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Research Article

1-QUASITOTAL GRAPHS VS. DEGREE OF VERTICES WITH RESPECT TO A VERTEX SET

[1]Satyanarayana Bhavanari, [2,*]Srinivasulu Devanaboina, [3]Mallikarjun Bhavanari and [4]Eswaraiah Setty Sriramula

[1]Department of Mathematics, Acharya Nagarjuna University, Nagarjuna Nagar – 522 510, Andhra Pradesh, India
[2]Department of BSH, NRI Institute of Technology, Agiripalli- 521 212, Andhra Pradesh, India
[3]Institute of Energy Engineering, Department of Mechanical Engineering, National Central University Jhongli, Taoyuan, Taiwan
[4]Department of Mathematics, SGS College, jaggaiahpet, Andhra Pradesh, India

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ABSTRACT

In [Satyanarayana Bhavanari, 2014] the authors Satyanarayana, Srinivasulu and Syam Prasad studied 1–quasitotal graphs and in [Rajeshkanna et al., 2013] the authors Rajesh kanna, Dharmendr, Sridhara and Pradeep kumar studied the concepts 'degree of a vertex with respect to a given vertex set'. Some examples related to 1–quasitotal graphs and the degree of vertices of these graphs with respect to a particular given vertex set were presented. Finally we obtained a theorem whose statement is as follows: (i) If A=V(G) and A⊆V($Q_1(G)$), then $d_A(v) = d_{Q_1(G)}(v)$ for all $v \in$ V(G) and $d_A(v) = 0$ for all$v \in$ E(G); and (ii) If A=E(G) and A⊆V($Q_1(G)$), then $d_A(v) = 0$ if $v \in V(G)$ and $d_A(v) = d_{Q_1(G)}(v)$ for all $v \in$ E(G). Where $Q_1(G)$is the 1–quasitotal graph of G and $d_A(v)$ is the degree of vertex v with respect to the given vertex set A.

INTRODUCTION

Let G = (V, E) be a graph consist of a finite non-empty set V of vertices and finite set E of edges such that each edge e_k is identified as an unordered pair of vertices {v_i, v_j}, where v_i, v_j are called end points of e_k. The edge $e_k$is also denoted by either $v_i v_j$ or $\overline{v_i v_j}$. We also write $G(V,E)$for the graph. Vertex set and edge set of G are also denoted by $V(G)$ and $E(G)$respectively. An edge associated with a vertex pair {v_i, v_i} is called a self-loop. The number of edges associated with the vertex is the degree of the vertex, and d(v) denotes the degree of the vertex v. If there is more than one edge associated with a given pair of vertices, then these edges are called parallel edges or multiple edges. A graph that does not have self-loops or parallel edges is called a simple graph. We consider simple graphs only.

1.1 Definition (Satyanarayana, Srinivasulu, Syam Prasad [Satyanarayana Bhavanari, 2014])**:** Let G be a graph with vertex set V(G) and edge set E(G). The 1–quasitotal graph, (denoted by $Q_1(G)$) of G is defined as follows:

The vertex set of $Q_1(G)$, that is $V(Q_1(G)) = V(G) \cup E(G)$.

Two vertices x, y in $V(Q_1(G))$ are adjacent if they satisfy one of the following conditions:

Corresponding author: Srinivasulu Devanaboina,

Department of BSH, NRI Institute of Technology, Agiripalli□ 521 212, Andhra Pradesh, India.

- x, y are in V(G) and $\overline{xy} \in$ G.(In other words, $E(G) \subseteq E\big(Q_1(G)\big)$)
- x, y are in E(G) and x, y are incident in G.
- In other words, $\{\overline{xy} \,/ x, y \in E(G) and\ are\ incident\ in\ G\} \subseteq E\big(Q_1(G)\big)$).

1.2 Note: It is clear that $E\big(Q_1(G)\big)$ =$E(G) \cup \{\overline{xy} \,/ x, y \in E(G) and\ are\ incident\ in\ G\}$.

1.3 Definition (Rajesh kanna, Dharmendra, Sridhara and Pradeep kumar Rajeshkanna et al., 2013]**):** Let G be a simple graph and A$\subseteq V(G)$. The degree of a vertex $\boldsymbol{v} \in$V of a graph G with respect to A is the number of vertices of A that are adjacent to v. This degree is denoted by $d_A(v)$. The degree of a vertex v in G is denoted by$d_G(v)$.

For other preliminary results and notations we use [Satyanarayana Bhavanari, 2009], [Satyanarayana Bhavanari, 2009] or [Satyanarayana Bhavanari, 2014]

Section-2: Some Examples

2.1 Example: Consider the graph G given in Fig. 2.1A.

The 1-quasitotal graph Q_1(G) of the graph G is given in Fig. 2.1B

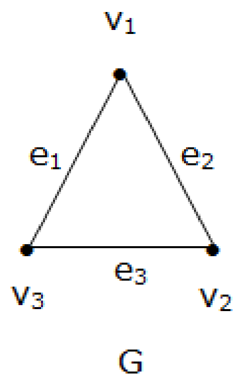

Fig. 2.1A

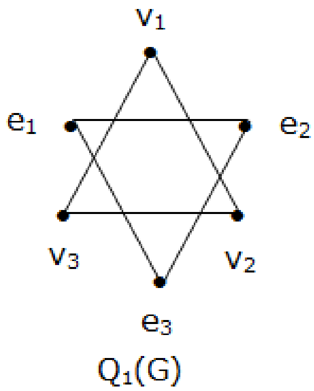

Fig 2.1B

- Suppose $A = V(G)$. Then
  $d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1)$ = 2;
  $d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2)$ = 2; and
  $d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3)$ = 2;
  So we have that $\square_{\square}(v) = d_G(v) = d_{Q_1(G)}(v)$ for all $v \in V(G)$.
  Suppose $A = E(G)$. Then $d_G(e) = 0, and\ d_A(e) = d_{Q_1(G)}(e)$ = 2 for all $e \in E(G)$.
- If $A = V(G) \cup \{e_1\}$. Then
  $d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 2$;
  $d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2)$ = 2;

$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 2$;
$d_A(e_1) = d_G(e_1) = 0,$ and $d_{Q_1(G)}(e_1) = 2$;
$d_A(e_2) = 1, d_G(e_2) = 0,$ and $d_{Q_1(G)}(e_2) = 2$; and
$d_A(e_3) = 1, d_G(e_3) = 0,$ and $d_{Q_1(G)}(e_3) = 2$.

- If $A = E(G) \cup \{v_1\} = \{e_1, e_2, e_3, v_1\}$. Then
  $d_A(v_1) = 0,\ d_G(v_1) = d_{Q_1(G)}(v_1) = 2$
  $d_A(v_2) = 1,\ d_G(v_2) = d_{Q_1(G)}(v_2) = 2$
  $d_A(v_3) = 1,\ d_G(v_3) = d_{Q_1(G)}(v_3) = 2$
  $d_A(e_1) = 2, d_G(e_1) = 0,$ and $d_{Q_1(G)}(e) = 2$
  $d_A(e_2) = 2,\ d_G(e_2) = 0,$ and $d_{Q_1(G)}(e_2) = 2$
  $d_A(e_3) = 2,\ d_G(e_3) = 0,$ and $d_{Q_1(G)}(e_3) = 2$

Example: Consider the graph given Fig. 2.2A.

The 1-quasitotal graph $Q_1(G)$ of the graph G is given in Fig. 2.2B.

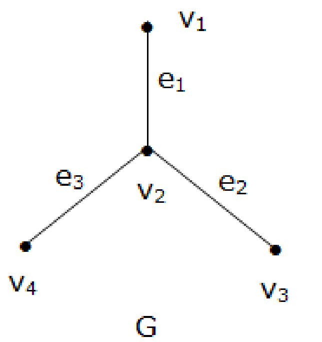

Fig 2.2A

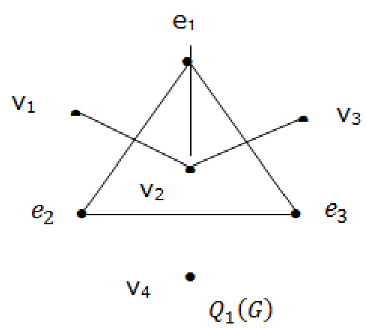

Fig 2.2B

- Suppose $A = V(G)$. Then

$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 3$;
$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;and
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 1$.

So we have that $d_A(v) = d_G(v) = d_{Q_1(G)}(v)$ for all $v \in V(G)$.

- Suppose $A = E(G)$. Then $d_G(e) = 0,$ and $d_A(e) = d_{Q_1(G)}(e) = 2$ for all $e \in E(G)$.
- Suppose$A = V(G) \cup \{e_1\}$. Then=

$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;

$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 3$;
$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 1$;
$d_A(e_1) = d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e_1) = 2$;
$d_A(e_2) = 1, d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 2$; and
$d_A(e_3) = 1, d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 2$.

●If $A = E(G) \cup \{v_1\} = \{e_1, e_2, e_3, v_1\}$. Then
$d_A(v_1) = 0,\ d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = 1,\ d_G(v_2) = d_{Q_1(G)}(v_2) = 3$;
$d_A(v_3) = 0,\ d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;
$d_A(v_4) = 0,\ d_G(v_4) = d_{Q_1(G)}(v_4) = 1$;
$d_A(e_1) = 2, d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e) = 2$;
$d_A(e_2) = 2,\ d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 2$; and
$d_A(e_3) = 2,\ d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 2$.

2.3 Example: Consider the graph given Fig. 2.3A

The 1-quasitotal graph $Q_1(G)$ of the graph G is given in Fig. 2.3B

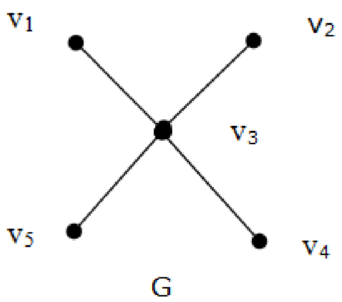

Fig. 2.3A

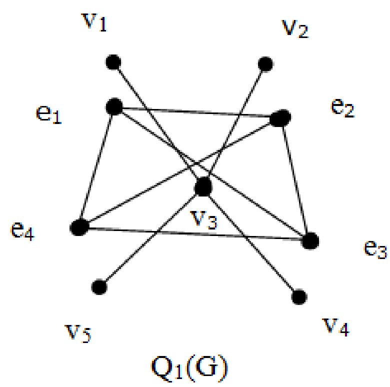

Fig. 2.3B

Suppose $A = V(G)$. Then

$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;
$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 4$;
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 1$; and
$d_A(v_5) = d_G(v_5) = d_{Q_1(G)}(v_5) = 1$.
So we have that $d_A(v) = d_G(v) = d_{Q_1(G)}(v)$ for all $v \in V(G)$.

- Suppose $A = E(G)$. Then $d_G(e) = 0, and\ d_A(e) = d_{Q_1(G)}(e) = 3$ for all $e \in E(G)$.
- Suppose $A = V(G) \cup \{e_1\}$.

Then

$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;
$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 4$;
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 1$;
$d_A(v_5) = d_G(v_5) = d_{Q_1(G)}(v_5) = 1$;
$d_A(e_1) = d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e_1) = 3$;
$d_A(e_2) = 1, d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 3$;
$d_A(e_3) = 1, d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 3$;
$d_A(e_4) = 1, d_G(e_4) = 0, and\ d_{Q_1(G)}(e_4) = 3$.

- If $A = E(G) \cup \{v_1\} = \{e_1, e_2, e_3, v_1\}$.

Then

$d_A(v_1) = 0,\ d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;

$d_A(v_2) = 0,\ d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;
$d_A(v_3) = 1,\ d_G(v_3) = d_{Q_1(G)}(v_3) = 4$;
$d_A(v_4) = 0,\ d_G(v_4) = d_{Q_1(G)}(v_4) = 1$;
$d_A(v_5) = 0,\ d_G(v_5) = d_{Q_1(G)}(v_5) = 1$;
$d_A(e_1) = 3, d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e_1) = 3$;
$d_A(e_2) = 3,\ d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 3$;
$d_A(e_3) = 3,\ d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 3$; and
$d_A(e_4) = 3,\ d_G(e_4) = 0, and\ d_{Q_1(G)}(e_4) = 3$.

Example: Consider the graph given Fig. 2.4A.

The 1-quasitotal graph $Q_1(G)$ of the graph G is given in Fig. 2.4B.

- v_2

Suppose $A = V(G)$. Then
e_2
$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
e_3
$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;
$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 5$;
$d_A(v_5) = d_G(v_5) = d_{Q_1(G)}(v_5) = 1$;and
$d_A(v_6) = d_G(v_6) = d_{Q_1(G)}(v_6) = 1$;

So we have that $d_A(v) = d_G(v) = d_{Q_1(G)}(v)$ for all $v \in V(G)$.

Suppose $A = E(G)$.
Then $d_G(e) = 0, and\ d_A(e) = d_{Q_1(G)}(e) = 4$

for all $e \in E(G)$

Suppose $A = V(G) \cup \{e_1\}$. Then
$d_A(v_1) = d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;

$d_A(v_3) = d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;
$d_A(v_4) = d_G(v_4) = d_{Q_1(G)}(v_4) = 5$;
$d_A(v_5) = d_G(v_5) = d_{Q_1(G)}(v_5) = 1$; and
$d_A(v_6) = d_G(v_6) = d_{Q_1(G)}(v_6) = 1$;
$d_A(e_1) = d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e_1) = 4$;
$d_A(e_2) = 1,\ d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 4$;
$d_A(e_3) = 1,\ d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 4$;
$d_A(e_4) = 1,\ d_G(e_4) = 0, and\ d_{Q_1(G)}(e_4) = 4$; and
$d_A(e_5) = 1,\ d_G(e_5) = 0, and\ d_{Q_1(G)}(e_5) = 4$.

Suppose $A = E(G) \cup \{v_1\} = \{e_1, e_2, e_3, v_1\}$.

Then

$d_A(v_1) = 0,\ d_G(v_1) = d_{Q_1(G)}(v_1) = 1$;
$d_A(v_2) = 0,\ d_G(v_2) = d_{Q_1(G)}(v_2) = 1$;
$d_A(v_3) = 0,\ d_G(v_3) = d_{Q_1(G)}(v_3) = 1$;
$d_A(v_4) = 1,\ d_G(v_4) = d_{Q_1(G)}(v_4) = 5$;
$d_A(v_5) = 0,\ d_G(v_5) = d_{Q_1(G)}(v_5) = 1$;
$d_A(v_6) = 0,\ d_G(v_6) = d_{Q_1(G)}(v_6) = 1$;
$d_A(e_1) = 4, d_G(e_1) = 0,\ and\ d_{Q_1(G)}(e_1) = 4$;
$d_A(e_2) = 4,\ d_G(e_2) = 0, and\ d_{Q_1(G)}(e_2) = 4$;
$d_A(e_3) = 4,\ d_G(e_3) = 0, and\ d_{Q_1(G)}(e_3) = 4$;
$d_A(e_4) = 4,\ d_G(e_4) = 0, and\ d_{Q_1(G)}(e_4) = 4$; and
$d_A(e_5) = 4,\ d_G(e_5) = 0, and\ d_{Q_1(G)}(e_5) = 4$.

3.A Theorem

3.1Theorem: Suppose A $\subseteq$ V($Q_1(G)$),
(i) If A $=$V(G), then $d_A(v) = d_{Q_1(G)}(v)$ for all $v \in$ V(G) and $d_A(v) = 0$ for all $v \in$ E (G)
(ii) If A $=$E(G), then $d_A(v) = 0$ if $v \in V(G)$ and $d_A(v) = d_{Q_1(G)}(v)$ for all $v \in$ E (G)

Proof: (i) Suppose A $=$V(G). Let $v \in$V(G). Then

$d_{Q_1(G)}(v) = |\{\overline{vu}/u \in V(G)\}|$
$= |\{\overline{vu}/u \in V(G) \cup E(G)\}|$
$= |\{\overline{vu}/u \in V(G)\}|$ (because $\{\overline{vu}/u \in V(G)\} = \phi$).
$= d_G(v) = d_A(v)$ (since A= V(G))

Suppose $v \in$E(G). Then $d_A(v) = |\{\overline{vu}/u \in A\}|$

$= |\{\overline{vu}/u \in V(G)\}|$ (since A= V(G)).
$= |\phi|$(since there is no edge in $Q_1(G)$ between a vertex of G and an edge of G)
= 0.

Suppose A $= E$(G).

Let $v \in$V(G). Since there is no edge (in $Q_1(G)$) between $v \in$V(G) and u $\in$ V(G) we have that $\{\overline{vu}/u \in E(G)\} = \phi$ and so $|\{\overline{vu}/u \in V(G)\}| = 0$.

Now $d_A(v) = |\{\overline{vu}/u \in A\}| = |\{\overline{vu}/u \in E(G)\}|$(SinceA=E(G))
= 0

Now suppose $v \in$E(G).

$d_{Q_1(G)}(v) = |\{\overline{vx} / x \in V(Q_1(G))\}|$

$= |\{\overline{vx} / x \in V(G) \cup E(G)\}|$ (Since $V(Q_1(G)) = V(G) \cup E(G)$)

$= |\{\overline{vx} / x \in V(G)\}| + |\{\overline{vx} / x \in E(G)\}|$ (since $V(G) \cap E(G) = \emptyset$)

$= 0 + |\{\overline{vx} / x \in E(G)\}|$

(since there is no edge in $Q_1(G)$ between an element in V(G) and an element $E(G)$)

$= |\{\overline{vx} / x \in A\}|$ (since A = $E(G)$

$= d_A(v)$.

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