Analysis of COVID-19 by Means of Graph Theory

Abstract: As a powerful displaying, investigation and computational device, graph theory is widely used in biological mathematics to deal with various biology problems. In the field of microbiology, graphs can communicate the sub-atomic structure. Where cell, quality or protein can be indicated as a vertex, and the associate component can be viewed as an edge. Thusly, the biological activity characteristic can be measured via topological index computing in the comparing graphs. In this article, we for the most part concentrate some topological lists for the Corona virus graph. At first, we give a general type of M-polynomial. From the M-polynomial, we recoup some well-known degree-based topological lists, for example, First and Second Zagreb Indices, Second Modified Zagreb Index, Randić Index, General Randić Index, Symmetric Division Index, Harmonic Index, Inverse Sum Index, Augmented Zagreb Index. Our results are extensions of many existing results.

Keywords: COVID-19, topological indices, Corona virus.

MSC: 26A51, 26A33, 33E12.

1. Introduction

Coronaviruses are group of large, enveloped, positive standard RNA viruses that is source of windpipe, digestive system and central nervous system disease in humans and other animals [1]. Human Coronavirus spread cause mild respiratory disease in humans [2]. During 2002-2004 SARC-CoV (severe acute respiratory syndrome) first rose in China and quickly spread to different parts of world causing in excess of 8000 contaminations and roughly 8000 related passings around the world (WHO-2004). Exploration reveal that SARC-CoV is transmitted from civet cats to humans. In 2012 MERS-CoV (Middle East Respiratory Syndrome) was first recognized in the middle east and afterward spanned to different nations. MERS-CoV transferred from dromedary camel to human. In december 2019 that third Zoonotic human Coronavirus emerged in Wuhan, China after (SARS-CoV) in 2002 and (MERS-CoV) in 2012. The causative agent is the Novel Coronavirus which are recognized and separated from a solitary patient towards the beginning of January and accordingly confirmed in 16 extra patients [3]. Specifically the human seafood market a live animal and seafood wholesale market in Wuhan, was regarded as essential source of this Novel Coronavirus. As it is discovered that 55 % cases connected to the market place [4]. In the interim ongoing correlation of the genetic sequences of this virus and bat Coronavirus show 96% similarity [5]. This virus rapidly spread in China and subsequently all over the world.

Concentration of my research paper is based on finding M-Polynomial of m-level $COVID-19$ graph $CoV_{n,m}$. A $COVID-19$ graph is defined as;

- n = No. of vertices of (Hemagglutinin+ Spikes+ RNA)

- m= No. of viruses= No. of Envelop

Where,

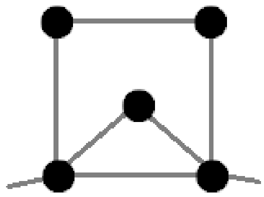

Figure 1. Hemaggluttinin

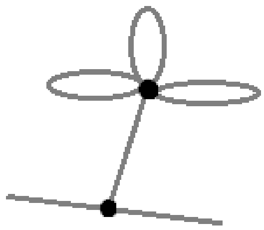

Figure 2. Spike

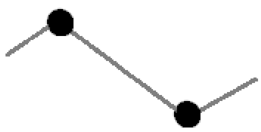

Figure 3. RNA

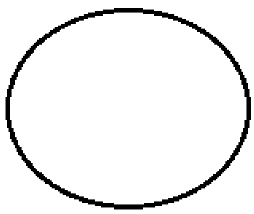

Figure 4. $CoV_{(}16, 1)$

2. Molecular Graph Of $CoV_{(n,m)}$

2.1. Finite Graph

If we have 16 (Hemagglutinin+ Spikes+ RNA) and 1 (Envelop or Viruses) then $CoV_{(n,m)}$ graph will be of form.

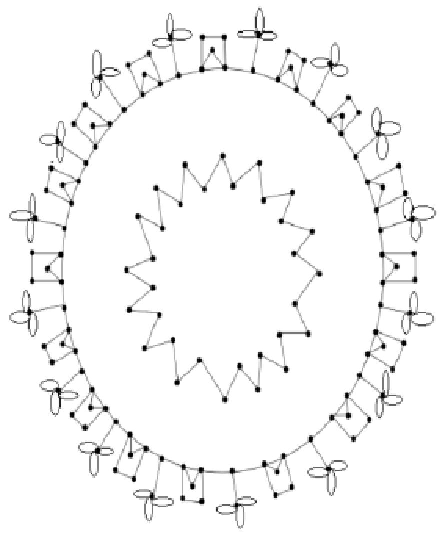

Figure 5. $CoV_{(n,m)}$

2.2. *Infinite Graph*

If we have n (Hemagglutinin+ Spikes+ RNA) and 1 (Envelop or Viruses) then $CoV_{(n,m)}$ graph will be of form.

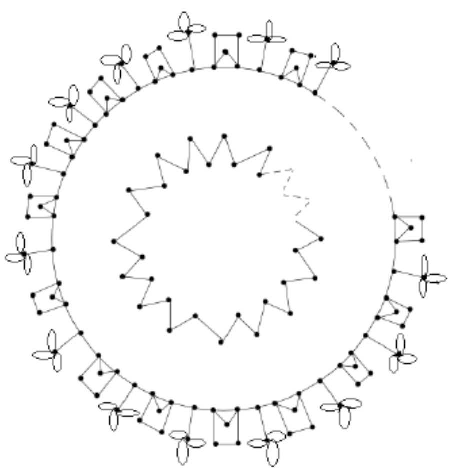

Figure 6. $CoV_{(n,1)}$

2.3. *Infinite Graph of m-Viruses*

If we have n (Hemagglutinin+ Spikes+ RNA) and m (Envelop or Viruses) then $CoV_{(n,m)}$ graph will be of form.

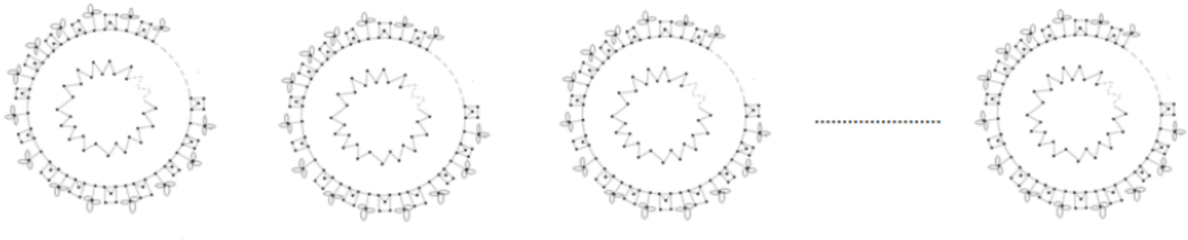

Figure 7. $CoV_{(n,m)}$

Mathematical chemistry provides tools such as polynomials and functions to capture information hidden in the symmetry of molecular graphs and thus predict properties of compounds without using quantum mechanics. A topological index is a numerical parameter of a graph and describe its topology. Topological indices describe the structure of molecules numerically and are used in the development of qualitative structure activity relationships (QSARs). Most commonly known invariants of such kinds are degree-based topological indices. These are actually the numerical values that correlate the structure with various physical properties, chemical reactivity, and biological activities. It is an established fact that many properties such as heat of formation, boiling point, strain energy, rigidity, and fracture toughness of a molecule are strongly connected to its graphical structure [6].

A Graph is number of distinct dots and lines. These dots are called vertices and lines/paths connecting that dots are called edges. The path between that two dots (vertices) like u and v are known as length between these two vertices. Number of edges connected to a vertex is called degree of that's vertex. Degree of a vertex is a key point of finding a M-polynomial of our desired graph. M-polynomial is use to find variations by changing our variables.

The tables of partition of Generalized $CoV_{(n,m)}$ graph consists of vertices, edges and loops are following,

Table 1. Partition of $E(CoV_{(n,m)})$

Size of Edges	Degree of Vertices
$3n$	$(2,2)$
$4n$	$(2,4)$
$2n$	$(3,4)$
n	$(4,4)$
n	$(3,7)$

Two parts are,

Vertices Set

$$\begin{aligned} V_2 &= \{CoV_{(n,m)}|d_v = 5nm\} \\ V_3 &= \{CoV_{(n,m)}|d_v = nm\} \\ V_4 &= \{CoV_{(n,m)}|d_v = 2nm\} \\ V_7 &= \{CoV_{(n,m)}|d_v = nm\} \end{aligned}$$

Edge set

$$\begin{aligned} E_{2,2} &= \{e = vu \in E(CoV_{(n,m)})|d_u = 2, d_v = 2\} \rightarrow| E_{2,2} |= 3nm \\ E_{2,4} &= \{e = vu \in E(CoV_{(n,m)})|d_u = 2, d_v = 4\} \rightarrow| E_{2,4} |= 4nm \\ E_{3,4} &= \{e = vu \in E(CoV_{(n,m)})|d_u = 3, d_v = 4\} \rightarrow| E_{3,4} |= 2nm \\ E_{4,4} &= \{e = vu \in E(CoV_{(n,m)})|d_u = 3, d_v = 4\} \rightarrow| E_{3,4} |= nm \\ E_{3,7} &= \{e = vu \in E(CoV_{(n,m)})|d_u = 3, d_v = 4\} \rightarrow| E_{3,4} |= nm \end{aligned}$$

Where,

- m denotes number of viruses.
- n denotes number of vertices.

3. M-Polynomial and Topological indices

Definition 1. If $G = (V, E)$ is a graph and v ϵV , then $d_v(G)$ denotes the degree of v. Let $m_{i,j}(G), i, j = 1$, be the number of edges uv of G such that $dv(G), du(G) = i, j$. The M-polynomial [7] of generalized graph G is defined as:

$$M(G, x, y) = \sum_{\delta \leq i \leq j \leq \Delta} m_{ij}(G) x^i y^j$$

This polynomial is an exciting new idea which is very rich in computational aspects of materials. From this M-polynomial, we can calculate many topological indices.

Definition 2. First and Second Zagreb indices was introduced by Gutman and Trinajstic[[8], [9], [10]] in 1972 and 1975 respectively. The 1st and 2nd Zagreb indices are stated as:

$$M_1(G) = \sum_{uv\epsilon E(G)} (d_u + d_v)$$

$$M_2(G) = \sum_{uv\epsilon E(G)} (d_u d_v)$$

Definition 3. The 2nd modified Zagreb index is stated as:

$${}^m M_2(G) = \sum_{uv\epsilon E(G)} \frac{1}{d_u d_v}$$

Definition 4. The RI is known as Randić Index which was introduced by Milan Randić in 1975. It is also known as connectivity index of graph.[11]

$$R_\alpha(G) = \sum_{uv\epsilon E(G)} \frac{1}{\sqrt{d_u d_v}}$$

where u and v are degree of vertices.

Definition 5. The GRI is known as General Randić Index of G which was introduced by Ballobas Erdos [12] and Amic [13] in 1998. This index was equally popular in mathematics and chemistry.[14]

$$RR_a(G) = \sum_{uv\epsilon E(G)} (dvdu)^\alpha$$

where α is an any real number, $\alpha \epsilon R$.[7]

Definition 6. The Symmetric Division Index (SDI) is one of the 148 discrete Adriatic indices is a good predictor of the total surface area for polychlorobiphenyls [15]. The Symmetric division index of a connected graph G, is defined as:

$$SDI(G) = \sum_{uv\epsilon E(G)} \left(\frac{min(d_u, d_v)}{max(d_u, d_v)} + \frac{max(d_u, d_v)}{min(d_u, d_v)}\right)$$

Definition 7. The HI known as Randić Index H(G) is another variant of Randić index which was introduced by Fajtlowicz [16] in 1987. It is stated as:

$$H(G) = \sum_{uv\epsilon E(G)} \frac{2}{d_u + d_v}$$

Definition 8. The Inverse Sum Index ISI stated as:

$$ISI(G) = \sum_{uv\epsilon E(G)} \frac{d_u d_v}{d_u + d_v}$$

Definition 9. The AZI known as Augmented Zagreb Index of G which was introduced by Boris Furtula et al [17]. It stated as:

$$AZI(G) = \sum_{uv\epsilon E(G)} (\frac{d_u d_v}{d_u + d_v - 2})^3$$

it is useful for computing heat of formation of alkanes. These indices make it viable to categorize the residences of molecules like chemical and physical. In past, M.Munir et al. calculated M-polynomials and their corresponding topological indices for Nanostar dendrimers and Titania Nanotubes in [17]. Some topological indices which are degree based totally determined from M-polynomial [12].

4. M-Polynomial of $CoV_{(n,m)}$

Here, we are going to discuss algebraic polynomials of $COVID-19$ Graph. Let us first compute M-polynomial for $CoV_{n,m}$.

Theorem 10. *Let $CoV_{n,m}$ is generalized COVID-19 graph. Then*

$$M(CoV_{n,m}, x, y) = 3nmx^2y^2 + 4nmx^2y^4 + 2nmx^3y^4 + nmx^4y^4 + nmx^3y^7 \tag{1}$$

Proof.

$$\begin{aligned}
M(CoV_{n,m}, x, y) &= \sum_{i \leq j} m_{ij}(CoV_{n,m})x^i y^j \\
&= \sum_{2\leq 2} m_{2,2}(CoV_{n,m})x^2y^2 + \sum_{2\leq 4} m_{2,4}(CoV_{n,m})x^2y^4 \\
&\quad + \sum_{3\leq 4} m_{3,4}(CoV_{n,m})x^3y^4 + \sum_{4\leq 4} m_{4,4}(CoV_{n,m})x^4y^4 \\
&\quad + \sum_{3\leq 7} m_{3,7}(CoV_{n,m})x^3y^7 \\
&= \mid E_{2,2} \mid x^2y^2 + \mid E_{2,4} \mid x^2y^4 + \mid E_{3,4} \mid x^3y^4 \\
&\quad + \mid E_{4,4} \mid x^4y^4 + \mid E_{3,7} \mid x^3y^7 \\
&= 3nmx^2y^2 + 4nmx^2y^4 + 2nmx^3y^4 + nmx^4y^4 + nmx^3y^7
\end{aligned}$$

□

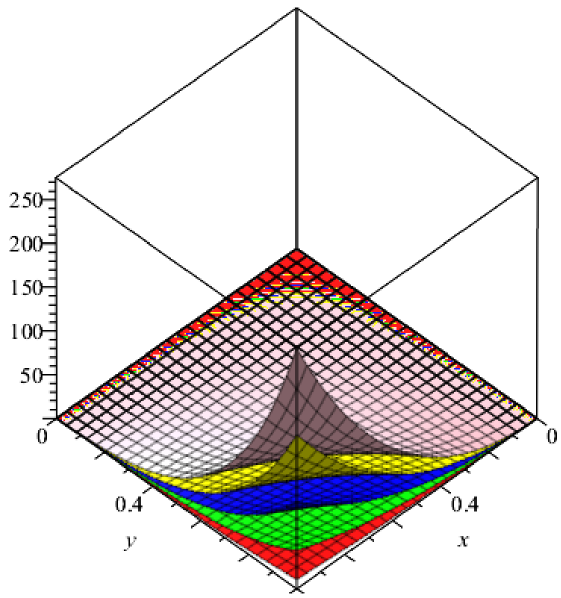

Figure 8. $CoV_{(n,m)}$

Figure 8, shows the graphical representation of M-polynomial for $CoV_{(n,m)}$. Different colors are used for different values of x and y. The Red color represents the values of and y equal to 1. Similarly, green, blue, yellow and pink are fixed for x and y equal to 2, 3, 4 and 5, respectively.

5. Degree-Based Topological Indices of $CoV_{(n,m)}$

Induction of some degree-based topological indices from M-polynomial.

Topological Index	Derived form $M(CoV_{n,m}, x, y)$
$1st$ Zagreb	$(Dx + Dy)[M(CoV_{n,m}, x, y)]_{y=x=1}$
$2nd$ Zagreb	$(DxDy)[M(CoV_{n,m}, x, y)]_{y=x=1}$
$2nd$ Modified Zagreb	$(SxSy)[M(CoV_{n,m}, x, y)]_{y=x=1}$
General Randić (GR) $\alpha \in N$	$(D_x^\alpha D_y^\alpha)[M(CoV_{n,m}, x, y)]_{y=x=1}$
General Inverse Randić (GR)$\alpha \in N$	$(S_x^\alpha S_y^\alpha)[M(CoV_{n,m}, x, y)]_{y=x=1}$
Symmetric Division Index (SDI)	$(D_x S_y + D_y S_x)[M(CoV_{n,m}, x, y)]_{y=x=1}$
Harmonic Index (HI)	$2S_x J[M(CoV_{n,m}, x, y)]_{y=x=1}$
Inverse Sum Index (ISI)	$S_x J D_x D_y[M(CoV_{n,m}, x, y)]_{y=x=1}$
Augmented Zagreb Index (AZI)	$S_x^3 Q_{-2} J D_x^3 D_y^3[M(CoV_{n,m}, x, y)]_{y=x=1}$

Where $D_x f = x\frac{\partial(f(x,y))}{\partial x}, D_y f = y\frac{\partial(f(x,y))}{\partial y}, S_x = \int_0^x \frac{f(y,t)}{t}dt$, $S_y = \int_0^y \frac{f(x,t)}{t}dt$, $j(f(x,y)) = f(x,x), Q_\alpha(f(x,y)) = x^\alpha f(x,y)$, for non zero α

Theorem 11. *Let $CoV_{n,m}$ be generalized $COVID-19$ Graph. Then First Zagreb of $COVID-19$ graph is given by,*

$$M_1(CoV_{n,m}) = 68nm$$

Proof. As we know that the **M-polynomial** of $CoV_{n,m}$ is defined in Eq(1),Then First Zagreb is,

$$\begin{aligned}
M_1(CoV_{n,m}) &= (D_x + D_y)[M(CoV_{n,m}, x, y)]_{x=y=1} \\
D_y &= [6nmx^2y^2 + 16nmx^2y^4 + 8nmx^3y^4 + 4nmx^4y^4 + 7nmx^3y^7] \\
D_x &= [6nmx^2y^2 + 8nmx^2y^4 + 6nmx^3y^4 + 4nmx^4y^4 + 3nmx^3y^7] \\
(D_x + D_y)_{x=y=1} &= 68nm
\end{aligned}$$

□

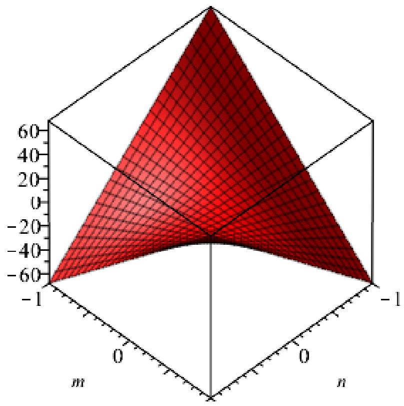

Figure 9. 1st Zagreb index

Theorem 12. *Let $CoV_{n,m}$ be generalized $COVID-19$ Graph. Then Second Zagreb of $COVID-19$ graph is given by,*

$$M_2(CoV_{n,m}) = 105nm$$

Proof. As **M-polynomial** of $CoV_{n,m}$ is defined in Eq(1), And D_x and D_y are defined in Theorem 4.1, Then Second Zagreb is,

$$\begin{aligned}
M_2(CoV_{n,m}) &= (D_x \cdot D_y)[M(CoV_{n,m}, x, y)]_{y=x=1} \\
&= 105nm
\end{aligned}$$

□

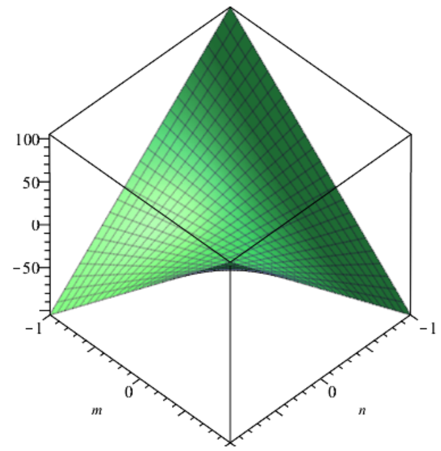

Figure 10. 2st Zagreb index

Theorem 13. *Let $CoV_{n,m}$ be generalized $COVID-19$ Graph. Then Second Modified Zagreb of $COVID-19$ graph is given by,*

$$^{m}M_2(CoV_{n,m}) = \left(\frac{171nm}{112}\right).$$

Proof. As we know that the **M-polynomial** of wheel $CoV_{n,m}$ is defined in Eq(1), then Second Modified Zagreb is,

$$\begin{aligned} ^{m}M_2(CoV_{n,m}) &= (S_xS_y)[M(CoV_{n,m},x,y)]_{x=y=1} \\ S_y &= \frac{3nmx^2y^2}{2} + nmx^2y^4 + \frac{nmx^3y^4}{2} + \frac{nmx^4y^4}{4} + \frac{nmx^3y^7}{7} \\ S_xS_y &= \frac{3nmx^2y^2}{4} + \frac{nmx^2y^4}{2} + \frac{nmx^3y^4}{6} + \frac{nmx^4y^4}{16} + \frac{nmx^3y^7}{21} \\ (S_xS_y)_{x=y=1} &= \left(\frac{171nm}{112}\right). \end{aligned}$$

□

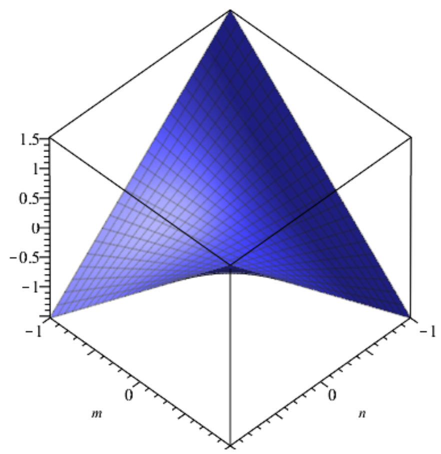

Figure 11. 2nd Modified Zagreb index

Theorem 14. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ Graph. Then General Randić of $COVID-19$ graph is given by,*

$$GR(CoV_{n,m}) = nm[4^{\alpha}\cdot 3 + 8^{\alpha}\cdot 4 + 12^{\alpha}\cdot 2 + 16^{\alpha} + 21^{\alpha}].$$

101 **Proof.** As we know that the **M-polynomial** of wheel $CoV_{n,m}$ is defined in Eq(1), then General Randić
102 is,

$$\begin{aligned}
GR(CoV_{n,m}) &= (D_x^\alpha D_y^\alpha)[M(CoV_{n,m}, x, y)]_{y=x=1} \\
D_y^\alpha &= (2)^\alpha \cdot 3nmx^2y^2 + (4)^\alpha \cdot 4nmx^2y^4 \\
&\quad + (4)^\alpha \cdot 2nmx^3y^4 + (4)^\alpha \cdot nmx^4y^4 + (7)^\alpha nmx^3y^7 \\
D_x^\alpha D_y^\alpha &= (2)^\alpha \cdot (2)^\alpha \cdot 3nmx^2y^2 + (2)^\alpha \cdot (4)^\alpha \cdot 4nmx^2y^4 \\
&\quad + (4)^\alpha \cdot (3)^\alpha \cdot 2nmx^3y^4 + (4)^\alpha (4)^\alpha \cdot nmx^4y^4 + (7)^\alpha \cdot (3)^\alpha nmx^3y^7 \\
(D_x^\alpha D_y^\alpha)_{y=x=1} &= (4)^\alpha \cdot 3nm + (8)^\alpha \cdot 4nm + (12)^\alpha \cdot 2nm + (16)^\alpha \cdot nm + (21)^\alpha \cdot nm \\
.
\end{aligned}$$

103 □

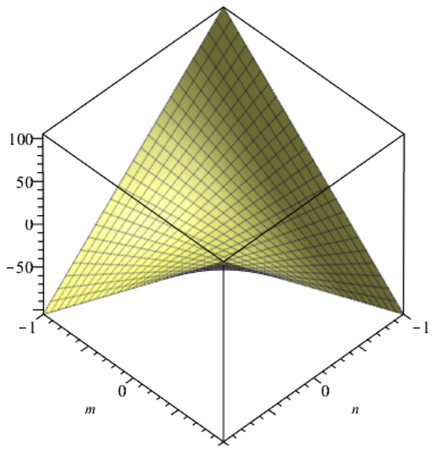

Figure 12. General Randić index

Theorem 15. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ graph, then General Inverse Randić of wheel graph is given by,*

$$RR_\alpha(CoV_{n,m}) = nm[\frac{3}{4^\alpha} + \frac{4}{8^\alpha} + \frac{2}{12^\alpha} + \frac{1}{16^\alpha} + \frac{1}{21^\alpha}].$$

104 **Proof.** As we know that the **M-polynomial** of $COVID-19$ $CoV_{n,m}$ is defined in Eq(1), then General
105 Inverse Randić is,

$$\begin{aligned}
RR[CoV_{n,m}] &= (S_x^\alpha S_y^\alpha)[M(CoV_{n,m}, x, y)]_{x=y=1} \\
S_y^\alpha &= \frac{3nmx^2y^2}{2^\alpha} + \frac{4nmx^2y^4}{(4)^\alpha} + \frac{2nmx^3y^4}{4^\alpha} \\
&\quad + \frac{nmx^4y^4}{4^\alpha} + \frac{nmx^3y^7}{7^\alpha} \\
S_x^\alpha S_y^\alpha &= \frac{3nmx^2y^2}{2^\alpha \cdot 2^\alpha} + \frac{4nmx^2y^4}{2^\alpha \cdot 4^\alpha} + \frac{2nmx^3y^4}{3^\alpha \cdot 4^\alpha} \\
&\quad + \frac{nmx^4y^4}{4^\alpha \cdot 4^\alpha} + \frac{nmx^3y^7}{3^\alpha \cdot 7^\alpha} \\
(S_x^\alpha S_y^\alpha)_{x=y=1} &= nm[\frac{3}{4^\alpha} + \frac{4}{8^\alpha} + \frac{2}{12^\alpha} + \frac{1}{16^\alpha} + \frac{1}{21^\alpha}].
\end{aligned}$$

106 □

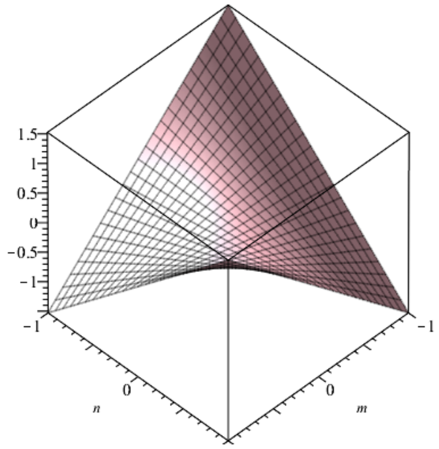

Figure 13. General Inverse Randić index (

Theorem 16. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ graph, then Symmetric Division Index of $COVID-19$ Graph is given by,*

$$SDI(CoV_{n,m}) = \frac{1047nm}{42}.$$

Proof. As we know that the **M-polynomial** of $COVID-19$ $CoV_{n,m}$ is defined in Eq(1), then Symmetric Division Index is,

$$\begin{aligned}
SDI(CoV_{n,m}) &= (D_xS_y + D_yS_x)[M(CoV_{n,m}, x, y)]_{y=x=1} \\
(D_yS_x) &= [3nmx^2y^2 + 8nmx^2y^4 + \frac{8nmx^3y^4}{3} + nmx^4y^4 + \frac{7nmx^3y^7}{3}] \\
(D_xS_y) &= [3nmx^2y^2 + 2nmx^2y^4 + \frac{3nmx^3y^4}{2} + nmx^4y^4 + \frac{3nmx^3y^7}{7}] \\
(D_yS_x + D_xS_y)_{x=y=1} &= \frac{1047nm}{42}.
\end{aligned}$$

□

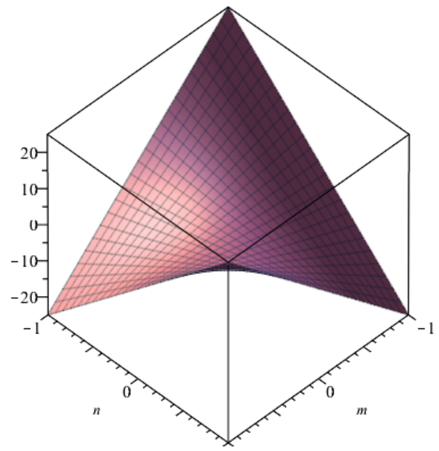

Figure 14. Symmetric Division index

Theorem 17. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ graph, then Harmonic Index of $COVID-19$ graphs is given by,*

$$HI(CoV_{n,m}) = \frac{1619nm}{420}.$$

Proof. As we know that the **M-polynomial** of $COVID-19$ $CoV_{n,m}$ is defined in Eq(1),Then Harmonic Index is,

$$\begin{aligned}
HI(CoV_{n,m}) &= 2S_xJ[M(W_{n,m},x,y)]_{y=x=1} \\
J[M(CoV_{n,m},x,x)] &= 3nmx^4 + 4nmx^6 + 2nmx^7 + nmx^8 + nmx^{10} \\
S_xJ[CoV_{n,m},x,x)] &= \frac{3nmx^4}{4} + \frac{2nmx^6}{3} + \frac{2nmx^7}{7} + \frac{nmx^8}{8} + \frac{nmx^{10}}{10} \\
2S_xJ[M(CoV_{n,m},x,y)]_{x=y=1} &= \frac{1619nm}{420}.
\end{aligned}$$

□

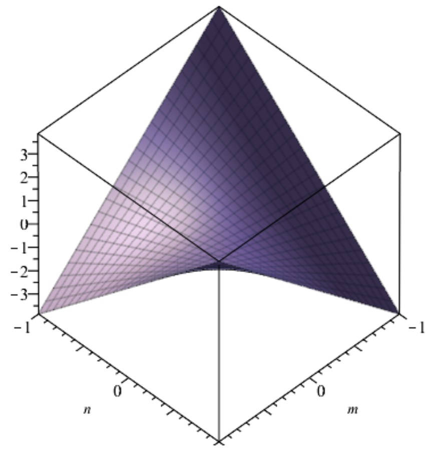

Figure 15. Harmonic index

Theorem 18. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ graph, then Inverse Sum Index of $COVID-19$ graphs is given by,*

$$ISI(CoV_{n,m}) = \frac{3331nm}{210}.$$

Proof. As we know that the **M-polynomial** of $CoV_{n,m}$ $CoV_{n,m}$ is defined in Eq(1), then Inverse Sum Index is,

$$\begin{aligned}
ISI(CoV_{n,m}) &= S_x[J(D_xD_y)][M(W_{n,m},x,y)]_{y=x=1} \\
D_xD_y &= 12nmx^2y^2 + 32nmx^2y^4 + 24nmx^3y^4 + 16nmx^4y^4 + 21nmx^3y^7 \\
J(D_xD_y) &= 12nmx^4 + 32nmx^6 + 24nmx^7 + 16nmx^8 + 21nmx^{10} \\
S_xJ(D_xD_y) &= 3nmx^4 + \frac{16nmx^6}{3} + \frac{24nm^7}{7} + 2nmx^8 + \frac{21nmx^{10}}{10} \\
S_x[J(D_xD_y)][M(CoV_{n,m},x,y)]_{y=x=1} &= \frac{3331nm}{210}.
\end{aligned}$$

□

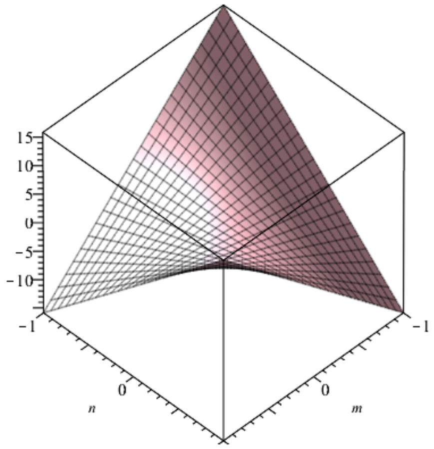

Figure 16. Inverse Sum index

Theorem 19. *Suppose $CoV_{n,m}$ be generalized $COVID-19$ graph, then Augmented Zagreb Index of $COVID-19$ graphs is given by,*

$$AZI(CoV_{n,m}) = 120\frac{1747nm}{2500}$$

116 **Proof.** As we know that the **M-polynomial** of $COVID-19$ $CoV_{n,m}$ is defined in Eq(1), then
117 Augmented Zagreb Index is,

$$\begin{aligned}
AZI(CoV_{n,m}) &= S_x^3 Q_{-2} J D_x^3 D_y^3 [M(CoV_{n,m}, x, y)]_{x=y=1} \\
D_y^3 &= (2)^3 \cdot 3nmx^2y^2 + (4)^3 \cdot 4nmx^2y^4 + (4)^3 \cdot 2nmx^3y^4 \\
&\quad + (4)^3 \cdot nmx^4y^4 + (7)^3 \cdot nmx^3y^7 \\
D_x^3 D_y^3 &= (4)^3 \cdot 3nmx^2y^2 + (8)^3 \cdot 4nmx^2y^4 + (12)^3 \cdot 2nmx^3y^4 \\
&\quad + (16)^3 \cdot nmx^4y^4 + (21)^3 \cdot nmx^3y^7 \\
J(D_x^3 D_y^3) &= 192nmx^4 + 2048nmx^6 + 3456nmx^7 + 4096nmx^8 + 9261nmx^{10} \\
Q_{-2} J(D_x^3 D_y^3) &= 192nmx^2 + 2048nmx^4 + 3456nmx^5 + 4096nmx^6 + 9261nmx^8 \\
S_x^3 Q_{-2} J D_x^3 D_y^3 [M(CoV_{n,m}, x, y)]_{x=y=1} &= 120\frac{1747nm}{2500}
\end{aligned}$$

118 □

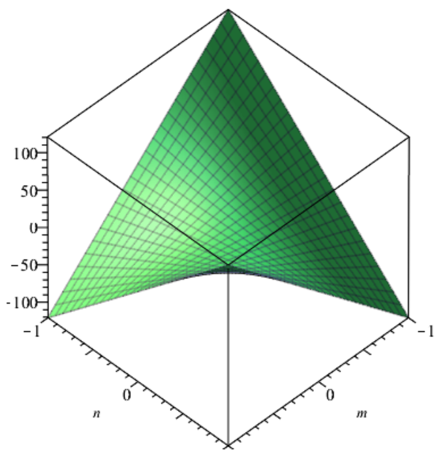

Figure 17. Augmented Zagreb index

Conclusion

The mathematical discipline which underpins the study of complex networks in biological and other applications is graph theory. It has been successfully applied to the study of biological network topology, from the global perspective between different biomolecules. Thus topological indices can help us to understand the physical features, chemical reactivity, and biological activities. So topological indices can be regarded as a score function that maps each molecular structure to a real number and are used as descriptors of the molecules under testing. In this paper we have proposed the M-polynomial of Coronavirus. From M-polynomial we find some degree based topological indices such as First and Second Zagreb Indices, Modified Second Zagreb Index, Symmetric Division Index, Augmented Zagreb

References

1. Gallagher, T. M., & Buchmeier, M. J. (2001). Coronavirus spike proteins in viral entry and pathogenesis. *Virology, 279*(2), 371-374. 22
2. Su, S., Wong, G., Shi, W., Liu, J., Lai, A. C., Zhou, J., & Gao, G. F. (2016). Epidemiology, genetic recombination, and pathogenesis of coronaviruses. *Trends in microbiology, 24*(6), 490-502. 25
3. Backer, J. A., Klinkenberg, D., & Wallinga, J. (2020). Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20 − 28 January 2020. *Eurosurveillance, 25*(5), 2000062. 26
4. Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., & Xing, X. (2020). Early transmission dynamics in Wuhan, China, of novel coronavirus infected pneumonia. *New England Journal of Medicine*. 27
5. Zhou, P., Yang, X. L., Wang, X. G., Hu, B., Zhang, L., Zhang, W., & Chen, H. D. (2020). Discovery of a novel coronavirus associated with the recent pneumonia outbreak in humans and its potential bat origin. bioRxiv. *Cold Spring Harb Lab, 2020*, 22-914952. 28
6. Kwun, Y. C., Ali, A., Nazeer, W., Ahmad Chaudhary, M., & Kang, S. M. (2018). M-polynomials and degree-based topological indices of triangular, hourglass, and jagged-rectangle benzenoid systems. *Journal of Chemistry, 2018*.
7. Deutsch, E., & Klavžar., S. (2014), M-polynomial and degree-based topological indices. *arXiv preprint arXiv*:1407.159, 93-102. 8
8. Gutman, I., & Trinajstic, N. (1972). Graph theory and molecular orbitals. Total f-electron energy of alternant hydrocarbons. *Chemical Physics Letters, 17*(4), 535-538. 5
9. Hao, J. (2011). Theorems about Zagreb indices and modified Zagreb indices. *MATCH Commun. Math. Comput. Chem, 65*, 659-670. 41
10. Gutman, I., Rudic, B., Trinajstic, N., & Wilcox Jr, C. F. (1975). Graph theory and molecular orbitals. XII. Acyclic polyenes. *The Journal of Chemical Physics, 62*(9), 3399-3405. 4

11. Randic, M. (1975). Characterization of molecular branching. *Journal of the American Chemical Society, 97*(23), 6609-6615. 5
12. Bollobas, B., & Erdos, P. (1998). Graphs of extremal weights. *Ars Combinatoria, 50*, 225-233. 6
13. Shao, Z., Virk, A. R., Javed, M. S., Rehman, M. A. & Farahani, M. R. (2019).Degree based graph invariants for the molecular graph of Bismuth Tri-Iodide, *Eng. Appl. Sci. Lett.,2*(1),01-11. 7
14. Virk, A. R., Jhangeer, M. N., & Rehman, M. A. (2018). Reverse Zagreb and reverse hyper-Zagreb indices for silicon carbide $Si_2C_3 - I[r,s]$ and $Si_2C_3 - II[r,s]$. *Eng. Appl. Sci. Lett.,1*(2), 37-48. 36
15. Ajmal, M., Nazeer, W., Munir, M., Kang, S. M., & Jung, C. Y. (2017). The M-polynomials and topological indices of generalized prism network. *International Journal of Mathematical Analysis, 11*(6), 293-303. 11
16. M. Munir, W. Nazeer, S. Rafique, A. R. Nizami. S. kang, M. Some Computational Aspects of Triangular Boron Nanotube. *Symmetry*. **2016**, 9, 6. 9
17. Bharati Rajan, A. W., Grigorious, C., & Stephen, S. (2012). On certain topological indices of silicate, honeycomb and hexagonal networks. *Journal of Computer and Mathematical Sciences Vol, 3*(5), 498-556. 19
18. M. Imran, M.A. Ali, S. Ahmad, k.M. Siddiqui,A. Q Baig, (2018). Topological Characterization of the Symmetrical Structure of Bismuth Tri-Iodide. Symmetry 2018, 10.