International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 7; Issue 2(K); February 2018; Page No. 10359-10362
DOI: http://dx.doi.org/10.24327/ijcar.2018.10362.1751

Research Article

DEGREE BASED MULTIPLICATIVE CONNECTIVITY INDICES OF NANOSTRUCTURES

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A R T I C L E I N F O

Article History:
Received 10th November, 2017
Received in revised form 27th December, 2017
Accepted 4th January, 2018
Published online 28th February, 2018

Key words:
multiplicative product connectivity index, multiplicative sum connectivity index, multiplicative geometric-arithmetic index, nanotube, nanotorus.

A B S T R A C T

In Chemical Graph Theory, connectivity indices have been found useful in practical application. In this paper, we compute the multiplicative product connectivity index, multiplicative sum connectivity index and geometric-arithmetic index of certain nanotubes and nanotorus.

INTRODUCTION

All graphs considered here are finite, simple connected graphs. Let G be a connected graph with vertex set $V(G)$ and edge set $E(G)$. The degree $d_G(v)$ of a vertex v is the number of vertices adjacent to v. For all further notation and terminology, we refer to the reader to [1].

A molecular graph is a finite simple graph such that its vertices correspond to the atoms and the edges to the bonds. Chemical graph theory is a branch of Mathematical Chemistry which has an important effect on the development of Chemical Sciences. There are many connectivity indices that have some applications in Chemistry, see [2].

Motivated by the definition of the product connectivity index and its wide applications, Kulli [3] introduced the multiplicative product connectivity index, multiplicative sum connectivity index and multiplicative geometric-arithmetic index of a molecular graph as follows:

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

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

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

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

The multiplicative geometric-arithmetic index of a graph G is defined as

$$GAII(G)=\prod_{uv\in E(G)}\frac{2\sqrt{d_G(u)d_G(v)}}{d_G(u)+d_G(v)}.$$

Recently, several multiplicative indices were studied, for example, in [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18]. Also some connectivity indices were studied, for example, in [19, 20, 21, 22, 23, 24, 25, 26]. In this paper, we compute the multiplicative product connectivity index, multiplicative sum connectivity index and multiplicative geometric-arithmetic index of $TUC_4C_8(S)$ nanotubes and $TUC_4C_8(R)$ nanotorus. For more information about nanotubes and nanotorus see [27].

$KTUC_4C_8(S)$ Nanotubes

In this section, we consider a family of $TUC_4C_8(S)$ nanotubes.

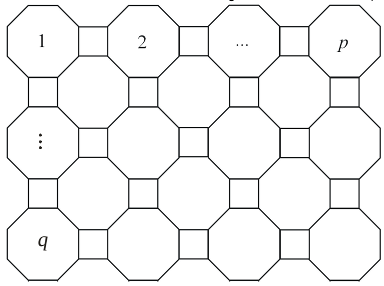

Figure 1 The graph of $KTUC_4C_8[p,q]$ nanotube

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The 2-dimensional lattice of $TUC_4C_8(S)$ is denoted by K=$KTUC_4C_8[p,q]$ where q is the number of rows and p is the number of columns, see Figure 1.

Let K be the molecular graph of $KTUC_4C_8[p,q]$ nanotube. By calculation, we obtain that K has three types of edges based on the degree of end vertices of each edge as given in Table 1.

Table 1 Edge partition of K

$d_K(u), d_K(v)\backslash uv \in E(K)$	(2, 2)	(2, 3)	(3, 3)
Number of edges	$2p+2q+4$	$4p+4q–8$	$12pq – 8(p+q)+4$

Theorem 1: The multiplicative product connectivity index of $KTUC_4C_8[p,q]$ nanotube is

$$PII\left(KTUC_4C_8[p,q]\right)=\left(\frac{1}{2}\right)^{2p+2q+4}\times\left(\frac{1}{6}\right)^{2p+2q-4}\times\left(\frac{1}{3}\right)^{12pq-8(p+q)+4}.$$

Proof: By definition, we have

$$PII(K)=\prod_{uv\in E(K)}\frac{1}{\sqrt{d_K(u)d_K(v)}}.$$

By using Table 1, we deduce

$$PII\left(KTUC_4C_8[p,q]\right)=\left(\frac{1}{\sqrt{2\times2}}\right)^{2p+2q+4}\times\left(\frac{1}{\sqrt{2\times3}}\right)^{4p+4q-8}\times\left(\frac{1}{\sqrt{3\times3}}\right)^{12pq-8(p+q)+4}$$

$$=\left(\frac{1}{2}\right)^{2p+2q+4}\times\left(\frac{1}{6}\right)^{2p+2q-4}\times\left(\frac{1}{3}\right)^{12pq-8(p+q)+4}.$$

Theorem 2: The multiplicative sum connectivity index of $KTUC_4C_8[p,q]$ nanotube is

$$SII\left(KTUC_4C_8[p,q]\right)=\left(\frac{1}{2}\right)^{2p+2q+4}\times\left(\frac{1}{5}\right)^{2p+2q-4}\times\left(\frac{1}{6}\right)^{6pq-4(p+q)+2}.$$

Proof: By definition, we have

$$SII(K)=\prod_{uv\in E(K)}\frac{1}{\sqrt{d_K(u)+d_K(v)}}.$$

By using Table 1, we have

$$SII\left(KTUC_4C_8[p,q]\right)=\left(\frac{1}{\sqrt{2+2}}\right)^{2p+2q+4}\times\left(\frac{1}{\sqrt{2+3}}\right)^{4p+4q-8}\times\left(\frac{1}{\sqrt{3+3}}\right)^{12pq-8(p+q)+4}$$

$$=\left(\frac{1}{2}\right)^{2p+2q+4}\times\left(\frac{1}{5}\right)^{2p+2q-4}\times\left(\frac{1}{6}\right)^{6pq-4(p+q)+2}.$$

Theorem 3: The multiplicative geometric-arithmetic index of $KTUC_4C_8[p,q]$ nanotube is

$$GAII\left(KTUC_4C_8[p,q]\right)=\left(\frac{2\sqrt{6}}{5}\right)^{4p+4q-8}.$$

Proof: By definition, we have

$$GAII(K)=\prod_{uv\in E(K)}\frac{2\sqrt{d_K(u)d_K(v)}}{d_K(u)+d_K(v)}.$$

By using Table 1, we deduce

$$GAII\left(KTUC_4C_8[p,q]\right)=\left(\frac{2\sqrt{2\times2}}{2+2}\right)^{2p+2q+4}\times\left(\frac{2\sqrt{2\times3}}{2+3}\right)^{4p\times4q-8}\times\left(\frac{2\sqrt{3\times3}}{3+3}\right)^{12pq-8(p+q)+4}$$

$$=\left(\frac{2\sqrt{6}}{5}\right)^{4p\times4q-8}.$$

$GTUC_4C_8(S)$ Nanotubes

In this section, we consider a family of $TUC_4C_8(S)$ nanotubes. The 2-dimensional lattice of $TUC_4C_8(S)$ is denoted by G=$GTUC_4C_8[p,q]$ where q is the number of rows and p is the number of columns, see Figure 2.

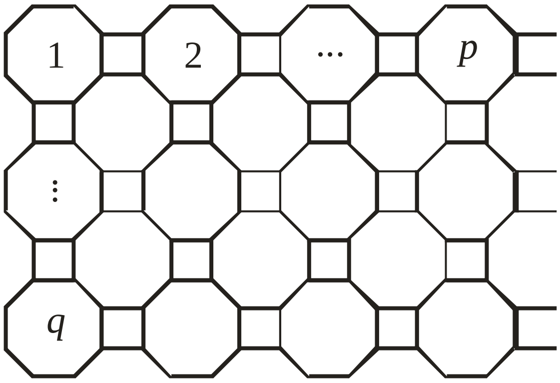

Figure 2 The graph of $GTUC_4C_8[p,q]$ nanotube

Let G be the molecular graph of $GTUC_4C_8[p,q]$ nanotube. By calculation, we obtain that G has three types of edges based on the degree of end vertices of each edge as given in Table 2.

Table 2 Edge partition of G

$d_G(u), d_G(v)\backslash uv \in E(G)$	(2, 2)	(2, 3)	(3, 3)
Number of edges	$2p$	$4p$	$12pq – 8p$

Theorem 4: The multiplicative product connectivity index of $GTUC_4C_8[p,q]$ nanotube is

$$PII\left(GTUC_4C_8[p,q]\right)=\left(\frac{1}{2}\right)^{2p}\times\left(\frac{1}{6}\right)^{2p}\times\left(\frac{1}{3}\right)^{12pq-8p}.$$

Proof: By definition, we have

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

By using Table 1, we derive

$$PII\left(GTUC_4C_8[p,q]\right)=\left(\frac{1}{\sqrt{2\times2}}\right)^{2p}\times\left(\frac{1}{\sqrt{2\times3}}\right)^{4p}\times\left(\frac{1}{\sqrt{3\times3}}\right)^{12pq-8p}$$

$$=\left(\frac{1}{2}\right)^{2p}\times\left(\frac{1}{6}\right)^{2p}\times\left(\frac{1}{3}\right)^{12pq-8p}.$$

Theorem 5: The multiplicative sum connectivity index of $GTUC_4C_8[p,q]$ nanotube is

$$SII\left(GTUC_4C_8[p,q]\right)=\left(\frac{1}{2}\right)^{2p}\times\left(\frac{1}{5}\right)^{2p}\times\left(\frac{1}{6}\right)^{6pq-4p}.$$

Proof: By definition, we derive

$$SII(G)=\prod_{uv\in E(G)}\frac{1}{\sqrt{d_G(u)+d_G(v)}}$$

By using Table 1, we have

$$SII\left(GTUC_4C_8[p,q]\right)=\left(\frac{1}{\sqrt{2+2}}\right)^{2p}\times\left(\frac{1}{\sqrt{2+3}}\right)^{4p}\times\left(\frac{1}{\sqrt{3+3}}\right)^{12pq-8p}$$

$$=\left(\frac{1}{2}\right)^{2p}\times\left(\frac{1}{5}\right)^{2p}\times\left(\frac{1}{6}\right)^{6pq-4p}.$$

***Theorem 6*:** The multiplicative geometric-arithmetic index of $GTUC_4C_8[p,q]$ nanotube is

$$GAII\left(GTUC_4C_8[p,q]\right)=\left(\frac{2\sqrt{6}}{5}\right)^{4p}.$$

Proof: By definition, we have

$$GAII(G)=\prod_{uv\in E(G)}\frac{2\sqrt{d_G(u)d_G(v)}}{d_G(u)+d_G(v)}.$$

By using Table 2, we deduce

$$GAII\left(GTUC_4C_8[p,q]\right)=\left(\frac{2\sqrt{2\times2}}{2+2}\right)^{2p}\times\left(\frac{2\sqrt{2\times3}}{2+3}\right)^{4p}\times\left(\frac{2\sqrt{3\times3}}{3+3}\right)^{12pq-8p}$$

$$=\left(\frac{2\sqrt{6}}{5}\right)^{4p}.$$

$HTUC_4C_8(R)$ Nanotorus

In this section, we consider a family of $TUC_4C_8(R)$ nanotorus. The 2-dimensional lattice of $TUC_4C_8(R)$ is denoted by $H=HTUC_4C_8[p,q]$ where p is the number of columns and q is the number of rows, see Figure 3.

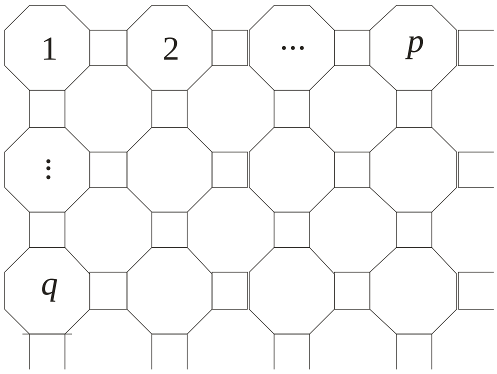

Figure 3 The graph of $HTUC_4C_8[p,q]$ nanotorus

Let H be the graph of $HTUC_4C_8[p,q]$ nanotorus. By calculation, we obtain that H has one type of edges based on the degree of end vertices of each edge as given in Table 3.

Table 3 Edge partition of H

$d_H(u), d_H(v)\backslash uv \in E(H)$	(3, 3)
Number of edges	$12pq$

Theorem 7. Let H be the graph of $HTUC_4C_8[p,q]$ nanotorus. Then

1) $PII\left(HTUC_4C_8[p,q]\right)=\left(\frac{1}{3}\right)^{12pq}.$

2) $SII\left(HTUC_4C_8[p,q]\right)=\left(\frac{1}{6}\right)^{6pq}.$

3) $GAII\left(HTUC_4C_8[p,q]\right)=1.$

Proof: Let H be the graph of $HTUC_4C_8[p,q]$ nanotorus.
Now using Table 3, we deduce

1) $$PII\left(HTUC_4C_8[p,q]\right)=\prod_{uv\in E(H)}\frac{1}{\sqrt{d_H(u)d_H(v)}}$$

$$=\left(\frac{1}{\sqrt{3\times3}}\right)^{12pq}=\left(\frac{1}{3}\right)^{12pq}.$$

2) $$SII\left(HTUC_4C_8[p,q]\right)=\prod_{uv\in E(H)}\frac{1}{\sqrt{d_H(u)+d_H(v)}}$$

$$=\left(\frac{1}{\sqrt{3+3}}\right)^{12pq}=\left(\frac{1}{6}\right)^{6pq}.$$

3) $$GAII\left(HTUC_4C_8[p,q]\right)=\prod_{uv\in E(H)}\frac{2\sqrt{d_H(u)d_H(v)}}{d_H(u)+d_H(v)}$$

$$=\left(\frac{2\sqrt{3\times3}}{3+3}\right)^{12pq}=1.$$

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How to cite this article:

Kulli V.R (2018) 'Degree Based Multiplicative Connectivity Indices of Nanostructures', *International Journal of Current Advanced Research,* 07(2), pp. 10359-10362. DOI: http://dx.doi.org/10.24327/ijcar.2018.10362.1751

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