RESEARCHERID
THOMSON REUTERS

[Kulli * *et al.*, 7(3): March, 2018]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ON FIFTH MULTIPLICATIVE ZAGREB INDICES OF TETRATHIAFULVALENE AND POPAM DENDRIMERS

V.R.Kulli*
*Department of Mathematics, Gulbarga University, Gulbarga 585106, India

DOI: 10.5281/zenodo.1199388

ABSTRACT

A topological index is a numerical parameter mathematically derived from the graph structure. In this paper, we compute the general fifth multiplicative M-Zagreb indices, fifth multiplicative product connectivity index, fifth multiplicative sum connectivity index, fourth multiplicative atom bond connectivity index and fifth multiplicative geometric-arithmetic index of different chemically interesting dendrimers like tetrathiafulvalene and POPAM dendrimers.

Keywords: molecular graph, fifth multiplicative indices, connectivity indices, dendrimer.
Mathematics Subject Classification: 05*C*05, 05*C*07, 05*C*35.

I. INTRODUCTION

Let G be a finite, simple connected graph with vertex set $V(G)$ and edge set $E(G)$. A molecular graph is a simple graph related to the structure of a chemical compound. Each vertex of a molecular graph represents an atom of the molecule and its edges to the bonds between atoms. Let $S_G(u)$ denote the sum of the degrees of all vertices adjacent to a vertex u. For other undefined notations, readers may refer to [1].

Chemical Graph Theory has an important effect on the development of Chemical Sciences. A topological index is a numerical parameter mathematically derived from the graph structure. Numerous topological indices have been considered in Theoretical Chemistry, especially in quantitative structure activity (*QSAR*) and quantitative structure property (*QSPR*) study, see [2].

The fifth multiplicative Zagreb indices were introduced by Kulli in [3] and they are defined as

$$M_1G_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)+S_G(v)\right], \qquad M_2G_5II(G)=\prod_{uv\in E(G)}S_G(u)S_G(v).$$

In [4], Kulli introduced the fifth multiplicative hyper-Zagreb indices, the general fifth multiplcative Zagreb indices, fifth multiplicative product connectivity index, fifth multiplicative sum connectivity index. They are defined as follows:

The fifth multiplicative hyper-Zagreb indices of a graph G are defined as

$$HM_1G_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)+S_G(v)\right]^2, \qquad HM_2G_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)S_G(v)\right]^2.$$

The fifth multiplicative sum connectivity index of a graph G is defined as

$$S_5II(G)=\prod_{uv\in E(G)}\frac{1}{\sqrt{S_G(u)+S_G(v)}}.$$

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

The fifth multiplicative product connectivity index of a graph *G* is defined as

$$P_5II(G)=\prod_{uv\in E(G)}\frac{1}{\sqrt{S_G(u)S_G(v)}}.$$

The general fifth multiplicative Zagreb indices of a graph *G* are defined as

$$M_1^aG_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)+S_G(v)\right]^a,$$

$$M_2^aG_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)S_G(v)\right]^a \qquad (1)$$

where *a* is a real number.

In [5], Kulli introduced the fourth multiplicative atom bond connectivity index of a graph *G* and it is defined as

$$ABC_4II(G)=\prod_{uv\in E(G)}\sqrt{\frac{S_G(u)+S_G(v)-2}{S_G(u)S_G(v)}}. \qquad (2)$$

The fifth multiplicative geometric-arithmetic index of a graph *G* was introduced by Kulli in [3] and it is defined as

$$GA_5II(G)=\prod_{uv\in E(G)}\frac{2\sqrt{S_G(u)S_G(v)}}{S_G(u)+S_G(v)}. \qquad (3)$$

Recently many other multiplicative indices were studied, for example, in [6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19].

In this paper, we compute the general fifth multiplicative M-Zagreb indices, fifth multiplicative product connectivity index, fifth multiplicative sum connectivity index, fourth multiplicative atom bond connectivity index and fifth multiplicative geometric-arithmetic index of tetrathiafulvalene and POPAM dendrimers. For more information about these dendrimers, see [20, 21].

II. TETRATHIAFULVALENE DENDRIMERS $TD_2[n]$

In this section, we focus on the molecular graph of a tetrathiafulvalene dendrimer. This family of tetrathiafulvalene dendrimers is denoted by $TD_2[n]$, where *n* is the steps of growth in this type of dendrimers for $n\geq 0$. The molecular graph of $TD_2[2]$ is shown in Figure 1.

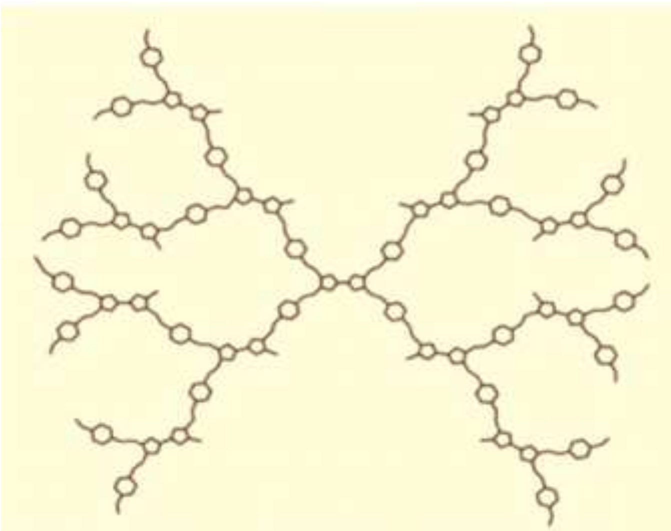

Figure 1. The molecular graph of $TD_2[2]$

Let G be the molecular graph of tetrathiafulvalene dendrimers $TD_2[n]$. By algebraic method, we obtain that $|V(G)|=31\times2^{n+2} - 74$ and $|E(G)|=35\times2^{n+2} - 85$. Also the edge partition of $TD_2[n]$ based on the degree sum of neighbors of end vertices of each edge is obtained as given in Table 1.

Table 1. Edge partition of $TD_2[n]$

$S_G(u), S_G(v)\backslash uv\in E(G)$	Number of edges
(2, 4)	2^{n+2}
(3, 6)	$2^{n+2} - 4$
(4, 6)	2^{n+2}
(5, 5)	$7\times2^{n+2} - 16$
(5, 6)	$11\times2^{n+2} - 24$
(5, 7)	$3\times2^{n+2} - 8$
(6, 6)	$2^{n+2} - 4$
(6, 7)	$8\times2^{n+2} - 24$
(7, 7)	$2\times2^{n+2} - 5$

Theorem 1. The general fifth multiplicative M_1-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$M_1^aG_5II(G)=6^{a(2^{n+2})}\times9^{a(2^{n+2}-4)}\times10^{a(8\times2^{n+2}-16)}\times11^{a(11\times2^{n+2}-24)}$$
$$\times12^{a(4\times2^{n+2}-12)}\times13^{a(8\times2^{n+2}-24)}\times14^{a(2\times2^{n+2}-5)}. \qquad (4)$$

Proof: From equation (1) and Table 1, we derive

$$M_1^aG_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)+S_G(v)\right]^a$$
$$=6^{a(2^{n+2})}\times9^{a(2^{n+2}-4)}\times10^{a(8\times2^{n+2}-16)}\times11^{a(11\times2^{n+2}-24)}$$
$$\times12^{a(4\times2^{n+2}-12)}\times13^{a(8\times2^{n+2}-24)}\times14^{a(2\times2^{n+2}-5)}.$$

Corollary 1.1. The fifth multiplicative M_1-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$M_1G_5II(G)=6^{2^{n+2}}\times9^{2^{n+2}-4}\times10^{8\times2^{n+2}-16}\times11^{11\times2^{n+2}-24}$$
$$\times12^{4\times2^{n+2}-12}\times13^{8\times2^{n+2}-24}\times14^{2\times2^{n+2}-5}.$$

Proof: Put a = 1 in equation (4), we get the desired result.

Corollary 1.2. The fifth multiplicative M_1 hyper-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$HM_1G_5II(G)=6^{2^{n+3}}\times9^{2^{n+3}-8}\times10^{8\times2^{n+3}-32}\times11^{11\times2^{n+3}-48}$$
$$\times12^{4\times2^{n+3}-24}\times13^{8\times2^{n+3}-48}\times14^{2\times2^{n+3}-10}.$$

Proof: Put a = 2 in equation (4), we get the desired result.

Corollary 1.3. The fifth multiplicative sum connectivity index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$S_5II(G)=\left(\frac{1}{\sqrt{6}}\right)^{2^{n+2}}\times\left(\frac{1}{\sqrt{9}}\right)^{2^{n+2}-4}\times\left(\frac{1}{\sqrt{10}}\right)^{8\times2^{n+2}-16}\times\left(\frac{1}{\sqrt{11}}\right)^{11\times2^{n+2}-24}$$
$$\times\left(\frac{1}{\sqrt{12}}\right)^{4\times2^{n+2}-12}\times\left(\frac{1}{\sqrt{13}}\right)^{8\times2^{n+2}-24}\times\left(\frac{1}{\sqrt{14}}\right)^{11\times2^{n+2}-5}.$$

Proof: Put $a = -\frac{1}{2}$ in equation (4), we get the desired result.

Theorem 2. The general fifth multiplicative M_2-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$M_2^aG_5II(G) = 8^{a\times 2^{n+2}} \times 18^{a(2^{n+2}-4)} \times 24^{a\times 2^{n+2}} \times 25^{a(7\times 2^{n+2}-16)}$$
$$\times 30^{a(11\times 2^{n+2}-24)} \times 35^{a(3\times 2^{n+2}-8)} \times 36^{a(2^{n+2}-4)} \times 42^{a(8\times 2^{n+2}-24)} \times 49^{a(2\times 2^{n+2}-5)}. \qquad (5)$$

Proof: From equation (1) and Table 1, we deduce

$$M_2^aG_5II(G) = \prod_{uv\in E(G)} \left[S_G(u)S_G(v)\right]^a$$
$$= 8^{a\times 2^{n+2}} \times 18^{a(2^{n+2}-4)} \times 24^{a\times 2^{n+2}} \times 25^{a(7\times 2^{n+2}-16)}$$
$$\times 30^{a(11\times 2^{n+2}-24)} \times 35^{a(3\times 2^{n+2}-8)} \times 36^{a(2^{n+2}-4)} \times 42^{a(8\times 2^{n+2}-24)} \times 49^{a(2\times 2^{n+2}-5)}.$$

Corollary 2.1. The fifth multiplicative M_2-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$M_2G_5II(G) = 8^{2^{n+2}} \times 18^{2^{n+2}-4} \times 24^{2^{n+2}} \times 25^{7\times 2^{n+2}-24}$$
$$\times 30^{11\times 2^{n+2}-24} \times 35^{3\times 2^{n+2}-8} \times 36^{2^{n+2}-4} \times 42^{8\times 2^{n+2}-24} \times 49^{2\times 2^{n+2}-5}.$$

Proof: Put a = 1 in equation (5), we get the desired result.

Corollary 2.2. The fifth multiplicative M_2 hyper-Zagreb index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$M_2G_5II(G) = 8^{2^{n+3}} \times 18^{2^{n+3}-8} \times 24^{2^{n+3}} \times 25^{7\times 2^{n+3}-48}$$

$$\times 30^{11\times 2^{n+3}-48} \times 35^{3\times 2^{n+3}-16} \times 36^{2^{n+3}-8} \times 42^{8\times 2^{n+2}-48} \times 49^{2\times 2^{n+3}-10}.$$

Proof: Put a = 2 in equation (5), we get the desired result.

Corollary 2.3. The fifth multiplicative product connectivity index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$P_5II(G) = \left(\frac{1}{\sqrt{8}}\right)^{2^{n+2}} \times \left(\frac{1}{\sqrt{18}}\right)^{2^{n+2}-4} \times \left(\frac{1}{\sqrt{24}}\right)^{2^{n+2}} \times \left(\frac{1}{\sqrt{25}}\right)^{7\times 2^{n+2}-24} \times \left(\frac{1}{\sqrt{30}}\right)^{11\times 2^{n+2}-24}$$
$$\times \left(\frac{1}{\sqrt{35}}\right)^{3\times 2^{n+2}-8} \times \left(\frac{1}{\sqrt{36}}\right)^{2^{n+2}-4} \times \left(\frac{1}{\sqrt{42}}\right)^{8\times 2^{n+2}-24} \times \left(\frac{1}{\sqrt{49}}\right)^{2\times 2^{n+2}-5}.$$

Proof: Put $a = -\frac{1}{2}$ in equation (5), we get the desired result.

Theorem 3. The fourth multiplicative atom bond connectivity index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$ABC_4II(G) = \left(\frac{1}{\sqrt{2}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{7}{18}}\right)^{2^{n+2}-4} \times \left(\frac{1}{\sqrt{3}}\right)^{2^{n+2}} \times \left(\frac{\sqrt{8}}{5}\right)^{7\times 2^{n+2}-16} \times \left(\sqrt{\frac{3}{10}}\right)^{11\times 2^{n+2}-24}$$
$$\times \left(\sqrt{\frac{2}{7}}\right)^{3\times 2^{n+2}-8} \times \left(\frac{\sqrt{10}}{6}\right)^{2^{n+2}-4} \times \left(\sqrt{\frac{11}{42}}\right)^{8\times 2^{n+2}-24} \times \left(\frac{\sqrt{12}}{7}\right)^{2\times 2^{n+2}-5}.$$

Proof: From equation (2) and Table 1, we derive

$$ABC_4II(G) = \prod_{uv\in E(G)} \sqrt{\frac{S_G(u)+S_G(v)-2}{S_G(u)S_G(v)}}$$

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

$$=\left(\sqrt{\frac{2+4-2}{2\times 4}}\right)^{2^{n+2}}\times\left(\sqrt{\frac{3+6-2}{3\times 6}}\right)^{2^{n+2}-4}\times\left(\sqrt{\frac{4+6-2}{4\times 6}}\right)^{2^{n+2}}\times\left(\sqrt{\frac{5+5-2}{5\times 5}}\right)^{7\times 2^{n+2}-16}\times\left(\sqrt{\frac{5+6-2}{5\times 6}}\right)^{11\times 2^{n+2}-24}$$

$$\times\left(\sqrt{\frac{5+7-2}{5\times 7}}\right)^{3\times 2^{n+2}-8}\times\left(\sqrt{\frac{6+6-2}{6\times 6}}\right)^{2^{n+2}-4}\times\left(\sqrt{\frac{6+7-2}{6\times 7}}\right)^{8\times 2^{n+2}-24}\times\left(\sqrt{\frac{7+7-2}{7\times 7}}\right)^{2\times 2^{n+2}-5}.$$

$$=\left(\frac{1}{\sqrt{2}}\right)^{2^{n+2}}\times\left(\sqrt{\frac{7}{18}}\right)^{2^{n+2}-4}\times\left(\frac{1}{\sqrt{3}}\right)^{2^{n+2}}\times\left(\frac{\sqrt{8}}{5}\right)^{7\times 2^{n+2}-16}\times\left(\sqrt{\frac{3}{10}}\right)^{11\times 2^{n+2}-24}$$

$$\times\left(\sqrt{\frac{2}{7}}\right)^{3\times 2^{n+2}-8}\times\left(\frac{\sqrt{10}}{6}\right)^{2^{n+2}-4}\times\left(\sqrt{\frac{11}{42}}\right)^{8\times 2^{n+2}-24}\times\left(\frac{\sqrt{12}}{7}\right)^{2\times 2^{n+2}-5}.$$

Theorem 4. The fifth multiplicative geometric-arithmetic index of a tetrathiafulvalene dendrimer $TD_2[n]$ is

$$GA_5II(G)=\left(\frac{2\sqrt{2}}{3}\right)^{2\left(2^{n+2}-2\right)}\times\left(\frac{2\sqrt{6}}{5}\right)^{2^{n+2}}\times\left(\frac{2\sqrt{30}}{11}\right)^{11\times 2^{n+2}-24}\times\left(\frac{\sqrt{35}}{6}\right)^{3\times 2^{n+2}-8}\times\left(\frac{2\sqrt{42}}{13}\right)^{8\times 2^{n+2}-24}.$$

Proof: From equation (3) and Table 1, we derive

$$GA_5II(G)=\prod_{uv\in E(G)}\frac{2\sqrt{S_G(u)S_G(v)}}{S_G(u)+S_G(v)}$$

$$=\left(\frac{2\sqrt{2\times 4}}{2+4}\right)^{2^{n+2}}\times\left(\frac{2\sqrt{3\times 6}}{3+6}\right)^{2^{n+2}-4}\times\left(\frac{2\sqrt{4\times 6}}{4+6}\right)^{2^{n+2}}\times\left(\frac{2\sqrt{5\times 5}}{5+5}\right)^{7\times 2^{n+2}-16}\times\left(\frac{2\sqrt{5\times 6}}{5+6}\right)^{11\times 2^{n+2}-24}$$

$$\times\left(\frac{2\sqrt{5\times 7}}{5+7}\right)^{3\times 2^{n+2}-8}\times\left(\frac{2\sqrt{6\times 6}}{6+6}\right)^{2^{n+2}-4}\times\left(\frac{2\sqrt{6\times 7}}{6+7}\right)^{8\times 2^{n+2}-24}\times\left(\frac{2\sqrt{7\times 7}}{7+7}\right)^{2\times 2^{n+2}-5}.$$

$$=\left(\frac{2\sqrt{2}}{3}\right)^{2\left(2^{n+2}-2\right)}\times\left(\frac{2\sqrt{6}}{5}\right)^{2^{n+2}}\times\left(\frac{2\sqrt{30}}{11}\right)^{11\times 2^{n+2}-24}\times\left(\frac{\sqrt{35}}{6}\right)^{3\times 2^{n+2}-8}\times\left(\frac{2\sqrt{42}}{13}\right)^{8\times 2^{n+2}-24}.$$

III. POPAM DENDRIMERS $TD_2[n]$

In this section, we focus on the molecular graph of POPAM dendrimers. This family of dendrimers is denoted by $POD_2[n]$, where n is the steps of growth in this type of dendrimers. The molecular graph of $POD_2[2]$ is shown in Figure 2.

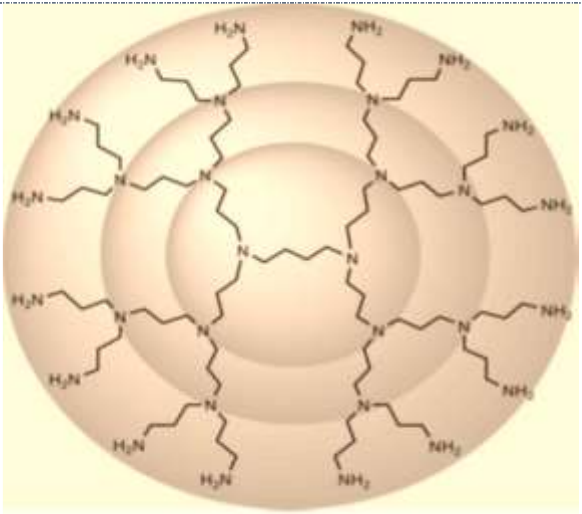

Figure 2. The graph of POPAM dendrimer $POD_2[2]$

Let G be the molecular graph of POPAM dendrimers $POD_2[n]$. By algebraic method, we obtain that $|V(POD_2[n])|= 2^{n+5} – 10$ and $|E(POD_2[n])|= 2^{n+5} – 11$. The edge partition of $POD_2[n]$ based on the degree sum of neighbors of end vertices of each edge is obtained as given in Table 2.

Table 2. Edge partition of $POD_2[n]$

$S_G(u), S_G(v)\backslash uv\in E(G)$	(2, 3)	(3, 4)	(4, 4)	(4, 5)	(5, 6)
Number of edges	2^{n+2}	2^{n+2}	1	$3\times2^n – 6$	$3\times2^n – 6$

Theorem 5. The general fifth multiplicative M_1-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$M_1^aG_5II(G)=5^{a\left(2^{n+2}\right)}\times 7^{a\left(2^{n+2}\right)}\times 8^a\times 9^{a\left(3\times2^n-6\right)}\times 11^{a\left(3\times2^n-6\right)}. \qquad (6)$$

Proof: From equation (1) and Table 2, we derive

$$M_1^aG_5II(G)=\prod_{uv\in E(G)}\left[S_G(u)+S_G(v)\right]^a$$

$$=5^{a\left(2^{n+2}\right)}\times 7^{a\left(2^{n+2}\right)}\times 8^a\times 9^{a\left(3\times2^n-6\right)}\times 11^{a\left(3\times2^n-6\right)}.$$

Corollary 5.1. The fifth multiplicative M_1-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$M_1G_5II(G)=5^{2^{n+2}}\times 7^{2^{n+2}}\times 8\times 9^{3\times2^n-6}\times 11^{3\times2^n-6}.$$

Proof: Put a = 1 in equation (6), we get the desired result.

Corollary 5.2. The fifth multiplicative M_1 hyper-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$HM_1G_5II(G)=5^{2\times2^{n+2}}\times 7^{2\times2^{n+2}}\times 8^2\times 9^{2\left(3\times2^n-6\right)}\times 11^{2\left(3\times2^n-6\right)}.$$

Proof: Put a = 2 in equation (6), we get the desired result.

Corollary 5.3. The fifth multiplicative sum connectivity index of a POPAM dendrimer $POD_2[n]$ is

$$S_5II(G)=\left(\frac{1}{\sqrt{5}}\right)^{2^{n+2}}\times\left(\frac{1}{\sqrt{7}}\right)^{2^{n+2}}\times\left(\frac{1}{2\sqrt{2}}\right)\times\left(\frac{1}{3}\right)^{3\times2^n-6}\times\left(\frac{1}{\sqrt{11}}\right)^{3\times2^n-6}.$$

Proof: Put $a = -\frac{1}{2}$ in equation (6), we get the desired result.

Theorem 6. The general fifth multiplicative M_2-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$M_2^aG_5II(G) = 6^{a\times 2^{n+2}} \times 12^{a\times 2^{n+2}} \times 16^a \times 20^{a(3\times 2^n-6)} \times 30^{a(3\times 2^n-6)}. \qquad (7)$$

Proof: From equation (1) and Table 2, we derive

$$M_2^aG_5II(G) = \prod_{uv\in E(G)} \left[S_G(u)S_G(v)\right]^a = 6^{a\times 2^{n+2}} \times 12^{a\times 2^{n+2}} \times 16^a \times 20^{a(3\times 2^n-6)} \times 30^{a(3\times 2^n-6)}.$$

Corollary 6.1. The fifth multiplicative M_2-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$M_2G_5II(G) = 6^{2^{n+2}} \times 12^{2^{n+2}} \times 16 \times 20^{3\times 2^n-6} \times 30^{3\times 2^n-6}$$

Proof: Put $a = 1$ in equation (7), we get the desired result.

Corollary 6.2. The fifth multiplicative M_2 hyper-Zagreb index of a POPAM dendrimer $POD_2[n]$ is

$$HM_2G_5II(G) = 6^{2^{n+3}} \times 12^{2^{n+3}} \times 16^2 \times 20^{2(3\times 2^n-6)} \times 30^{2(3\times 2^n-6)}.$$

Proof: Put $a = 2$ in equation (7), we get the desired result.

Corollary 6.3. The fifth multiplicative product connectivity index of a POPAM dendrimer $POD_2[n]$ is

$$P_5II(G) = \left(\frac{1}{\sqrt{6}}\right)^{2^{n+2}} \times \left(\frac{1}{\sqrt{12}}\right)^{2^{n+2}} \times \left(\frac{1}{4}\right) \times \left(\frac{1}{\sqrt{20}}\right)^{3\times 2^n-6} \times \left(\frac{1}{\sqrt{30}}\right)^{3\times 2^n-6}.$$

Proof: Put $a = -\frac{1}{2}$ in equation (7), we get the desired result.

Theorem 7. The fourth multiplicative atom bond connectivity index of a POPAM dendrimer $POD_2[n]$ is

$$ABC_4II(G) = \left(\frac{1}{\sqrt{2}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{5}{12}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{3}{8}}\right) \times \left(\sqrt{\frac{7}{20}}\right)^{3\times 2^n-6} \times \left(\sqrt{\frac{3}{10}}\right)^{3\times 2^n-6}.$$

Proof: From equation (2) and Table 2, we deduce

$$ABC_4II(G) = \prod_{uv\in E(G)} \sqrt{\frac{S_G(u)+S_G(v)-2}{S_G(u)S_G(v)}}$$

$$= \left(\sqrt{\frac{2+3-2}{2\times 3}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{3+4-2}{3\times 4}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{4+4-2}{4\times 4}}\right)^{1} \times \left(\sqrt{\frac{4+5-2}{4\times 5}}\right)^{3\times 2^n-6} \times \left(\sqrt{\frac{5+6-2}{5\times 6}}\right)^{3\times 2^n-6}$$

$$= \left(\frac{1}{\sqrt{2}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{5}{12}}\right)^{2^{n+2}} \times \left(\sqrt{\frac{3}{8}}\right)^{1} \times \left(\sqrt{\frac{7}{20}}\right)^{3\times 2^n-6} \times \left(\sqrt{\frac{3}{10}}\right)^{3\times 2^n-6}.$$

Theorem 8. The fifth multiplicative geometric-arithmetic index of a POPAM dendrimer $POD_2[n]$ is

$$GA_5II(G) = \left(\frac{2\sqrt{6}}{5}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{12}}{7}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{20}}{9}\right)^{3\times 2^{n+2}-6} \times \left(\frac{2\sqrt{30}}{11}\right)^{3\times 2^n-6}.$$

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Proof: From equation (3) and Table 2, we deduce

$$GA_5II(G) = \prod_{uv \in E(G)} \frac{2\sqrt{S_G(u)S_G(v)}}{S_G(u)+S_G(v)}$$

$$= \left(\frac{2\sqrt{2\times 3}}{2+3}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{3\times 4}}{3+4}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{4\times 4}}{4+4}\right)^{1} \times \left(\frac{2\sqrt{4\times 5}}{4+5}\right)^{3\times 2^n-6} \times \left(\frac{2\sqrt{5\times 6}}{5+6}\right)^{3\times 2^n-6}$$

$$= \left(\frac{2\sqrt{6}}{5}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{12}}{7}\right)^{2^{n+2}} \times \left(\frac{2\sqrt{20}}{9}\right)^{3\times 2^n-6} \times \left(\frac{2\sqrt{30}}{11}\right)^{3\times 2^n-6}.$$

IV. REFERENCES

[1] V.R.Kulli, *College Graph Theory*, Vishwa International Publications, Gulbarga, India (2012).
[2] I. Gutman and O.E. Polansky, *Mathematical Concepts in Organic Chemistry*, *Springer*, Berlin, (1986).
[3] V.R.Kulli, Some new multiplicative geometric-arithmetic indices, *Journal of Ultra Scientist of Physical Sciences*, A, 29(2) (2017) 52-57. DOI: http://dx.doi.org/10.22147/jusps.A/290201.
[4] V.R.Kulli, Some new fifth multiplicative Zagreb indices of PAMAM dendrimers, *Journal of Global Research in Mathematics*, 5(2) (2018) 82-86.
[5] V.R.Kulli, Two new multiplicative atom bond connectivity indices, *Annals of Pure and Applied Mathematics*, 13(1) (2017) 1-7. DOI:http://dx.doi.org/10.22457/apam.vl3nlal.
[6] V.R.Kulli, Multiplicative hyper-Zagreb indices and coindices of graphs: Computing these indices of some nanostructures, *International Research Journal of Pure Algebra*, 6(7), (2016) 342-347.
[7] V.R. Kulli, On multiplicative connectivity indices of certain nanotubes, *Annals of Pure and Applied Mathematics*, 12(2) (2016), 169-176.
[8] V.R. Kulli, First multiplicative *K* Banhatti index and coindex of graphs, *Annals of Pure and Applied Mathematics*, 11(2) (2016) 79-82.
[9] V.R. Kulli, Second multiplicative *K* Banhatti index and coindex of graphs, *Journal of Computer and Mathematical Sciences*, 7(5), (2016) 254-258.
[10] V.R. Kulli, On multiplicative *K* Banhatti and multiplicative *K* hyper-Banhatti indices of *V*-Phenylenic nanotubes and nanotorus, *Annals of Pure and Applied Mathematics*, 11(2) (2016) 145-150.
[11] V.R.Kulli, Multiplicative connectivity indices of nanostructures, *Journal of Ultra Scientist of Physical Sciences*, A 29(1) (2017) 1-10. DOI:http://dx.doi-org/10.22147/jusps.A/290101.
[12] V.R. Kulli, Multiplicative *K* hyper-Banhatti indices and coindices of graphs, *International Journal of Mathematical Archive*, 7(6), (2016) 254-258.
[13] V.R. Kulli, General multiplicative Zagreb indices of $TUC_4C_8[m, n]$ and $TUC_4[m, n]$ nanotubes, *International Journal of Fuzzy Mathematical Archive*, 11(1) (2016) 39-43.
[14] V.R. Kulli, Multiplicative connectivity indices of $TUC_4C_8[m,n]$ and $TUC_4[m,n]$ nanotubes, *Journal of Computer and Mathematical Sciences*, 7(11) (2016) 599-605.
[15] V.R.Kulli, Some new multiplicative atom bond connectivity indices, *Annals of Pure and Applied Mathematics*, 13(1) (2017) 1-7.
[16] V.R.Kulli, A new Banhatti geometric-arithmetic index, *International Journal of Mathematical Archive*, 8(4) (2017) 112-115.
[17] V.R.Kulli, New multiplicative arithmetic-geometric indices, *Journal of Ultra Scientist of Physical Sciences*, A, 29(6) (2017) 205-211.
[18] V.R.Kulli, New multiplicative inverse sum indeg index of certain benzenoid systems, *Journal of Global Research in Mathematical Archives*, 4(10) (2017) 15-19.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

[19] V.R. Kulli, Multiplicative Revan and multiplicative hyper-Revan indices of certain networks, *Journal of Computer and Mathematical Sciences*, 8(12) (2017) 750-757.

[20] V.R.Kulli, General fifth M-Zagreb indices and fifth M-Zagreb polynomials of PAMAM dendrimers, *Journal of Global Research in Mathematical Archives*, 12(1) (2017) 99-103.

[21] M.N.Husin, R. Hasni, N.E.Arif and M.Imran, On topological indices of certain families of nanostar dendrimers, *Molecules*, 21(2016) 821: doi:10.3390/molecule 521070821.

CITE AN ARTICLE

Kulli, V. R. (n.d.). ON FIFTH MULTIPLICATIVE ZAGREB INDICES OF TETRATHIAFULVALENE AND POPAM DENDRIMERS. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 7*(3), 471-479.