophonic set of G so that $odm(G) = 3$.*

Theorem 2.4. *Every minimal open detour monophonic set of G contains its detour monophonic simplicial vertices. Also, if the set M of all detour monophonic simplicial vertices is an open detour monophonic set of G, then M is the unique minimal open detour monophonic set of G.*

Proof. Let M be a monophonic set of G and v be an open detour simplicial vertex of G. Let $\{v_1, v_2, ..., v_k\}$ be the neighbors of v in G. Suppose that $v \notin M$. Then v lies on a detour monophonic path $P : x = x_1, x_2, ..., v_i, v, v_j, ..., x_m = y$, where $x, y \in M$. Since $v_i v_j$ is a chord of P and so P is not a detour monophonic path, which is a contradiction. Hence it follows that $v \in M$. □

Theorem 2.5. *Let G be a connected graph with cut-vertices and M be a monophonic set of G. If v is a cut-vertex of G, then every component of G–v contains at least two element of M.*

Proof. Suppose that there is a component G_1 of G–v such that G_1 contains no vertex of S. By Theorem 2.4, G_1 does not contain any end-vertex of G. Thus G_1 contains at least one vertex, say u. Since M is a detour monophonic set, there exists vertices $x, y \in M$ such that z lies on the x–y detour monophonic path $P : x = u_0, u_1, , u_2, ..., u, .., u_t = y$ in G. Let P_1 be a $x - u$ sub path of P and P_2 be a u–y subpath of P. Since v is a cut-vertex of G, both P_1 and P_2 contain v so that P is not a path, which is a contradiction. Thus every component of G-v contains an element of M. □

Theorem 2.6. *For any connected graph G, no cut-vertex of G belongs to any minimal open detour monophonic set of G.*

Proof. Let M be a minimal open detour monophonic set of G and $v \in M$ be any vertex. We claim that v is not a cut vertex of G. Suppose that v is a cut vertex of G. Let $G_1, G_2, ..., G_r$ $(r \geq 2)$ be the components of $G - v$. By Theorem 2.5, each component G_i $(1 \leq i \leq r)$ contains an element of M. We claim that $M_1 = M – \{v\}$ is also a open detour monophonic set of G. Let x be a vertex of G. Since M is a monophonic set, x lies on a monophonic path P joining a pair of vertices u and v of M. Assume without loss of generality that $u \in G_1$. Since v is adjacent to at least one vertex of each G_i $(1 \leq i \leq r)$, assume that v is adjacent to z in $G_k, k \neq 1$. Since M is a open detour monophonic set, z lies on a detour monophonic path Q joining v and a vertex w of M such that w must necessarily belongs to G_k. Thus $w \neq v$. Now, since v is a cut vertex of G, $P \cup Q$ is a path joining u and w in M and thus the vertex x lies on this detour monophonic path joining two vertices u and w of M_1. Thus we have proved that every vertex that lies on a detour monophonic path joining a pair of vertices u and v of M also lies on a detour monophonic path joining two vertices of M_1. Hence it follows that every vertex of G lies on a detour monophonic path joining two vertices of M_1, which shows that M_1 is a open detour monophonic set of G. Since $M_1 \subsetneq M$, this contradicts the fact that M is a minimal open detour monophonic set of G. Hence $v \notin M$ so that no cut vertex of G belongs to any minimal open detour monophonic set of G. □

Corollary 2.7. *For any non-trivial tree T, the monophonic number $odm^+(T) = odm(T) = k$, where k is number of end vertices of T.*

Proof. This follows from Theorems 2.4 and 2.6. □

Corollary 2.8. *For the complete graph K_n $(n \geq 2)$, $odm(K_n) = odm^+(K_n) = n$.*

Proof. Since every vertex of the complete graph K_n $(n \geq 2)$ is an open detour simplicial vertex, the vertex set of K_n is the unique detour monophonic set of K_n. Thus $odm^+(K_n) = odm(K_n) = n$. □

Theorem 2.9. *For the cycle $G = C_n$ $(n \geq 4)$, $odm^+(G) = 4$.*

Proof. If n is even, then let x and y be two monophonic antipodal vertices of $G = C_n$, and w be a detour monophonic antipodal vertex of x and z be a detour monophonic antipodal vertex of y. Then $M = \{x, y, w, z\}$ is a a minimal open detour monophonic set of G and so $odm^+(G) \geq 4$. We show that $odm^+(G) = 4$. Suppose that $odm^+(G) \geq 5$. Then there exists a minimal open detour monophonic set M_1 such that $|M_1| \geq 5$. Suppose that M_1 is a set of independent vertices of G. Then $M_2 = M_1 - \{u\}$, where $u \in M_1$ is an open detour monophonic set of G with $M_2 \subset M_1$, which is a contradiction. Therefore $G[M_1]$ contains at least one edge. Let uv be an edge of $G[M_1]$. Then either $M_1 - \{u\}$ or $M_1 - \{u\}$ is an open detour monophonic set of G, which is a contradiction. Therefore M_1 is not a minimal open detour monophonic set of G, which is a contradiction. Therefore $odm^+(G) = 4$ if n is even. If n is odd, then let x and y be two antipodal vertices of G, and w be a detour antipodal vertices of x and z be a detour antipodal vertex of w. Let $M_3 = \{x, y, w, z\}$. Then as in the argument above, we can prove that $odm^+(G) = 4$ if n is odd. Therefore $odm^+(G) = 4$ for $n \geq 4$. □

3. Some Results On The Upper Open Detour Monophonic Number of a Graph

Theorem 3.1. *For a connected graph G, $2 \leq odm(G) \leq odm^+(G) \leq n$.*

Proof. Any open detour monophonic set needs at least two vertices and so $odm(G) \geq 2$. Since every minimal open detour monophonic set is an open detour monophonic set, $odm(G) \leq odm^+(G)$. Also, since $V(G)$ is an open detour monophonic set of G, it is clear that $odm^+(G) \leq n$. Thus $2 \leq odm(G) \leq odm^+(G) \leq n$. □

Theorem 3.2. *For a connected graph G of order n, $odm^+(G) = 2$ if and only if $odm(G) = 2$.*

Proof. Let $odm^+(G) = 2$. Then by Theorem 3.1, $odm(G) = 2$. Conversely, let $odm(G) = 2$. Let M be a odm-set of G with $|M| = 2$. Then by Theorem 1.1, M consists of two detour simplicial vertices. By Theorem 1.1, M is a subset of every open detour monophonic set of G. Hence it follows that M is the unique minimal open detour monophonic set of G. Therefore $odm^+(G) = 2$. □

Theorem 3.3. *Let G be a connected graph. If G has a minimal open detour monophonic set M of cardinality three, then all the vertices in M are detour monophonic simplicial vertices.*

Proof. Let $M = \{x, y, z\}$ be a minimal open detour monophonic set of G. On the contrary suppose that z is not a detour monophonic simplicial vertex of G. We consider the following three cases.

Case(1) x and y are non-detour simplicial vertices of G. Then M is the set of M contains no detour monophonic simplicial vertices. By Theorem 1.2, $odm(G) \geq 4$, which is a contradiction.

Case(2) x is a detour monophonic simplicial vertex of G and y is not detour monophonic simplicial vertex of G. Since M is an open detour monophonic set of G, we have $y \in J_{dm}(x, z)$ and $z \in J_{dm}(x, y)$. Then we have $d_m(x, z) > d_m(x, y)$ and $d_m(x, y) > d_m(x, z)$. Hence $d_m(x, y) > d_m(x, y)$, which is a contradiction.

Case(3) x and y are detour monophonic simplicial vertices of G. Since M is an open detour monophonic simplicial vertex of G. We have $z \in J_{dm}(x, y)$. Let $d_m(u, v) = l$ and P be an u - v detour monophonic path of length k. Let us assume that $d(x, z) = k_1$ and $d(y, z) = k_1$. Then $k_1 + k_1 \leq k$. Let P' be a x - z subpath of P and P'' a z - y subpath of P. We prove that $M' = \{x, y\}$ is an open detour monophonic set of G. Let $v \in V - M'$. Then v is non-detour simplicial vertex of G. It follows that x and y are the only two detour monophonic vertices of G. We have $v \in J_{dm}(y, z)$ or $v \in J_{dm}(x, z)$. If $v \in J_{dm}(x, y)$, then nothing to prove. Let us assume that $v \in I_d(x, z)$. Let v be an internal vertex of detour monophonic x - z, say R. Let a be the $x - y$ walk obtained from R followed by P''. Then $|R| = k$ and so R is a x - y detour monophonic containing v. Thus $v \in J_{dm}(x, y)$. Similarly, if $v \in J_{dm}(x, z)$, we can prove that

$v \in J_{dm}(x,y)$. Hence $M^{'}$ is an open detour monophonic set of G with $M^{'} \subset M$, which is a contradiction to M a minimal open detour monophonic set of G. Therefore all the vertices of detour monophonic simplicial vertex of G. □

Theorem 3.4. *For a connected graph G of order n, $odm^+(G) = 3$ if and only if $odm(G) = 3$.*

Proof. Let $odm(G) = 3$. Let M be a odm-set of G. Since every minimum open detour monophonic set of G is a minimal open detour monophonic set of G, by Theorem 3.3, all the vertices of M are detour simplicial vertices. Then by Theorem 1.1, $odm^+(G) = 3$. Conversely, let $odm^+(G) = 3$. Let S be a minimal open detour monophonic set of G. Then by Theorem 1.1, all the vertices of M are detour simplicial vertices. Hence it follows from Theorem 1.1 that $odm(G) = 3$. □

Theorem 3.5. *For a connected graph G of order n, $odm^+(G) = n$ if and only if $odm(G) = n$.*

Proof. Let $odm^+(G) = n$. Then $M = V(G)$ is the unique minimal open detour monophonic set of G. Since no proper subset of M is an open detour monophonic set, it is clear that M is the unique minimum open detour monophonic set of G and so $odm(G) = n$. The converse follows from Theorem 3.1. □

Theorem 3.6. *For positive integers r_m, d_m and $l \geq 4$ with $r_m < d_m$, there exists a connected graph G with $rad_m G = r_m$, $dia_m G = d_m$ and $odm^+(G) = l$.*

Proof. For convenience, we assume $r_m = r$ and $d_m = d$. When $r = 1$, we let $G = K_l$. Then the result follows from Corollary 2.9. Let $r \geq 2$. Let $C_{r+2} v_1, v_2, ..., v_{r+2}$ be a cycle of length $r+2$ and let $P_{d-r+1} : u_0, u_1, u_2, ..., u_{d-d}$. Let H be a graph obtained from C_{r+2} and P_{d-r+1} by identifying v_1 in C_{r+2} and u_0 in P_{d-r+1}. Now add $l-3$ new vertices $w_1, w_2, ..., w_{l-3}$ to H and join each w_i $(1 \leq i \leq l-3)$ to the vertex u_{d-r-1} and obtain the graph G of Figure 3.1. Then $rad_m G = r$ and $diama_m G = d$. Let $W = \{w_1, w_2, ..., w_{l-3}, u_{d-r}\}$ be the set of all end-vertices of G. Then by Theorem 1.1, W is contained in every open detour monophonic set of G. $M_1 = W \cup \{v_3, v_{r+1}\}$. Then M_1 is an open detour monophonic set of G. If M_1 is not a minimal open detour monophonic set of G, then there is a proper subset T of M_1 such that T is an open detour monophonic set of G. Then there exists $v \in M_1$ such that $v \notin T$. By Theorem 1.1, $v \neq w_i$ $(1 \leq i \leq l-3)$ and $v \neq u_{d-r}$. Therefore v is either v_3 or v_{r+2}. If $v = v_2$, then v_2 does not lie on a detour monophonic path joining some vertices of T. If $v = v_{r+1}$, then v_{r+1} does not lie on a detour monophonic path joining some vertices of T and so T is not an open detour monophonic set of G, which is a contradiction. Thus M_1 is a minimal open detour monophonic set of G and so $odm^+(G) \geq l$. We show that $odm^+(G) = l$. Suppose that $odm^+(G) \geq l+1$. Let $T^{'}$ be a minimal open detour monophonic set of G with $\mid T^{'} \mid \geq l+1$. By Theorem 2.4, $W \subseteq T^{'}$. Since $W \cup \{v_i\}$ $(3 \leq i \leq r+1)$ is an open detour monophonic set of G, $v_i \notin T^{'}$ $(3 \leq i \leq r+1)$. Since M_1 is an open detour monophonic set of G,$v_2, v_{r+2} \notin T^{'}$. By Theorem 2.6, $u_i \notin T^{'}$ $(0 \in i \in d-r-1)$. Hence no such $T^{'}$ exists. Therefore $odm^+(G) = l$. □

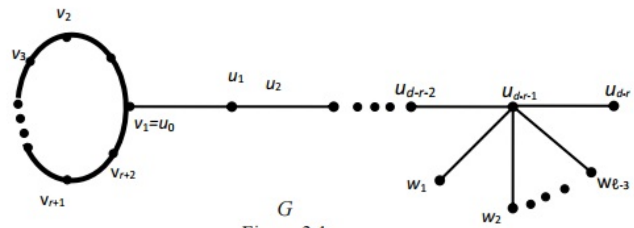


Figure 3.1

In view of Theorem 3.1, we have the following realization result.

Theorem 3.7. *For every pair a and b of positive integers with $2 \leq a \leq b$, there exists a connected graph G such that $odm(G) = a$ and $odm^+(G) = b$.*

Proof. Let $P_7 : v_1, v_2, v_3, v_4, v_5, v_6, v_7$ be a path on seven vertices. Let K be a graph obtained from K_{a-2} and K_{b-a} with $V(K_{a-2}) = \{z_1, z\{\{2, ..., z_{a-2}\}$ and $V(K_{b-a}) = \{h_1, h_2, ..., h_{b-a}\}$ by joining each z_i $(1 \leq i \leq a-2)$ with v_1 and each h_i $(1 \leq i \leq b-a)$. Let G be the graph obtained from H and K by joining each h_i $(1 \leq i \leq b-a)$ with v_7. The graph G is obtained in Figure 3.2.

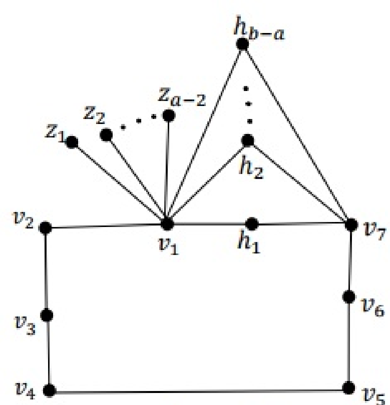


Figure 3.2

First we show that $odm(G) = a$. Let $Z = \{z_1, z_2, ..., z_{a-2}\}$ be the set of all end vertices of G. Then by Theorem 1.1, Z is a subset of every open detour monophonic set of G and so $od_m(G) \geq a-2$. It is easily verified that Z or $Z \cup \{x\}$, where $u \notin Z$ is not an open detour monophonic set of G so that $odm(G) \geq a$. Let $M = Z \cup \{v_4, v_7\}$. Then M is an open detour monophonic set of G so that $odm(G) = a$.

Next we prove that $odm^+(G) = b$. Let $M = Z \cup \{h_1, h_2, ..., h_{b-a}\} \cup \{v_2, v_7\}$. Then M is an open detour monophonic set of G. We prove that M is a minimal open detour monophonic set of G. On the contrary suppose M is not a minimal open detour monophonic set of G. Then there exists an open detour monophonic set M of G such that $M^{'} \subset M$.

Then there exists $x \in M$ such that $x \notin M^{'}$. By Theorem 1.1, $x \neq z_i$ for all i $(1 \leq i \leq a-2)$. If $x = h_i$ for some $(1 \leq i \leq b-a)$, then $x \in J_{dm}(M)$, If $x = v_2$ then $v_7, h_i \notin I(M)$ for all i $(1 \leq i \leq b-a)$. If $x = v_7$, then $v_2, h_i \notin I(M)$ for all i $(1 \leq i \leq b-a)$. Therefore $M^{'}$ is not an open detour monophonic set of G, which is a contradiction. Therefore M is a minimal open detour monophonic set of G and so $odm^{+}(G) = b$. Suppose that $odm^{+}(G) \geq b+1$. Then there exist a minimal open detour monophonic set $M^{'}$ of G such that $\mid M^{'} \mid \geq b+1$. Then by similar argument as above, we prove that $M^{'}$ is not a minimal open detour monophonic set of G. Therefore $odm^{+}(G) = b$. □

Acknowledgment

The authors would like to thank anonymous reviewers for their valuable and constructive comments.

References

[1] M. C. Dourado, Fabio Protti and Jayme. L. Szwarcter, Algorithmic aspects of mono- phonic convexity, *Electronic Notes in Discrete Mathematics*, 30, (2008), 177 - 182.

[2] F. Harary. Graph Theory. Addison-Wesley, 1969.

[3] J. John and S. Panchali, The upper monophonic number of a graph, *Int. J. Math. Combin.* 4, (2010), 46 – 52

[4] J. John, P. Arul Paul Sudhahar and A. Vijayan, The connected monophonic number of a graph, *International Journal of Combinatorial Graph Theory and Applications*, 5(1), (2012), 83-90.

[5] J. John ,P. Arul Paul Sudhahar and A. Vijayan, The connected edge monophonic number of a graph, *Journal of Computer and Mathematical Sciences*, 3 (2), (2012), 131-136.

[6] J. John and S. Panchali, The forcing monophonic number of a graph, *IJMA*-3 (3), (2012), 935– 938.

[7] J. John and K.U. Samundeswari, The forcing edge fixing edge-to-vertex monophonic number of a graph, *Discrete Math. Algorithms Appl.*, 5(4), (2013), 1 – 10.

[8] J. John and K.U. Samundeswari, The edge fixing edge-to-vertex monophonic number of a graph, *Appl. Math. E-Notes*, 15, (2015), 261 – 275.

[9] J. John and K.U. Samundeswari, Total and forcing total edge-to-vertex monophonic numbers of graph, *J. Comb. Optim.*, 34, (2017), 1 – 14.

[10] J. John, D. Stalin and P. Arul Paul Sudhahar, On the (M,D) number of a graph, *Proyecciones Journal of Mathematics*, 38 (2),(2019), 255-266,

[11] J. John, On the forcing monophonic and forcing geodetic numbers of a graph, *Indonesian Journal of Combinatorics*, 4(2), (2020), 114 – 125.

[12] J. John and V. R. Sunil Kumar, The open detour number of a graph, *Discrete Mathematics, Algorithms and Applications*, 13(1),(2021),2050088(12 pages)

[13] K.Krishna Kumari, S.Kavitha and D.Nidha, The open detour monophonic number of a graph.(communicated)

[14] K.Krishna Kumari, S.Kavitha and D.Nidha, The open detour monophonic number of join,corona product and cluster product of graphs.(communicated)

[15] A. P. Santhakumaran and P. Titus, Monophonic Distance in Graphs, D*iscrete Mathematics, Algorithms and Applications*, 3(2), (2011),159-169.

[16] P. Titus, K. Ganesamoorthy and P. Balakrishnan. The Detour Monophonic Number of a Graph, *J. Combin. Math. Combin. Comput.*, 84(2013), 179-188.

⋆⋆⋆⋆⋆⋆⋆⋆⋆
ISSN(P):2319 – 3786
Malaya Journal of Matematik
ISSN(O):2321 – 5666
⋆⋆⋆⋆⋆⋆⋆⋆⋆