

# Total Domination Number and Chromatic Number of a Fuzzy Graph

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## ABSTRACT

A subset  $S$  of  $V$  is called a domination set in  $G$  if every vertex in  $V-S$  is adjacent to at least one vertex in  $S$ . A dominating set is said to be Fuzzy Total Dominating set if every vertex in  $V$  is adjacent to at least one vertex in  $S$ . Minimum cardinality taken over all total dominating set is called as fuzzy total domination number and is denoted by  $\gamma_{ft}(G)$ . The minimum number of colours required to colour all the vertices such that adjacent vertices do not receive the same colour is the chromatic number  $\chi(G)$ . For any graph  $G$  a complete sub-graph of  $G$  is called a clique of  $G$ . In this paper we find an upper bound for the sum of the fuzzy total domination and chromatic number in fuzzy graphs and characterize the corresponding extremal fuzzy graphs.

## General Terms

$G(\mu, \sigma)$  be simple undirected fuzzy graph

## Keywords

Fuzzy Total Domination Number, Chromatic Number, Clique, Fuzzy Graphs

## 1. INTRODUCTION

The study of dominating sets in graphs was begun by Ore and Berge, the domination number, total domination number are introduced by Cockayne and Hedetniemi. A Mathematical framework to describe the phenomena of uncertainty in real life situation is first suggested by L. A. Zadeh in 1965.

Research on the theory of fuzzy sets has been witnessing an exponential growth, both within mathematics and in its applications. This ranges from traditional mathematical subjects like logic, topology, algebra, analysis etc. consequently fuzzy set theory has emerged as potential area of interdisciplinary research and fuzzy graph theory is of recent interest.

The fuzzy definition of fuzzy graphs was proposed by Kaufmann [4], from the fuzzy relations introduced by Zadeh [9]. Although Rosenfeld[5] introduced another elaborated definition, including fuzzy vertex and fuzzy edges. Several fuzzy analogs of graph theoretic concepts such as paths, cycles, connectedness etc. The concept of domination in fuzzy graphs was investigated by A. Somasundram, S. Somasundram [6]. A. Somasundram presented the concepts of independent domination, total domination, connected domination and domination in cartesian product and composition of fuzzy graphs:[7][8].

Several authors have studied the problem of obtaining an upper bound for the sum of a domination parameter and a graph theoretic parameter and characterized the corresponding extremal graphs. In [10], Paulraj Joseph J and Arumugam S proved that  $\gamma_{ft}(G) + \chi \leq p+1$ . In[9], Paulraj Joseph J and Arumugam S proved that  $\gamma_{ft}(G) + \chi \leq p+1$ . They also characterized the class of graphs for which the upper bound is attained. They also

proved similar results for  $\gamma$  and  $\gamma_t$ . In[14], Mahadevan G introduced the concept the complementary perfect domination number  $\gamma_{cp}$  and proved that  $\gamma_{cp}(G) + \chi \leq 2n-2$ , and characterized the corresponding extremal graphs. In[15], S.Vimala and J.S.Sathya proved that  $\gamma_t(G) + \chi(G) = 2n-5$ . They also characterized the class of graphs for which the upper bound is attained. In this paper we obtain sharp upper bound for the sum of the fuzzy total domination number and chromatic number and characterize the corresponding extremal fuzzy graphs.

## 2. PRELIMINARIES

If  $X$  is collection of objects denoted generically by  $x$ , then a Fuzzy set  $\tilde{A}$  in  $X$  is a set of ordered pairs:  $\tilde{A} = \{(x, \mu_{\tilde{A}}(x)) / x \in X\}$ ,  $\mu_{\tilde{A}}(x)$  is called the membership function of  $x$  in  $\tilde{A}$  that maps  $X$  to the membership space  $M$  (when  $M$  contains only the two points 0 and 1). Let  $E$  be the (crisp) set of nodes. A fuzzy graph is then defined by,  $\tilde{G}(x_i, x_j) = \{(x_i, x_j), \mu_{\tilde{G}}(x_i, x_j)\} / (x_i, x_j) \in E \times E$ .  $\tilde{H}(x_i, x_j)$  is a Fuzzy Sub graph of  $\tilde{G}(x_i, x_j)$  if  $\mu_{\tilde{H}}(x_i, x_j) \leq \mu_{\tilde{G}}(x_i, x_j) \forall (x_i, x_j) \in E \times E$ .  $\tilde{H}(x_i, x_j)$  is a spanning fuzzy sub graph of  $\tilde{G}(x_i, x_j)$  if the node set of  $\tilde{H}(x_i, x_j)$  and  $\tilde{G}(x_i, x_j)$  are equal, that is if they differ only in their arc weights.

Let  $G(\mu, \sigma)$  be simple undirected fuzzy graph. The degree of any vertex  $u$  in  $G$  is the number of edges incident with  $u$  and is denoted by  $d(u)$ . The minimum and maximum degree of a vertex is denoted by  $\delta(G)$  and  $\Delta(G)$  respectively.  $P_n$  denotes the path on  $n$  vertices. The vertex connectivity  $\kappa(G)$  of a graph  $G$  is the minimum number of vertices whose removal results in a disconnected graph. The chromatic number  $\chi$  is defined to be the minimum number of colours required to colour all the vertices such that adjacent vertices do not receive the same colour. For any graph  $G$  a complete sub graph of  $G$  is called a clique of  $G$ . The number of vertices in a largest clique of  $G$  is called the clique number of  $G$ .

A subset  $S$  of  $V$  is called a dominating set in  $G$ , if every vertex in  $V-S$  is adjacent to at least one vertex in  $S$ . The minimum cardinality taken over all minimal dominating sets in  $G$  is called the domination number of  $G$  and is denoted by  $\gamma$ . A dominating set  $S$  is said to be fuzzy total dominating set if every vertex in  $V$  is adjacent to at least one vertex in  $S$ . Minimum cardinality taken over all total dominating set is called as fuzzy total domination number and is denoted by  $\gamma_{ft}(G)$ . We use the following previous results.

2.1 Theorem: [1]: For any connected graph  $G$ ,  $\gamma_t(G) \leq n$

2.2 Theorem: [2]: For any connected graph  $G$ ,  $\chi(G) \leq \Delta(G)+1$ .

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