Level Set of Direct Product of Intuitionistic Fuzzy BG-ideals in BG-algebra

[1] R. Rashma, [2] K. R. Sobha

[1]Research scholar,Reg.No:21113182092001
Sree Ayyappa college for Women, Chunkankadai, Nagercoil-629001, Tamil Nadu, India.
[2]Assistant Professor, Department of Mathematics, Sree Ayyappa College for Women, Chunkankadai, Nagercoil.
[Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli-627012, Tamil Nadu, India.]

E-mail: [1] rashmamariagiri@gmail.com, [2] vijayakumar.sobha9@gmail.com

Abstract: In this paper, we investigate some properties of level set of direct product of intuitionistic fuzzy BG-ideals in BG-algebra.

Keywords: BG-algebra, fuzzy BG-ideal, intuitionistic fuzzy BG-ideal, direct product of intuitionistic fuzzy BG-ideals, level set.

1. Introduction:

The idea of intuitionistic fuzzy set was first published by Atanassov [4] as a generalization of the notion of fuzzy set. In 1966, Imai and Iseki introduced the two classes of abstract algebra, viz., BCK/BCI-algebra. It is known that the class of BCK-algebra is a proper sub-class of the class of BCI-algebras. Negger and kim[8] introduced a new notion, called B-algebra which is related to several classes of algebras of intrest such as BCI/BCK-algebras.Cho and kim[5] discussed further relation between B-algebra and other topic especially quasigroups. Kim and kim[6] introduced the notion of BG-algebra, which is a generalization of B-algebra. Ahn and Lee fuzzified BG-algebra. Muthuraj et al.[7] investigated properties of fuzzy BG-ideals in BG-algebra. Senapati et al. presented the concept and basic properties of intuitionistic fuzzy BG-subalgebras. In 2005, Zarandi and Saeid[10] introduced the new concept called intuitionistic fuzzy ideals of BG-algebra and investigate some of their properties. In 2021 R.Angelin Suba and K.R.Sobha[2] introduced upper and lower level sets of absolute direct product of doubt intuitionistic fuzzy k-ideals of BCK/BCI-algebra. In this paper, we investigate some properties of level sets of direct product of intuitionistic fuzzy BG-ideals in BG-algebra.

2. Preliminaries

Definition:2:1

A BG-algebra is a non empty set X with a constant 0 and a binary operation "$*$" satisfying the following axioms:

(i) $x * x = 0$

(ii) $x * 0 = x$

(iii) $(x * y) * (0 * y) = x \; \forall x, y \in X$.

For brevity we also call X BG-algebra. A binary relation '$\leq$' on X can be defined by $x \leq y$ if and only if $x * y = 0$.

A non-empty set S of a BG-algebra X is called a BG-subalgebra of X if $x * y \epsilon S \; \forall \; x, y \epsilon S$.

Definition:2.2

A fuzzy set μ in X is called a fuzzy BG-ideal of X if it satisfies the following condition:

$(i)\ \mu(0) \geq \mu(x)$

$(ii) \mu(x) \geq min\{\mu(x * y), \mu(y)\}\ \forall x, y \epsilon X.$

Definition:2.3

If $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ is an intuitionistic fuzzy sets of BG-Algebra $X \times Y$ is said to be a intuitionistic fuzzy BG-ideal of $X \times Y$ if it satisfies the following axioms

(i) $\mu_{A\times B}(0,0) \geq \mu_{A\times B}(x_1, y_1)$

(ii) $\mu_{A\times B}(x_1, y_1) \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

(iii) $\mu_{A\times B}((x_1, y_1) * (x_2, y_2)) \geq \min\{\mu_{A\times B}((x_1, y_1)), \mu_{A\times B}(x_2, y_2)\}$

(iv) $\gamma_{A\times B}(0,0) \leq \gamma_{A\times B}(x_1, y_1)$

(v) $\gamma_{A\times B}(x_1, y_1) \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

(vi) $\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)) \leq \max\{\gamma_{A\times B}((x_1, y_1)), \gamma_{A\times B}(x_2, y_2)\}\ \ \forall x_1, x_2, y_1, y_2 \epsilon X.$

Definition:2.4

let $A = (\mu_A, \gamma_A)$ and $B = (\mu_B, \gamma_B)$ be intuitionistic fuzzy sets in X and Y respectively.Then the direct product of intuitionistic fuzzy sets A and B is defined by $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ where $\mu_{A\times B}: X \times Y \to [0,1]$ is given by

$\mu_{A\times B}(x, y) = \min\{\mu_A(x), \mu_B(y)\}$ and $\gamma_{A\times B}: X \times Y \to [0,1]$ is given by

$\gamma_{A\times B}(x, y) = \max\{\gamma_A(x), \gamma_B(y)\}$ for all $(x, y) \epsilon X \times Y$.

3. Level Set of Direct Product of Intuitionistic Fuzzy BG-Ideals

Let $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ be a intuitionistic BG-ideals of a BG-algebra $X \times Y$ and $\alpha, \beta \epsilon [0,1]$ then $\alpha -$ level cut of μ and $\beta -$ level cut of γ of $A \times B$ is as follows

$\mu_{A\times B,\alpha} = \{(x, y) \epsilon X \times Y / \mu_{A\times B}(x, y) \geq \alpha\}$ and

$\gamma_{A\times B,\beta} = \{(x, y) \epsilon X \times Y / \mu_{A\times B}(x, y) \leq \beta\}$

Theorem 3:1

If $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ is a intuitionistic fuzzy BG-ideal of $X \times Y$, then $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are BG-ideal of $X \times Y$ for any $\alpha, \beta \epsilon [0,1]$.

Solution:

Let $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ be a intuitionistic fuzzy BG-ideal of $X \times Y$ and

Let $\alpha\ \epsilon [0,1]$

Then we have(i) $\mu_{A\times B}(0,0) \geq \mu_{A\times B}(x, y) \forall (x, y) \epsilon X \times Y$

By definition, $\mu_{A\times B}(x, y) \geq \alpha\ \ \forall\ (x, y) \epsilon \mu_{A\times B,\alpha}$

So $\mu_{A\times B}(0,0) \geq \alpha$

Therefore $(0,0) \epsilon \mu_{A\times B,\alpha}$

(ii) Let $(x_1, y_1), (x_2, y_2) \epsilon X \times Y$ be such that$(x_1, y_1) * (x_2, y_2) \epsilon \mu_{A\times B,\alpha}$ and $(x_2, y_2) \epsilon \mu_{A\times B,\alpha}$

Then $\mu_{A\times B}[(x_1, y_1) * (x_2, y_2)] \geq \alpha$

$\mu_{A\times B}[(x_2, y_2)] \geq \alpha$

Since $\mu_{A\times B}$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ it follows that

$\mu_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \geq \min\{\mu_{A\times B}(x_1, y_1), \mu_{A\times B}(x_2, y_2)\}$

$\geq \min\{\alpha, \alpha\}$

$\geq \alpha$

Therefore $\mu_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \geq \alpha$

Hence $(x_1, y_1) * (x_2, y_2) \epsilon X \times Y$

Therefore $\mu_{A\times B,\alpha}$ is a intuitionistic fuzzy BG-ideal in BG-algebra.

(iii)Clearly, $\mu_{A\times B}$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ it follows that

$\mu_{A\times B}\{(x_1, y_1)\} \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

$\geq \min\{\alpha, \alpha\}$

$\geq \alpha$

Hence $\mu_{A\times B,\alpha}$ is a intuitionistic fuzzy BG-ideal in BG-algebra.

Similiarly,

let $\beta \epsilon [0,1]$

Also we have (iv) $\gamma_{A\times B}(0,0) \leq \gamma_{A\times B}(x, y) \forall (x, y) \epsilon X \times Y$

By definition, $\gamma_{A\times B}(x, y) \leq \alpha \ \forall\ (x, y) \epsilon \mu_{A\times B,\alpha}$

So $\gamma_{A\times B}(0,0) \leq \alpha$

Therefore$(0,0) \epsilon \gamma_{A\times B,\beta}$

(v)Let $(x_1, y_1), (x_2, y_2) \epsilon X \times Y$ be such that$(x_1, y_1) * (x_2, y_2) \epsilon \gamma_{A\times B,\beta}$

and $(x_2, y_2) \epsilon \gamma_{A\times B,\beta}$

Then $\gamma_{A\times B}[(x_1, y_1) * (x_2, y_2)] \leq \beta$

$\gamma_{A\times B}[(x_2, y_2)] \leq \beta$

Since $\gamma_{A\times B}$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ it follows that

$\gamma_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \leq \max\{\gamma_{A\times B}(x_1, y_1), \gamma_{A\times B}(x_2, y_2)\}$

$\leq \max\{\beta, \beta\}$

$\leq \beta$

Therefore $\gamma_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \leq \beta$

Hence $(x_1, y_1) * (x_2, y_2) \epsilon X \times Y$

Therefore $\gamma_{A\times B,\beta}$ is a intuitionistic fuzzy BG-ideal in BG-algebra.

(iii)Clearly, $\gamma_{A\times B}$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ it follows that

$\gamma_{A\times B}\{(x_1, y_1)\} \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

$\leq \max\{\beta, \beta\}$

$\leq \beta$

Therefore $\gamma_{A\times B,\beta}$ is a intuitionistic fuzzy BG-ideal in BG-algebra.

Hence $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are intuitionistic fuzzy BG-ideals in BG-algebra.

Theorem 3:2

An intuitionistic fuzzy set $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ iff for all $\alpha, \beta \epsilon [0,1]$, $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are either empty or BG-ideals of $X \times Y$.

Solution:

Assume that $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are either empty or BG-ideals of $X \times Y$ for $\alpha, \beta \epsilon [0,1]$

For any $(x, y) \epsilon\ X \times Y$

(i) Let $\mu_{A\times B}(x, y) = \alpha$ and

$\gamma_{A\times B}(x, y) = \beta$

Then $(x, y) \epsilon \mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$, so $\mu_{A\times B,\alpha} \neq \emptyset \neq \gamma_{A\times B,\beta}$

Since $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are BG-ideals of $X \times Y$

Therefore $(0,0) \epsilon \mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$

Hence $\mu_{A\times B}(0,0) \geq \alpha$

$= \mu_{A\times B}(x, y)$

Also $\gamma_{A\times B}(0,0) \leq \beta$

$= \gamma_{A\times B}(x, y)$ where $(x, y) \epsilon X \times Y$

Hence condition (i) satisfy

(ii) If there exist $(x_1, y_1), (x_2, y_2) \epsilon X \times Y$ be such that

$\mu_{A\times B}\{(x_1, y_1)\} < \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

Then by taking

$\alpha_0 = \frac{1}{2}(\mu_{A\times B}(x_1, y_1)) + \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

We have $\mu_{A\times B}(x_1, y_1) < \alpha_0 < min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

Hence $(x_1, y_1) \notin \mu_{A\times B,\alpha_0}$

$(x_1, y_1) * (x_2, y_2) \epsilon \mu_{A\times B,\alpha_0}$ and $(x_2, y_2) \epsilon \mu_{A\times B,\alpha_0}$

That is, $\mu_{A\times B,\alpha_0}$ is not a BG-ideals of $X \times Y$.

Which is a contradiction

Therefore

$\mu_{A\times B}\{(x_1, y_1)\} \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\} \forall (x_1, y_1), (x_2, y_2) \epsilon X \times Y$

Similiarly,

By taking

$\beta_0 = \frac{1}{2}(\gamma_{A\times B}(x_1, y_1)) + \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

We have $\gamma_{A\times B}(x_1, y_1) > \beta_0 > max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

Hence $(x_1, y_1) \notin \gamma_{A\times B,\beta_0}$

$(x_1, y_1) * (x_2, y_2) \epsilon \gamma_{A\times B,\beta_0}$ and $(x_2, y_2) \epsilon \gamma_{A\times B,\beta_0}$

That is, $\gamma_{A\times B,\beta_0}$ is not a BG-ideals of $X \times Y$.

Which is a contradiction

Therefore

$\gamma_{A\times B}\{(x_1, y_1)\} \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\} \forall (x_1, y_1), (x_2, y_2) \epsilon X \times Y.$

(iii) Clearly

$\mu_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \geq \min\{\mu_{A\times B}(x_1, y_1), \mu_{A\times B}(x_2, y_2)\} \forall (x_1, y_1), (x_2, y_2) \epsilon X \times Y.$

Similiarly,

$\gamma_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \leq \max\{\gamma_{A\times B}(x_1, y_1), \gamma_{A\times B}(x_2, y_2)\}$

$\forall (x_1, y_1), (x_2, y_2) \epsilon X \times Y.$

Conversely,

Assume $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ is a intuitionistic fuzzy BG-ideal of $X \times Y$

To prove: $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are either empty or BG-ideals of $X \times Y$

Suppose that $\mu_{A\times B,\alpha} \neq \emptyset$ for any $\alpha, \beta \epsilon [0,1]$

It is clear that $(0,0) \epsilon \mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$

Since $\mu_{A\times B}(0,0) \geq \mu_{A\times B}(x, y) \geq \alpha$

Also $\gamma_{A\times B}(0,0) \leq \gamma_{A\times B}(x, y) \leq \beta$

(ii) Let $(x_1, y_1) * (x_2, y_2) \epsilon \mu_{A\times B,\alpha}$ and $(x_2, y_2) \epsilon \mu_{A\times B,\alpha}$

$\mu_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \geq \alpha$ and

$\mu_{A\times B}\{(x_2, y_2)\} \geq \alpha$

$\mu_{A\times B}\{(x_1, y_1)\} \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

$\geq \alpha$

$\mu_{A\times B}\{(x_1, y_1)\} \geq \alpha$

Therefore $(x_1, y_1) \epsilon \mu_{A\times B,\alpha}$

Hence $\mu_{A\times B,\alpha}$ are BG-ideals of $X \times Y$.

Also $(x_1, y_1) * (x_2, y_2) \epsilon \gamma_{A\times B,\beta}$ and $(x_2, y_2) \epsilon \gamma_{A\times B,\beta}$

$\gamma_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \leq \beta$ and

$\gamma_{A\times B}\{(x_2, y_2)\} \leq \beta$

$\gamma_{A\times B}\{(x_1, y_1)\} \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

$\leq \beta$

$\gamma_{A\times B}\{(x_1, y_1)\} \leq \beta$

Therefore $(x_1, y_1) \epsilon \gamma_{A\times B,\beta}$

Hence $\gamma_{A\times B,\beta}$ are BG-ideals of $X \times Y$.

Therefore $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are BG-ideals of $X \times Y$.

(iii) Clearly,

$\mu_{A\times B}\{(x_1, y_1)\} \geq \alpha$ and $\mu_{A\times B}\{(x_2, y_2)\} \geq \alpha$

$(x_1, y_1) * (x_2, y_2) \epsilon \mu_{A\times B,\alpha}$

That is ,$\mu_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \geq \min\{\mu_{A\times B}(x_1, y_1), \mu_{A\times B}(x_2, y_2)\}$

Hence $\mu_{A\times B,\alpha}$ are BG-ideals of $X \times Y$.

Similiarly,

$$\gamma_{A\times B}\{(x_1, y_1) * (x_2, y_2)\} \leq \max\{\gamma_{A\times B}(x_1, y_1), \gamma_{A\times B}(x_2, y_2)\}$$

Therefore $\gamma_{A\times B,\beta}$ are BG-ideals of $X \times Y$.

Hence $\mu_{A\times B,\alpha}$ and $\gamma_{A\times B,\beta}$ are intuitionistic fuzzy BG-ideals of $X \times Y$.

Theorem 3:3

For any intuitionistic fuzzy set $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ is a intuitionistic fuzzy BG-ideal of $X \times Y$ iff the non-empty upper $\alpha -$ level cut $\mu_{A\times B} : \alpha$ and the non-empty lower $\beta -$ level cut of $\gamma_{A\times B}: \beta$ are ideals of $X \times Y$ for any $\alpha, \beta \epsilon [0,1]$

Solution:

Let $A \times B = (\mu_{A\times B}, \gamma_{A\times B})$ be a intuitionistic fuzzy BG-ideal of $X \times Y$.

(i) $\mu_{A\times B}(0,0) \geq \mu_{A\times B}((x_1, y_1))$ and

$\gamma_{A\times B}(0,0) \leq \gamma_{A\times B}\big((x_1, y_1)\big)\ \forall (x_1, y_1) \epsilon X \times Y$

(ii) $\mu_{A\times B}\{(x_1, y_1)\} \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

and

$\gamma_{A\times B}\{(x_1, y_1)\} \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

for any $\alpha, \beta \epsilon [0,1]$, if $\mu_{A\times B}\{(x_1, y_1)\} \geq \alpha$

That is ,

$\min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\} \geq \alpha$

This implies $(x_1, y_1)\ \epsilon \mu_{A\times B,\alpha}$

Clearly $(x_1, y_1) * (x_2, y_2) \epsilon \mu_{A\times B,\alpha}$

$(x_2, y_2) \epsilon \mu_{A\times B,\alpha}$

Now $\mu_{A\times B}\{(x_1, y_1)\} \geq \min\{\mu_{A\times B}((x_1, y_1) * (x_2, y_2)), \mu_{A\times B}(x_2, y_2)\}$

$\geq \min\{\alpha, \alpha\}$

$\geq \alpha$

This implies $(x_1, y_1)\ \epsilon \mu_{A\times B,\alpha}$

Thus $\alpha \epsilon [0,1]$,is a intuitionistic fuzzy BG-ideal of $X \times Y$.

Clearly, if $\gamma_{A\times B}(x_1, y_1) \leq \beta$

Then

$\max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\} \leq \beta$

This implies $(x_1, y_1)\ \epsilon \gamma_{A\times B,\beta}$

Clearly $(x_1, y_1) * (x_2, y_2) \epsilon \gamma_{A\times B,\beta}$

$(x_2, y_2) \epsilon \gamma_{A\times B,\beta}$

Now $\gamma_{A\times B}\{(x_1, y_1)\} \leq \max\{\gamma_{A\times B}((x_1, y_1) * (x_2, y_2)), \gamma_{A\times B}(x_2, y_2)\}$

$\leq \max\{\beta, \beta\}$

$\leq \beta$

This implies $(x_1, y_1)\ \epsilon \gamma_{A\times B,\beta}$

Thus $\beta \epsilon [0,1]$, is a intuitionistic fuzzy BG-ideal of $X \times Y$.

Hence $\alpha, \beta \epsilon [0,1]$ is a intuitionistic fuzzy BG-ideal of $X \times Y$.

Conversely,

Let $(x_1, y_1), (x_2, y_2) \epsilon X \times Y$ such that

$\mu_{A\times B}\big((x_1, y_1)\big) = \alpha$

$\gamma_{A\times B}\big((x_1, y_1)\big) = \beta$

This implies $(x_1, y_1)\ \epsilon \mu_{A\times B,\alpha}$ and $(x_1, y_1)\ \epsilon \gamma_{A\times B,\beta}$

Therefore

$$\mu_{A\times B}\big((x_1,y_1)\big)\geq \alpha$$
$$\gamma_{A\times B}\big((x_1,y_1)\big)\leq \beta$$

This gives

$$\mu_{A\times B}\{(x_1,y_1)\}\geq \min\{\mu_{A\times B}((x_1,y_1)*(x_2,y_2)),\mu_{A\times B}(x_2,y_2)\}$$

and

$$\gamma_{A\times B}\{(x_1,y_1)\}\leq \max\{\gamma_{A\times B}((x_1,y_1)*(x_2,y_2)),\gamma_{A\times B}(x_2,y_2)\}$$

Hence $A\times B$ is a intuitionistic fuzzy BG-ideal of $X\times Y$.

Reference

[1] Ahn,S.S., Lee,H.D. Fuzzy subalgebras of BG-algebra. Commun.Korean Math.Soc.19(2),243-251(2004).
[2] R.Angelin suba and K.R.Sobha, Upper and Lower level sets of absolute direct product of doubt intuitionistic fuzzy K-Ideal of BCK/BCI-algebra, International Journal of Research in engineering and Science volume 9 Issue 3/2021/pp.12-15.
[3] R.Angelin suba and K.R.Sobha, Absolute direct product of doubt intuitionistic fuzzy K-ideals in BCK/BCI-algebras,International journal of applied engineering research,ISSN 0973-4562 volume 14, Number 8, 2019.
[4] Atanassov.K.T, (1986); Intuitionistic fuzzy sets, Fuzzy sets and systems, 20 :87.
[5] Cho.J.R, Kim.H.S . On B-algebra and quasigroup. Quasigroups Relat. Syst. 8,1-6(2001).
[6] C.B.Kim and H.S.Kim, On BG-algebras, Demonstraction Mathematica 41 (2008) 497-505.
[7] Muthuraj.R, Sridharan, Sitharselvam, P.M.: Fuzzy BG-ideals in BG-algebra.Int. J. Comput. Appl. 2(1), 26-30(2010).
[8] J.Neggers, H.S.Kim, On B-algebra, Math.Vensik 54 (2002) 21-29.
[9] L.A.zadeh, Fuzzy sets, information and Control 8 (1965) 338-353.
[10] A.Zarandi, A.B.Saeid, On intuitionistic fuzzy ideals of BG-algebra, World Academy of Sciences Engineering an Technology 5 (2005) 187-189.