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# First Redefined Zagreb Index of Generalized Transformation Graph

[1],*Sharan Hegde, [2]Anjum Khan, [3]Vinay Prasad.T
[1],[2],[3],[4] Dept. of Mathematics, BIT, Mangalore
*Corresponding author. Email: [1],*hegdesharan3@gmail.com, [2]khananjum73@gmail.com, [3]vinayprasad34@gmail.com

***Abstract*— In Mathematical chemistry, The topological chemical descriptive is valuable part to investigate (QSPR) & (QSAR). Here, The articulations for the First Redefined Zagreb index of generalized transformation graph Gxy and its complement were acquired.**

***Index Terms*— Zagreb index; First Redefined Zagreb index, Mathematics Subject Classification: 05C76, 05C07, 92E10**

## I. INTRODUCTION

The investigation of topological indices plays an highly vital part in QSAR & QSPR. Topological indices associate the exact physico-chemical properties. For more details see [4], [7], [10], [11]. Let p and q be the vertices and edges of simple undirected graph G respectively, its compliment $\bar{G}$. . Let Vs (G) set of vertices & $E_S(G)$ set of edges of Graph G respectively. Let u & v both vertices adjacent to each other such that uv = e an edge of G. degree represented by $de_G(u)$, the cardinality of edges incident to vertex u.

Ranjini et al. [13] characterized the First Redefined Zagreb index $ReZG_1$, that is

$$ReZG_1(G) = \sum_{uv\in E(G)} \frac{de_G(u) + de_G(v)}{de_G(u).de_G(v)}$$

The generalized transformation graphs and topological indices introduced by H. S.Ramane et al. [8,9]. W.Nazeer et. al [12] obtained the First Redefined Zagreb index of line graph of subdivision of friendship & star graphs and M. Ahmad et. al [15] computed First Redefined Zagreb index of dominating David derived networks.

Here we acquired the expresssions for generalized transformation graphs *Gxy* and their compliments $\overline{G^{xy}}$ interms of First Redefined Zagreb index.

## II. GENERALIZED TRANSFORMATION GRAPHS GXY

The semi total − point graph $T_2(G)$ was introduced by Chikkodimath & Sampathkumar[14].R.B Jummannaver et al.[3] defined $k^{th}$ Generalized transformation graphs, some new graphical transformation defined by Basavanagoud et al. [1] which generalizes the semi total-point graph.

The generalized transformation graph $G^{xy}$, $V_s(T_2(G))$ = $V_s(G) \cup E_s(G)$ and i,j∈ $V_s(G^{x,y})$. The points i & j are adjacent in G if and only if (1)&(2) holds:

(1) i, j ∈ $V_s(G)$, i,j points are not adjacent if x = − & i,j are adjacent if x = +

(2) i∈ $V_s(G)$ and j ∈ $E_s(G)$, i,j points are not incident if y = −and i,j points are incident if y =+

2.1 Proposition: [1] q & p be the edges and vertices of graph G. Let u ∈ $V_s(G)$ and e∈ $E_s(G)$. Then degrees of line vertices & vertex in $G^{xy}$

(a) $de_{G^{++}}(u) = 2\, de_G(u)$
(b) $de_{G^{++}}(e) = 2$.
(c) $de_{G^{+-}}(u) = q$
(d) $de_{G^{+-}}(e) = (-2+p)$.
(e) $de_{G^{-+}}(u) = (-1+p)$
(f) $de_{G^{-+}}(e) = 2$.
(g) $de_{G^{--}}(u) = q+p-(2de_G(u)+1)$
(h) $de_{G^{--}}(e) = (-2+p)$.

Number of vertices of $G^{xy}$ is p+ *q*. By 2.1 Proposition & considering that $de_{\bar{G}}(u) = p - (de_G(u)+1)$.

2.2 Proposition: q & p be the edges and vertices of graph G. Let e∈ $E_s(G)$ & u ∈ $V_s(G)$, degrees of line vertices and vertex of $\overline{G^{xy}}$

(a) $de_{\overline{G^{++}}}(u) = q+p-(2de_G(u)+1)$
(b) $de_{\overline{G^{++}}}(e) = q+p-3$
(c) $de_{\overline{G^{+-}}}(u) = p-1$
(d) $de_{\overline{G^{+-}}}(e) = q+1$
(e) $de_{\overline{G^{+-}}}(u) = q$
(f) $de_{\overline{G^{+-}}}(e) = q+p-3$
(g) $de_{\overline{G^{+-}}}(u) = 2\, de_G(u)$
(h) $de_{\overline{G^{+-}}}(e) = 1+q$

Notations used for future Results

| | |
|---|---|
| $de_{G^{++}}(u) = a_1$ | $de_{G^{++}}(e) = b_1$ |
| $de_{G^{+-}}(u) = a_2$ | $de_{G^{+-}}(e) = b_2$ |
| $de_{G^{-+}}(u) = a_3$ | $de_{G^{-+}}(e) = b_3$ |
| $de_{G^{--}}(u) = a_4$ | $de_{G^{--}}(e) = b_4$ |

## III. FIRST REDEFINED ZAGREB INDEX (REZG1) OF $G^{xy}$

**Theorem 3.1:** q & p be the edges and vertices of graph G, then $ReZG_1(G^{++}) = \frac{1}{2}ReZG_1(G) + \sum_{u\in E_{S2}(G)} \frac{[1+deg_G(u)]}{2}$

**Proof :** Suppose $E_S(G^{++})$ is the set of edges Partition into subsets $E_{S1}$ and $E_{S2}$, $E_{S1}$ ={$ue$ | $uv \in E_s(G)$} ,$E_{S2}$={$ue$ such that $u$ is incident to $e$}. Therefore | $E_{S1}$ |= $q$ , | $E_{S2}$|= $2q$. from 2.1 Proposition, $u \in V_s(G)$ as well $a_1 = 2deg_G(u)$ & $e \in E_s(G)$ as well $b_1$=2

$$ReZG_1(G^{++}) = \sum_{uv\in E_s(G^{++})} \frac{a_1 + b_1}{a_1 . b_1}$$

$$= \sum_{u,v\in E_{S1}} \frac{a_1 + b_1}{a_1 . b_1} + \sum_{u,e\in E_{S2}} \frac{a_1 + b_1}{a_1 . b_1}$$

$$= \sum_{u,v\in E_{S1}} \frac{2a_1 + 2b_1}{2a_1 . 2\, b_1} + \sum_{u,e\in E_{S2}} \frac{2a_1 + 2}{2a_1 . 2}$$

$$= \frac{1}{2}ReZG_1(G) + \sum_{u\in E_{S2}(G)} \frac{[1 + deg_G(u)]}{2deg_G(u)}$$

$$= \frac{1}{2}ReZG_1(G) + \sum_{u\in V_s(G)} \frac{deg_G(u)[1 + deg_G(u)]}{2deg_G(u)}$$

$$= \frac{1}{2}ReZG_1(G) + \sum_{u\in V_s(G)} \frac{[1 + deg_G(u)]}{2}$$

**Theorem 3.2:** q & p be the edges and vertices of graph G, then

$$ReZG_1(G^{+-}) = q + p$$

**Proof**: Suppose $E_s(G^{+-})$ is the set of edges Partition into subsets $E_{S1}$ and $E_{S2}$, $E_{S1}$ ={$ue$ | $uv \in E_s(G)$} ,$E_{S2}$={$ue$ such that $u$ is $u$ not incident to $e$}. Therefore | $E_{S1}$ |= $q$ , | $E_{S2}$|= $q(p-2)$. from 2.1 Proposition, $u \in V_s(G)$ as well $a_2 = q$ & $e \in E_s(G)$ as well $b_2 = (p-2)$

$$ReZG_1(G^{+-}) = \sum_{u,v\in E_s(G^{+-})} \frac{a_2 + b_2}{a_2 . b_2}$$

$$= \sum_{u,v\in E_{S1}} \frac{a_2 + b_2}{a_2 . b_2} + \sum_{u,e\in E_{S2}} \frac{a_2 + b_2}{a_2 . b_2}$$

$$= \sum_{u,v\in E_s(G)} \frac{q + q}{q . q} + + \sum_{ue\in E_2} \frac{q + p - 2}{q . (p-2)}$$

$$= 2 + \frac{(q + p - 2)}{(p-2) . q} q . (p-2)$$

$$= q + p$$

**Theorem 3.3:** q & p be the edges and vertices of graph G, then

$$ReZG_1(G^{-+}) = \frac{2}{(p-1)}\left[\binom{p}{2} - q\right] + \frac{(p+1)q}{(p-1)}$$

**Proof:** Suppose $E_s(G^{-+})$ is the set of edges Partition into subsets $E_{S1}$ and $E_{S2}$, $E_{S1}$ ={$ue$ | $uv \notin E_s(G)$} ,$E_{S2}$={$ue$ such that $u$ is incident to $e$}. Therefore $|E_{s1}| = \binom{p}{2} - q$ , $|E_{s2}| =$ 2q. from 2.1 Proposition, $u \in V_s(G)$ as well $a_3 = (p-1)$ & $e \in E_s(G)$ as well $b_3 = 2$

$$ReZG_1(G^{-+}) = \sum_{u,v\in E_s(G^{-+})} \frac{a_3 + b_3}{a_3 . b_3}$$

$$= \sum_{u,v\in E_{S1}} \frac{a_3 + b_3}{a_3 . b_3} + \sum_{u,e\in E_{S2}} \frac{a_3 + b_3}{a_3 . b_3}$$

$$= \sum_{u,v\notin E_{S1}} \frac{2(p-1)}{(p-1)^2} + \sum_{ue\in E_{S2}} \frac{(p+1)}{2 . (p-1)}$$

$$= \frac{2}{(p-1)}\left[\binom{p}{2} - q\right] + \frac{(p+1)2q}{2(p-1)}$$

$$= \frac{2}{(p-1)}\left[\binom{p}{2} - q\right] + \frac{(p+1)q}{(p-1)}$$

**Theorem 3.4:** q & p be the edges and vertices of graph G, then

$$ReZG_1(G^{--}) = \sum_{uv\notin E_s(G)} \frac{2[p + q - 1 - (deg_G(u) + deg_G(v))]}{[q + p - 1 - 2deg_G(u)][q + p - 1 - 2deg_G(v)]} + \sum_{u\in V_s(G)} [q - deg_G(u)] \times \frac{2p + q - 3 - 2deg_G(u)}{[p + q - 1 - 2deg_G(u)](p-2)}$$

**Proof:** Suppose $E_s(G^{--})$ is the set of edges Partition into subsets $E_{S1}$ and $E_{S2}$, $E_{S1}$ ={$ue$ | $uv \notin E_s(G)$} ,$E_{S2}$={$ue$ such that $u$ not incident to $e$}. Therefore $|E_{s1}| = \binom{p}{2} - q$ , $|E_{s2}| = q(p-2)$. from 2.1 Proposition, $u \in V_s(G)$ as well $a_4 = p + q - 1 - 2deg_G(u)$ & $e \in E_s(G)$ as well $b_4 = (P - 2)$

$$ReZG_1(G^{--}) = \sum_{u,v\in E_s(G^{--})} \frac{a_4 + b_4}{a_4 b_4}$$

$$= \sum_{u,v\in E_{S1}} \frac{a_4 + b_4}{a_4 b_4} + \sum_{u,e\in E_{S2}} \frac{a_4 + b_4}{a_4 b_4}$$

$$= \sum_{u,v\notin E_s(G)} \frac{q + p - 1 - 2deg_G(u) + q + p - 1 - 2deg_G(v)}{(q + p - 1 - 2deg_G(u))(q + p - 1 - 2deg_G(v))}$$

$$+\sum_{u,v\in E_{s2}} \frac{q+p-1-2de_G(u)+p-2}{(q+p-1-2de_G(u))(p-2)}$$
$$=\sum_{uv\notin E_s(G)} \frac{2[q+p-1-(de_G(u)+de_G(v))]}{[q+p-1-2de_G(u)][q+p-1-2de_G(v)]}$$
$$+\sum_{u\in V_s(G)} [q-de_G(u)]$$
$$\times\frac{2p+q-3-2de_G(u)}{[p+q-1-2de_G(u)](p-2)}$$

Notations used for future Results

$de_{\overline{G^{++}}}(u) = c_1$  $de_{\overline{G^{++}}}(e) = d_1$

$de_{\overline{G^{++}}}(u) = c_2$  $de_{\overline{G^{++}}}(e) = d_2$

$de_{\overline{G^{++}}}(u) = c_3$  $de_{\overline{G^{++}}}(e) = d_3$

$de_{\overline{G^{++}}}(u) = c_4$  $de_{\overline{G^{++}}}(e) = d_4$

## IV. FIRST REDEFINED ZAGREB INDEX (REZG1) OF $\overline{G^{XY}}$

**Theorem 4.1:** q & p be the edges and vertices of graph G, then

$$ReZG_1(\overline{G^{++}})$$
$$=\sum_{u,v\notin E_s(G)} \frac{2[p+q-1-(de_G(u)+de_G(v))]}{[q+p-1-2de_G(u)][q+p-1-2de_G(v)]}$$
$$+\sum_{u,\in V_s(G)} [q-de_G(u)]$$
$$\times\frac{2[q+p-2-de_G(u)]}{[q+p-1-2de_G(u)](q+p-3)}$$
$$+\frac{q(p-1)}{(p+q-3)}$$

**Proof :** Suppose $E_s(\overline{G^{++}})$ is the set of edges Partition into subsets $E_{s1}$,$E_{s2}$,$E_{s3}$ , $E_{s1}$={$ue$ | $uv \notin E_s(G)$} ,$E_{s2}$={$ue$ such that $u$ not incident to $e$},$E_{s3}$={ef | e,f $\in E_s(G)$}. Therefore $|E_{s1}| = \binom{p}{2} - q$, $|E_{s2}| = q(P-2)$, $|E_{s3}| = \binom{q}{2}$, from 2.1 Proposition, $u \in V_s(G)$ as well $c_1 = p+q-1-2de_G(u)$ & $e \in E_s(G)$ as well $d_1 = p+q-3$.

$$ReZG_1(\overline{G^{++}}) = \sum_{u,v\in E_S(\overline{G^{++}})} \frac{c_1 + d_1}{c_1.d}$$
$$=\sum_{u,v\in E_{s1}} \frac{c_1+c_1}{c_1.c_1}$$
$$+\sum_{u,e\in E_{s2}} \frac{c_1+d_1}{c_1.d_1}$$
$$+\sum_{e,f\in E_{s3}} \frac{d_1+d_1}{d_1.d_1}$$
$$=\sum_{u,v\notin E_s(G)} \frac{[q+p-1-2de_G(u)]+[q+p-1-2de_G(v)]}{[q+p-1-2de_G(u)].[q+p-1-2de_G(v)]}$$
$$+\sum_{u,e\in E_{s2}} \frac{[q+p-1-2de_G(u)]+[q+p-3]}{[q+p-1-2de_G(u)].[q+p-3]}$$
$$+\sum_{e,f\in E_{s3}} \frac{[q+p-3]+[q+p-3]}{[q+p-3].[q+p-3]}$$
$$=\sum_{u,v\notin E_s(G)} \frac{2[p+q-1-(de_G(u)+de_G(v))]}{[p+q-1-2de_G(u)][p+q-1-2de_G(v)]}$$
$$+\sum_{u,\in V_s(G)} [q-de_G(u)]$$
$$\times\frac{2[q+p-2-de_G(u)]}{[q+p-1-2de_G(u)](q+p-3)}$$
$$+\frac{q(p-1)}{(p+q-3)}$$

**Theorem 4.2:** q & p be the edges and vertices of graph G, then

$$ReZG_1(\overline{G^{+-}}) = \frac{\{p+qp+q(p-1)\}(p-1)-2q+2qp}{(q+1)(p-1)}$$

**Proof :** Suppose $E_s(\overline{G^{+-}})$ is the set of edges Partition into subsets $E_{s1}$,$E_{s2}$,$E_{s3}$ , $E_{s1}$={$ue$ | $uv \notin E_s(G)$} ,$E_{s2}$={$ue$ such that $u$ incident to $e$},$E_{s3}$={ef | e,f $\in E_s(G)$}. Therefore $|E_{s1}| = \binom{p}{2} - q$ , $|E_{s2}| = 2q$ , $|E_{s3}| = \binom{q}{2}$ , from 2.1 Proposition, $u \in V_s(G)$ as well $c_2 = p-1$ & $e \in E_s(G)$ as well $d_2 = q+1$.

$$ReZG_1(\overline{G^{+-}}) = \sum_{u,v\in E_S(\overline{G^{+-}})} \frac{c_2 + d_2}{c_2.d_2}$$
$$=\sum_{u,v\in E_{s1}} \frac{c_2+c_2}{c_2.c_2}$$
$$+\sum_{u,e\in E_{s2}} \frac{c_2+d_2}{c_2.d_2}$$
$$+\sum_{e,f\in E_{s3}} \frac{d_2+d_2}{d_2.d_2}$$
$$=\sum_{u,v\notin E_s(G)} \frac{p-1+p-1}{(p-1)(p-1)}$$
$$+\sum_{u,e\in E_{s2}} \frac{p-1+q+1}{(q+1)(p-1)}$$
$$+\sum_{e,f\in E_{s3}} \frac{q+1+q+1}{(q+1)(q+1)}$$
$$=\frac{2}{(p-1)}\left[\frac{p(q-1)}{2}-q\right]+\frac{(p+q)2q}{(q+1)(p-1)}$$
$$+\frac{(q-1)}{(q+1)}$$
$$=\frac{\{p+qp+q(p-1)\}(p-1)-2q+2qp}{(q+1)(p-1)}$$

**Theorem 4.3:** q & p be the edges and vertices of graph G, then $ReZG_1(\overline{G^{-+}}) = \frac{q^2-3q+p(2q+p-3)}{(p+q-3)}$

**Proof :** Suppose $E_s(\overline{G^{-+}})$ is the set of edges Partition into subsets $E_{s1}$,$E_{s2}$,$E_{s3}$ , $E_{s1}$={$ue$ | $uv \in E_s(G)$} ,$E_{s2}$={$ue$ such that $u$ not incident to $e$},$E_{s3}$={ef | e,f $\in E_s(G)$}. Therefore $|E_{s1}| = q$, $|E_{s2}| = q(p-2)$, $|E_{s3}| = \binom{q}{2}$, from 2.1 Proposition, $u \in V_s(G)$ as well $c_3 = q$ & $e \in E_s(G)$ as well $d_3 = p+q-3$.

$$ReZG_1(\overline{G^{-+}}) = \sum_{u,v\in E_S(\overline{G^{-+}})} \frac{c_3 + d_3}{c_3.d_3}$$

$$= \sum_{u,v\in E_{s1}} \frac{c_3 + c_3}{c_3.c_3} + \sum_{u,e\in E_{s2}} \frac{c_3 + d_3}{c_3.d_3} + \sum_{e,f\in E_{s3}} \frac{d_3 + d_3}{d_3.d_3}$$

$$= \sum_{u,v\in E_s(G)} \frac{q+q}{q.q} + \sum_{ue\in E_{s2}} \frac{q+p+q-3}{q.(p+q-3)} + \sum_{ef\in E_{s3}} \frac{p+q-3+p+q-3}{(p+q-3)(p+q-3)}$$

$$= 2 + \left[\frac{2q+p-3}{(p+q-3)q}\right] q(p-2) + \frac{2}{(p+q-3)}\left[\frac{q(q-1)}{2}\right]$$

$$= \frac{q^2-3q+(2q+p-3)p}{(p+q-3)}$$

**Theorem 4.4:** q & p be the edges and vertices of graph G, then $ReZG_1(\overline{G^{--}}) = \frac{1}{2}ReZG_1(G) + \sum_{u\in V_S(G)} \frac{2de_G(u)+q+1}{2(q+1)} + \frac{q(q-1)}{(q+1)}$

**Proof :** Suppose $E_s(\overline{G^{--}})$ is the set of edges Partition into subsets $E_{s1}$,$E_{s2}$,$E_{s3}$ , $E_{s1}$={$ue$ | $uv \in E_s(G)$} ,$E_{s2}$={$ue$ such that $u$ incident to $e$},$E_{s3}$={ef | e,f $\in E_s(G)$}. Therefore $|E_{s1}| = q$, $|E_{s2}| = 2q$, $|E_{s3}| = \binom{q}{2}$, from 2.1 Proposition, $u \in V_s(G)$ as well $c_4 = 2de_G(u)$ & $e \in E_s(G)$ as well $d_4 = q+1$.

$$ReZG_1(\overline{G^{--}}) = \sum_{u,v\in E_S(\overline{G^{--}})} \frac{c_4 + d_4}{c_4.d_4}$$

$$= \sum_{u,v\in E_{s1}} \frac{c_4 + c_4}{c_4.c_4} + \sum_{u,e\in E_{s2}} \frac{c_4 + d_4}{c_4.d_4} + \sum_{e,f\in E_{s3}} \frac{d_4 + d_4}{d_4.d_4}$$

$$= \sum_{u,v\in E_s(G)} \frac{2de_{(G)}(u) + 2de_G(v)}{2de_{(G)}(u).2de_G(v)} + \sum_{u,e\in E_s(G)} \frac{2de_G(u)+q+1}{2de_G(u)(q+1)} + \sum_{e,f\in E_{s3}} \frac{q+1+q+1}{(q+1)(q+1)}$$

$$ReZG_1(\overline{G^{--}}) = \frac{1}{2}ReZG_1(G) + \sum_{u\in V_S(G)} \frac{2de_G(u)+q+1}{2(q+1)} + \frac{q(q-1)}{(q+1)}$$

## V. CONCLUSION:

Here, we acquired the expressions of the First Redefined Zagreb Index for Generalized Transformation Graph $G^{XY}$ and its complements $\overline{G^{xy}}$ in terms of the specifications of elemental graph G. Therefore One can obtain other descriptors for generalized transformation graph using same edge partition method and also can acquired expression for topological indices for generalized transformation graphs $G^{XY}$ also for its complements.

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