

## Fuzzy Minimal Weakly Generalized Continuous Maps

<sup>1</sup>R. Parimelazhagan and <sup>2</sup>N. Nagaveni

<sup>1</sup>*Department of Science and Humanities, Karpagam college of Engineering,  
coimbatore -32. Tamil Nadu India  
E- mail : pari tce@yahoo.co.in*

<sup>2</sup>*Assistant Professor in Mathematics, coimbatore Institute of  
Technology, coimbatore-14*

### Abstract

We have introduce new class of maps called fuzzy minimal weakly genralized continuous function, a new class of fuzzy closed and fuzzy open maps called fuzzy minimal genralized closed functions and fuzzy weakly generalized open maps. Further we have introduced the Fuzzy minimal strongly continuous, almost continuous, perfectly continuous functions and studied their properties.

**Keywords:** Fuzzy Miminal space, fmgw-continuous, fuzzy minimal strongly continuous, fuzzy minimal almost continuous, fuzzy minimal perfectly continuous.

### 1. Introduction

In 1968, Chang [4] introduced fuzzy topological spaces by using fuzzy sets[14]. Since then various authors have contributed to this area. Various results in ordinary topological spaces have been put in the fuzzy settings and also various departures have been observed. Azad[3] observed that for fuzzy topological space the closure of a product of two fuzzy sets is not equal to the product of their closures. Coining the concept of a fuzzy space “product related” ro a fuzzy space, he overcome this departure further introducing the notions of fuzzy regular open(regular closed) set, he defined and studied semicontinuous, almost continuous and weakly continuous mappings in the fuzzy settings.  $\alpha$ -open ( $\alpha$ -closed) sets, preopen (preclosed) sets, strongly semi continuous mappings and precontinuous mappings were introduced by Njastad[10], Mashaour[8], Noiri[11] and Mashhour[8] respectively. Abdulla[1]

introduced and studied on fuzzy strong semi continuity and precontinuous. Nagaveni[9] studied the fuzzy generalized weakly closed sets.

In this paper, We have a certain kind of investigation of fuzzy minimal weakly generalized continuous functions. Also we introduced and studied the fuzzy minimal strongly continuous, fuzzy minimal almost continuous and fuzzy minimal perfectly continuous functions.

Further we have studied the properties of these continuous functions.

## 2. Preliminaries

In this section, we begin by recalling some definitions and properties. For easy understanding of the material incorporated in this article. We recall some basic some basic definitions and results. For details on the following notions we refer to [4,7,12].

**Definition 2.1[2]:** Let  $(X, \tau)$  be a fuzzy topological space. A fuzzy set  $A$  in  $X$  is said to be fuzzy semi open if  $A \leq \text{cl}(\text{int}(A))$ .

**Definition 2.2[2]:** Let  $(X, \tau)$  be a fuzzy topological space. A fuzzy set  $A$  in  $X$  is said to be fuzzy pre open if  $A \leq \text{int}(\text{cl}(A))$

**Definition 2.3[2]:** Let  $(X, \tau)$  be a fuzzy topological space. A fuzzy set  $A$  in  $X$  is said to be fuzzy  $\alpha$ -open if  $A \leq \text{int}(\text{cl}(\text{int}(A)))$ .

**Definition 2.4[2]:** Let  $(X, \tau)$  be a fuzzy topological space. A fuzzy set  $A$  in  $X$  is said to be fuzzy  $\beta$ -open if  $A \leq \text{cl}(\text{int}(\text{cl}(A)))$ .

The family of all fuzzy semi open fuzzy preopen fuzzy  $\alpha$  open and fuzzy  $\beta$ -open set is denoted by  $\text{FSO}(X)$ ,  $\text{FPO}(X)$ ,  $\text{F}\alpha\text{O}(X)$  and  $\text{F}\beta\text{O}(X)$  respectively and they studied by many authors [5,6,12]. The complement of a fuzzy semi open, fuzzy preopen, fuzzy  $\alpha$ -open and fuzzy  $\beta$ -open set is called fuzzy semi closed fuzzy preclosed, fuzzy  $\alpha$ -closed and fuzzy  $\beta$ -closed set respectively. The union of all fuzzy semi open fuzzy preopen, fuzzy  $\alpha$ -open and fuzzy  $\beta$ -open sets of  $X$  contained in  $A$  is called fuzzy semi interior, fuzzy pre interior, fuzzy  $\alpha$ -interior and fuzzy  $\beta$ - interior of  $A$  and is denoted by  $\text{sint}(A)$ ,  $\text{pint}(A)$ ,  $\alpha\text{-int}(A)$  and  $\beta\text{-int}(A)$  respectively. Similarly  $\text{scl}(A)$ ,  $\text{pcl}(A)$ ,  $\alpha\text{cl}(A)$  and  $\beta\text{cl}(A)$  are defined.

**Definiton 2.5[2]:** A family  $\mu$  of fuzzy sets in  $X$  is said to be a fuzzy minimal structures on  $X$  if  $\alpha, X \in \mu$  for any  $\alpha \in I$ . In this case  $(X, \mu)$  is called a fuzzy minimal space.

**Example 2.6[2]:** Let  $(X, \tau)$  be a fuzzy a fuzzy topological space. Then  $\mu = \tau$ ,  $\text{Fso}(X)$ ,  $\text{Fpo}(X)$ ,  $\text{F}\alpha(X)$  and  $\text{f}\beta\text{o}(X)$  are fuzzy minimal structures on  $X$ .

**Definition 2.7[2]:** A fuzzy set  $A \in I^X$  is said to be a fuzzy  $m$ -open set if  $B^c \in \mu$ . we get  $m\text{-int}(A) = \bigvee U : U \leq A, U \in \mu$   $m\text{-cl}(A) = \bigwedge F : A \leq F, F^c \in \mu$

**Remark 2.8:** Choosing one of  $\tau$ ,  $Fso(X)$ ,  $Fpo(X)$ ,  $F\alpha(X)$  and  $F\beta o(X)$  instead of  $\mu$  then  $m\text{-int}(A)$  would be  $\text{int}(A)$ ,  $\text{sint}(A)$   $\text{pint}(A)$ ,  $\alpha(A)$  and  $\beta(A)$  respectively . similarly  $m\text{-cl}(A)$  is equal to  $\text{cl}(A)$ ,  $\text{scl}(A)$ ,  $\text{pcl}(A)$ ,  $\alpha\text{cl}(A)$  and  $\beta\text{cl}(A)$  respectively.

**Proposition 2.9 [2]:** For any two fuzzy sets A and B

- (a)  $m\text{-int}(A) \leq A$  and  $m\text{-int}(A) = A$  is a fuzzy mopenset. specially  $m\text{-int}(\alpha 1_x) = \alpha 1_x$  for all  $\alpha \in I$ .
- (b)  $A \leq m\text{-cl}(A)$  and  $A = m\text{-cl}(A)$  if A is fuzzy mclosedset. Specially  $m\text{-cl}(\alpha 1_x) = \alpha 1_x$  for all  $\alpha \in I$ .
- (c)  $m\text{-int}(A) \leq m\text{-int}(B)$  and  $m\text{-cl}(A) \leq m\text{-cl}(B)$  if  $A \leq B$
- (d)  $m\text{-int}(A \cap B) = m\text{-int}(A) \cap (m\text{-int}(B))$  and  $m\text{-int}(A) \cup (m\text{-int}(B)) \leq m\text{-int}(A \cup B)$
- (e)  $m\text{-cl}(A \cup B) = m\text{-cl}(A) \cup (m\text{-cl}(B))$  and  $m\text{-cl}(A \cap B) \leq (m\text{-cl}(A)) \cap (m\text{-cl}(B))$
- (f)  $m\text{-int}(m\text{-int}(A)) = m\text{-int}(A)$  and  $m\text{-cl}(m\text{-cl}(B)) = m\text{-cl}(B)$
- (g)  $[m\text{-cl}(A)]^c = m\text{-int}(A^c)$  and  $[m\text{-int}(A)]^c = m\text{-cl}(A^c)$

### 3. Fuzzy minimal weakly generalized Continuous

In this section we have introduce the new class of definition fuzzy minimal weakly generalazed continuous function (fmwg-Continuous).Also we studied some of its properties.

**Definition 3.1:** Let  $(X, m_x)$  and  $(Y, m_y)$  be fuzzy minimal space. A map  $f : (X, m_x) \rightarrow (Y, m_y)$  is said to be fuzzy minimal weakly generalized continuous functions (fmwg-continuous) if the inverse image of every fuzzy minimal open set in  $(Y, m_y)$  is fmwg-open in  $(X, m_x)$ .

**Theorem 3.2:** If a map  $f : (X, m_x) \rightarrow (Y, m_y)$  from a fuzzy minimal space  $(X, m_x)$  into a fuzzy minimal space  $(Y, m_y)$  is fuzzy minimal continuous then it is fmwg-continuous but not conversely.

**Proof:** Let  $\gamma$  be a fuzzy minimal open set in fuzzy minimal space  $(Y, m_y)$ . Since  $f$  is fuzzy minimal continuous,  $f^{-1}(\gamma)$  is fuzzy minimal open in  $(X, m_x)$ . As every fuzzy minimal open set is fmwg-open. We have  $f^{-1}(\gamma)$  is fmwg-open in  $(X, m_x)$ . Therefore  $f$  is fmwg-continuous.

**Remark 3.3:** The following example shows that the converse of the above theorem need not be true.

**Example 3.4** Let  $(X, m_x) = (Y, m_y) = \{a, b, c\} : I = [0, 1]$  and the function  $\alpha, \beta, \gamma : (X, m_x) \rightarrow [0, 1]$  defined as

$$\begin{aligned}\alpha(x) &= \begin{cases} 1 & X = a \\ 0, & \text{otherwise} \end{cases} \\ \beta(x) &= \begin{cases} 1 & X = b \\ 0, & \text{otherwise} \end{cases} \\ \gamma(x) &= \begin{cases} 1 & X = b, c \\ 0, & \text{otherwise} \end{cases}\end{aligned}$$

consider  $m_x = \{1, 0, \alpha\}$  . and  $m_y = \{0, 1, \beta, \gamma\}$ . Now  $(X, m_x)$  and  $(Y, m_y)$  are fuzzy minimal spaces. Define  $f : (X, m_x) \rightarrow (Y, m_y)$  by  $f(a) = b$   $f(b) = c$   $f(c) = a$

then  $f$  is fmwg-continuous but not fuzzy minimal continuous as the inverse image of the fuzzy minimal open set  $\gamma$  in  $(Y, m_y)$  is  $\gamma : (X, m_x) \rightarrow I$  defined as

$$\gamma(x) = \begin{cases} 1 & X = b, c \\ 0, & \text{otherwise} \end{cases}$$

which is not fuzzy minimal open in  $(X, m_x)$ .

**Theorem 3.5:** A map  $f : (X, m_x) \rightarrow (Y, m_y)$  is fmwg-continuous if and only if the inverse image of every minimal closed set in fuzzy minimal space  $(Y, m_y)$  is fmwg-closed in fuzzy minimal space  $(X, m_x)$ .

**Proof:** Let be a fuzzy minimal closed set in a fuzzy minimal space  $(Y, m_y)$ . Then  $\gamma^c$  is fuzzy minimal open in a fuzzy minimal space  $(Y, m_y)$ . Since  $f$  is fmwg-continuous.  $f^{-1}(\gamma^c)$  is fmwg-open in  $(X, m_x)$ . But  $f^{-1}(\gamma^c) = 1 - f^{-1}(\gamma)$  and so  $f^{-1}(\gamma)$  is fmwg-closed set in  $(X, m_x)$ .

Conversely assume that the inverse image of every fuzzy minimal closed set in  $(Y, m_y)$  is fmwg-closed set in  $(X, m_x)$ . Let  $\mu$  be a fuzzy minimal open set in  $(Y, m_y)$ . Then  $\mu^c$  is fuzzy minimal closed set in  $(Y, m_y)$ . By hypothesis  $f^{-1}(\mu^c) = 1 - f^{-1}(\mu)$  is fmwg-closed in  $(X, m_x)$  and  $f^{-1}(\mu)$  is fmwg-open in  $(X, m_x)$ . Thus  $f$  is fmwg - continuous.

**Theorem 3.7 :** Let  $(X, m_x)$  and  $(Y, m_y)$  be a fuzzy minimal space. If a map  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal g-continuous then it is fmwg-continuous but not conversely.

**Proof :** Assume that  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal g-continuous. Let  $\mu$  be a fuzzy minimal open set in  $(Y, m_y)$ . Since  $f$  is fuzzy minimal gcontinuous  $f^{-1}(\mu)$  is fuzzy minimal g-open in  $(X, m_x)$ . As every fuzzy minimal g-open set in fmwg-open,  $f^{-1}(\mu)$  is fmwg-open. Therefore  $f$  is fmwg-continuous.

**Remark 3.8:** The converse of above theorem need not be true from the following example.

**Example 3.9:** Let  $(X, m_x) = (Y, m_y) =$

$\{a, b, c\} : I = [0, 1]$  and the function  $\alpha, \beta, \gamma : (X, m_x) \rightarrow [0, 1]$  defined as

$$\begin{aligned} \alpha(x) &= \begin{cases} 1 & X = a \\ 0, & \text{otherwise} \end{cases} \\ \beta(x) &= \begin{cases} 1 & X = a, b \\ 0, & \text{otherwise} \end{cases} \\ \gamma(x) &= \begin{cases} 1 & X = a, c \\ 0, & \text{otherwise} \end{cases} \end{aligned}$$

consider the minimal space  $m_x = \{0, 1, \alpha, \beta\}$  and  $m_y = \{0, 1, \gamma\}$ . Then  $(X, m_x)$  and  $(Y, m_y)$  are the fuzzy minimal spaces. Now the identity map from  $(X, m_x)$  into  $(Y, m_y)$  is fmwg-continuous but not fuzzy minimal g-continuous as the inverse image of the fuzzy minimal open set in  $(Y, m_y)$  is in  $(X, m_x)$  which is not fuzzy minimal g-open.

#### 4. Fuzzy minimal Perfectly continuous, almost continuous Strongly continuous and pre-continuous mappings

In this section, we have introduced the new class of definitions almost continuous, perfectly continuous, strongly continuous and pre-continuous in fuzzy minimal weakly mappings. Also we studied the some of its properties and the relationship between the fmwg-continuous functions.

**Theorem 4.1:** If a function  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal perfectly continuous and fmwg-continuous then it is fuzzy minimal g-continuous.

**Proof:** Let  $f : (X, m_x) \rightarrow (Y, m_y)$  be fuzzy minimal perfectly continuous and fmwg-continuous,  $\mu$  be a fuzzy minimal open set in  $(Y, m_y)$  then  $f^{-1}(\mu)$  is both fuzzy minimal open and fuzzy minimal closed in  $(X, m_x)$  as  $f$  is fuzzy minimal perfectly continuous. Since  $f^{-1}(\mu)$  is fuzzy minimal closed, it is fuzzy minimal semi-closed and  $f$  is fmwg-continuous implied  $f^{-1}(\mu)$  is fmwg-open. Thus  $f^{-1}(\mu)$  is both fuzzy semi-closed and fmwg-open and hence it is fuzzy minimal g-open. Thus  $f$  is fuzzy minimal g-continuous.

**Definition 4.2:** A mapping  $f : (X, m_x) \rightarrow (Y, m_y)$  from a fuzzy minimal space  $(X, m_x)$  to a fuzzy minimal space  $(Y, m_y)$  is said to be fuzzy minimal almost continuous mapping if  $f^{-1}(\mu)$  is fuzzy minimal open in  $(X, m_x)$  for each fuzzy minimal regular open set  $\mu$  of  $(Y, m_y)$ .

**Theorem 4.3:** If  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal almost continuous then it is fmwg-continuous.

**Proof:** Assume that  $f$  is fuzzy minimal almost continuous and a fuzzy set  $\mu$  be fuzzy minimal open in  $(X, m_x)$ . Then  $f^{-1}(\mu)$  is fuzzy minimal regular open in  $(X, m_x)$ . Now  $f^{-1}(\mu)$  is fmwg-open. Then  $f$  is fmwg-continuous.

**Definition 4.4:** A mapping  $f : (X, m_x) \rightarrow (Y, m_y)$  be a fuzzy minimal spce  $(X, m_x)$  to a fuzzy minimal space  $(Y, m_y)$ . Then  $f$  is called a fuzzy strongly semi continuous if  $f^{-1}(\mu)$  is a fuzzy minimal  $\alpha$ -open set in  $(X, m_x)$  for  $\mu \in m_x$ .

**Theorem 4.5:** If  $f$  is fuzzy minimal strongly semicontinuous then it is fmwg-continuous but not conversely.

**Proof:** Assume that  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal strongly semi continuous. Let  $\mu$  be a fuzzy minimal open set in  $(Y, m_y)$ . Since  $f$  is fuzzy minimal strongly semi continuous  $f^{-1}(\mu)$  is fuzzy minimal  $\alpha$ -open and hence fmwg-open in  $(X, m_x)$ . Thus  $f$  is fmwg-continuous.

**Remark 4.6:** The converse of the above theorem need not be true from the following example.

**Example 4.7:** Let  $(X, m_x) = (Y, m_y) = \{a, b, c\} : I = [0, 1]$  and the function  $\alpha, \beta, \gamma : (X, m_x) : \rightarrow [0, 1]$  defined as

$$\begin{aligned} \alpha(x) &= \begin{cases} 1 & X = a \\ 0, & \text{otherwise} \end{cases} \\ \beta(x) &= \begin{cases} 1 & X = b, c \\ 0, & \text{otherwise} \end{cases} \\ \gamma(x) &= \begin{cases} 1 & X = a, b \\ 0, & \text{otherwise} \end{cases} \end{aligned}$$

consider the minimal space  $m_x = \{0, 1, \alpha, \beta\}$  and  $m_y = \{0, 1, \gamma\}$ . Then  $(X, m_x)$  and  $(Y, m_y)$  are the fuzzy minimal spaces. Define the function  $f : (X, m_x) \rightarrow (Y, m_y)$  by  $f(a) = a = f(b)$  and

$f(c) = b$ . This is a function is fmwg-continuous but not fuzzy minimal strongly semi continuous. Since the inverse image of the fuzzy minimal open set. Now the identity map from  $(X, m_x)$  into  $(Y, m_y)$  is fmwgcontinuous but not fuzzy minimal open set  $\alpha$  in  $(Y, m_y)$  is not fuzzy  $\alpha$ -open in  $(X, m_x)$ .

**Definition 4.8:** A mapping  $f : (X, m_x) \rightarrow (Y, m_y)$  be a fuzzy minimal spce  $(X, m_x)$  to a fuzzy minimal space  $(Y, m_y)$ . Then  $f$  is called a fuzzy pre- continuous if  $f^{-1}(\mu)$  is a fuzzy minimal pre-open set in  $(X, m_x)$  for  $\mu \in m_x$ .

**Theorem 4.9:** If a map  $f : (X, m_x) \rightarrow (Y, m_y)$  is fuzzy minimal pre-continuous then it is fmwg-continuous but conversely.

**Proof:** Let  $f : (X, m_x) \rightarrow (y, m_y)$  is fuzzy minimal pre-continuous and  $\mu$  be a fuzzy minimal open set in  $(Y, m_y)$ . Then  $f^{-1}(\mu)$  is fuzzy minimal pre-open and hence fmwg-open in  $(X, m_x)$ . Thus  $f$  is fmwg-continuous.

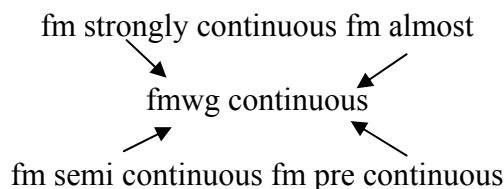
**Remark 4.10:** The converse of the above theorem need not be true for the following example.

**Example 4.11:** Let  $(X, m_x) = (Y, m_y) = \{a, b, c\} : I = [0, 1]$  and the function  $\alpha, \beta, \eta, \gamma : (X, m_x) \rightarrow [0, 1]$  defined as

$$\begin{aligned} \alpha(x) &= \begin{cases} 1 & X = a \\ 0, & \text{otherwise} \end{cases} \\ \beta(x) &= \begin{cases} 1 & X = a, c \\ 0, & \text{otherwise} \end{cases} \\ \eta(x) &= \begin{cases} 1 & X = b, c \\ 0, & \text{otherwise} \end{cases} \\ \gamma(x) &= \begin{cases} 1 & X = c \\ 0, & \text{otherwise} \end{cases} \end{aligned}$$

If  $m_x = \{0, 1, \alpha, \beta\}$  and  $m_y = \{0, 1, \alpha, \gamma\}$  be the minimal spaces then  $(X, m_x)$  and  $(Y, m_y)$  are fuzzy minimal spaces. consider the function  $f : (X, m_x) \rightarrow (Y, m_y)$  by  $f(a) = a = f(b)$  and  $f(c) = c$ . This is a function is fmwg-continuous but not fuzzy minimal pre-continuous as the inverse image of the fuzzy minimal open set in  $(Y, m_y)$  is in  $(X, m_x)$  which is not fuzzy minimal pre-open.

**Remark 4.12:** The following implications contained in the following digram are true.



**References**

- [1] Abdulla .S.BinShahana , On Fuzzy Strong Semi Conitnuity and Fuzzy Pre Continuity, Fuzzy sets and Systems, (1),44(1991), 303-308.
- [2] Alimohammody M. Roohi M. Fuzzy Minimal Structure and Fuzzy Minimal Vector space , Solitons and Fractals, 27 (2006), 599-605.
- [3] K.K.Azad On Fuzzy Continuity, Fuzzy almost Continuity and Fuzzy Weakly Continuity' J.Math.Anal.Appl. 82(1981) 14-32.
- [4] Chang .C.L. Fuzzy topological space, J.Math.Anal. Appl. 24(1968), 182-190.
- [5] El Naschie MS. On the uncertainty of Cantorian Geometry and the Two -slit Experiment. Chaos, Solitons and Fractals 1998, 9(3), 517-529.
- [6] J.A.Goguen, Fuzzy Tychonoff Theorem , J.Math. Anal. Appl. 43 (1973), 734-742.

- [7] Maki.H., On Generalizing semi open sets and preopen set. Meeting on topological space theory and its application August 1996, Yatsushiro Coll.Tech. P.13-18.
- [8] Mashhour.A.S,M.E.Abd, El-Mansef and El.Deeb, On Pre Continuous and Weak Pre cContinuous Mappings, Proc.Math.Phys.Soc.Egypt 51(1981)
- [9] Nagaveni.N Studies on generalisation of homeomorphisms in topological spaces,Ph.D, Thesis Bharathiar University,Coimbatore(1999)
- [10] O.Njastad, On Some Classes of Nearly Open Sets, Pacific.J.Math.51(1965) 961-970.
- [11] Noiri T.A Function Which Preserves Connected Spaces Casopis. Pest.Math.107(1982) 393-396.
- [12] Palaniappan N. Fuzzy topology Alpha Science International Limited ; 2002
- [13] Ying-Ming L.Mao-Kang L. Fuzzy topology: World Scientific Publishing Co. Pvt. Ltd. 1997.
- [14] L.A.Zadh. Fuzzy sets in form and Control 8(1965) 338-353.

**R. Parimelazhagan** completed his under graduate and postgraduate study at St. Joseph college Trichy. Later he acquired M.Phil degree from Bharathiar University, Coimbatore and qualified himself in B.Ed from Annamalai University, Chidambaram India. His major field of studies Mathematics throughout higher education. He has part in 13 years of teaching experience as a Lecturer, Senior Lecturer, Assistant Professor and Head of the department (Science and Humanities/Applied Sciences). Currently he is working at Karpagam college of Engineering, Coimbatore, Tamil Nadu, India. He has published 17 books in Engineering Mathematics. He was presented research papers in Malaysia, Hong Kong and Turkey in the international conferences. He is member of MISTE, ISCA and CSI.

E.Mail: pari tce@yahoo.com

**Nagaveni. N** received the B.Sc., M.Sc and B.Ed degrees in Mathematics from Bharathiar University, India in 1985, 1987 and 1988 respectively. M.Phil degree from Avinashilingam University, India in 1989 and M.Ed degree from Annamalai University, India in 1992. And Ph.D degree in the area of Topology in Mathematics from Bharathiar University, India in 2000. Since 1992, She has been with the department of Mathematics Coimbatore Institute of Technology, Coimbatore Tamil Nadu, India where she is currently as Assistant Professor. She is engaged as a research supervisor and her research interests includes Topology, Fuzzy sets and continuous function, data mining, distributed computing, Web mining and privacy preservation in data mining. She is the member in Indian Science Congress Association (ICSA). she has been presented many research papers in the annual conference of ICSA. She has been published many papers in the international and national Journals