

# 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  $\gamma_t(G) + \chi \leq p+1$ . In[9], Paulraj Joseph J and Arumugam S proved that  $\gamma_t(G) + \chi \leq p+1$ . 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 concepts 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 characterised 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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## **Table of Contents Journal For Fuzzy Graph Theory Domination Number**

1. Understanding the eBook Journal For Fuzzy Graph Theory Domination Number
  - The Rise of Digital Reading Journal For Fuzzy Graph Theory Domination Number
  - Advantages of eBooks Over Traditional Books
2. Identifying Journal For Fuzzy Graph Theory Domination Number
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Journal For Fuzzy Graph Theory Domination Number
  - User-Friendly Interface
4. Exploring eBook Recommendations from Journal For Fuzzy Graph Theory Domination Number
  - Personalized Recommendations
  - Journal For Fuzzy Graph Theory Domination Number User Reviews and Ratings
  - Journal For Fuzzy Graph Theory Domination Number and Bestseller Lists

5. Accessing Journal For Fuzzy Graph Theory Domination Number Free and Paid eBooks
  - Journal For Fuzzy Graph Theory Domination Number Public Domain eBooks
  - Journal For Fuzzy Graph Theory Domination Number eBook Subscription Services
  - Journal For Fuzzy Graph Theory Domination Number Budget-Friendly Options
6. Navigating Journal For Fuzzy Graph Theory Domination Number eBook Formats
  - ePub, PDF, MOBI, and More
  - Journal For Fuzzy Graph Theory Domination Number Compatibility with Devices
  - Journal For Fuzzy Graph Theory Domination Number Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Journal For Fuzzy Graph Theory Domination Number
  - Highlighting and Note-Taking Journal For Fuzzy Graph Theory Domination Number
  - Interactive Elements Journal For Fuzzy Graph Theory Domination Number
8. Staying Engaged with Journal For Fuzzy Graph Theory Domination Number
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Journal For Fuzzy Graph Theory Domination Number
9. Balancing eBooks and Physical Books Journal For Fuzzy Graph Theory Domination Number
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Journal For Fuzzy Graph Theory Domination Number
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Journal For Fuzzy Graph Theory Domination Number
  - Setting Reading Goals Journal For Fuzzy Graph Theory Domination Number
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Journal For Fuzzy Graph Theory Domination Number
  - Fact-Checking eBook Content of Journal For Fuzzy Graph Theory Domination Number
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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