Available online at www.elixirpublishers.com (Elixir International Journal)

Applied Mathematics

Elixir Appl. Math. 80 (2015) 30949-30953

ISSN: 2229-712X

Remarks on nano gb-irresolute maps

Dhanis Arul Mary A and Arockiarani I
Department of Mathematics, Nirmala College for women, Coimbatore, Tamilnadu, India.

ARTICLE INFO

Article history:
Received: 21 January 2015;
Received in revised form:
25 February 2015;
Accepted: 5 March 2015;

Keywords
Nano gb-continuity,
Nano gb-irresoluteness,
Strongly nano gb-continuity,
Perfectly nano gb-continuity.

ABSTRACT
The aim of this paper is to introduce the stronger forms of nano gb-continuous functions namely, nano gb-irresolute function, strongly nano gb-continuous functions and perfectly nano gb-continuous functions and to establish the relationship between them. Also some of their properties of those functions are derived.

Introduction

Generalized open sets play a very important role in general topology and they are now the research topics of many topologists worldwide. One of the most well known notions and also an inspiration source is the notion of b-open sets [2] introduced by Andrijevic in 1996. Levine [9] introduced the concept of generalized closed sets as a generalization of closed sets in topological spaces. This concept was found to be useful to develop many results in general topology. The notion of nano topology was introduced by Lellis Thivagar [11] which was defined in terms of approximations and boundary region of a subset of an universe using an equivalence relation on it. He also established the weak forms of nano open sets namely nano α -open sets, nano semi open sets and nano pre open sets [11]. Extensive research on generalizing closedness in nano topological spaces was done in recent years by many mathematicians [5, 6, 16].

In the present paper, the authors have studied basic properties of nano gb-irresolute functions. The relationships of nano gb-continuity with the other stronger forms of nano gb-continuity have also been studied.

Preliminaries

Definition 2.1[17]: Let U be a non-empty finite set of objects called the universe and R be an equivalence relation on U named as the indiscernibility relation. Then U is divided into disjoint equivalence classes. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair (U, R) is said to be the approximation space.

Let $X \subseteq U$

1. The lower approximation of X with respect to R is the set of all objects, which can be for certainly classified as X with respect to R and it is denoted by $L_R(X)$. That is

$L_R(X) = \bigcup_{x\in U}\{R(x) : R(x) \subseteq X\}$, where R(x) denotes the equivalence class determined by $x \in U$.

2. The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by $U_R(X)$. That is

$$U_R(X) = \bigcup_{x\in U}\{R(x) : R(x) \cap X \neq \phi\}$$

3. The boundary region of X with respect to R is the set of all objects, which can be classified neither as X nor as not-X with respect to R and it is denoted by $B_R(X)$. That is

$B_R(X) = U_R(X) – L_R(X)$.

Definition 2.2[11]: Let U be non-empty, finite universe of objects and R be an equivalence relation on U. Let $X \subseteq U$. Let $\tau_R(X)$ = {U, ϕ, $L_R(X)$, $U_R(X)$, $B_R(X)$}. Then $\tau_R(X)$ is a topology on U, called as the nano topology with respect to X. Elements of the nano topology are known as the nano-open sets in U and $(U, \tau_R(X))$ is called the nano topological space. $[\tau_R(X)]^c$ is called as the dual nano topology of $\tau_R(X)$. Elements of $[\tau_R(X)]^c$ are called as nano closed sets.

Definition 2.3[12]: If $(U, \tau_R(X))$ is a nano topological space with respect to X where $X \subseteq U$ and if $A \subseteq U$, then the nano interior of A is defined as the union of all nano-open subsets of A and it is denoted by Nint(A). That is, Nint(A) is the largest nano open subset of A. The nano closure of A is defined as the intersection of all nano closed sets containing A and is denoted by Ncl(A). That is, Ncl(A) is the smallest nano closed set containing A.

Tele:
E-mail addresses: dhanisarulmary@gmail.com

Definition 2.4: A subset A of a nano topological space $(U,\tau_R(X))$ is called nano generalized b-closed (briefly, nano gb-closed), if Nbcl(A) $\subseteq$ G whenever A $\subseteq$ G and G is nano open in U.

The complement of a nano generalized b-closed set is called nano generalized b-open (simply nano gb-open).

Definition 2.5[12]: Let $(U,\tau_R(X))$ and $(V,\tau_{R'}(Y))$ be nano topological spaces. Then a mapping $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is said to be

(i) nano continuous if $f^{-1}(B)$ is nano open in U for every nano-open set B in V.
(ii) nano α- continuous if $f^{-1}(B)$ is nano α-open in U for every nano-open set B in V.
(iii) nano semi-continuous if $f^{-1}(B)$ is nano semi-open in U for every nano-open set B in V.
(iv) nano pre-continuous if $f^{-1}(B)$ is nano pre-open in U for every nano-open set B in V.
(v) nano g-continuous if $f^{-1}(B)$ is nano g-open in U for every nano-open set B in V.
(vi) nano gb-continuous if $f^{-1}(B)$ is nano gb-open in U for every nano-open set B in V.

Nano gb-irresolute functions

Definition 3.1: A function $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is called a nano gb-irresolute function if the inverse image of every nano gb-closed set in $(V,\tau_{R'}(X))$ is nano gb-closed in $(U,\tau_R(X))$.

Remark 3.2: The notion of nano irresolute functions and nano gb-irresolute functions are independent as can be seen from the following examples.

Example 3.3: Let U = {a, b, c, d} with U/R = {{a}, {b, d}, {c}} and X = {b, d}. Then the nano topology is defined as $\tau_R(X)$ = {U, ϕ, {b, d}}. Let V = {x, y, z, w} with V/R' = {{x}, {z}, {y, w}} and Y = {x, y}. Then $\tau_{R'}(Y)$ = {V, ϕ, {x}, {x, y, w}, {y, w}}.Define $f:U\to V$ as f(a) = x, f(b)= z, f(c) = w and f(d) = x. Then f is nano gb-irresolute but not nano irresolute since $f^{-1}(\{z\})$ = {b} is not nano closed in $(U,\tau_R(X))$.

Example 3.4: Let U = {a, b, c, d} with U/R = {{a}, {c}, {b, d}} and X = {a, b}. Then the nano topology is defined as $\tau_R(X)$ = {U, ϕ, {a}, {a, b, d}, {b, d}}. Let V = {x, y, z, w} with V/R' = {{x}, {y, w}, {z}} and Y = {y, w}. Then $\tau_{R'}(Y)$ = {V, ϕ, {y, w}}.Define $f:U\to V$ as f(a) = x, f(b)= y, f(c) = z and f(d) = w. Then f is nano irresolute but not nano gb-irresolute because $f^{-1}(\{x,y,w\})$ = {a, b, d} which is not nano gb-closed in $(U,\tau_R(X))$.

Theorem 3.5: A map $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is nano gb-irresolute if and only if the inverse image of every nano gb-open set in $(V,\tau_{R'}(X))$ is nano gb-open in $(U,\tau_R(X))$.

Proof: Let f be nano gb-irresolute and G be any nano gb-open set in $(V,\tau_{R'}(X))$, then $f^{-1}(G^c)$ is nano gb-closed in $(U,\tau_R(X))$. Since $f^{-1}(G^c)=f^{-1}(G)^c$, $f^{-1}(G)$ is nano gb-open in $(U,\tau_R(X))$. Conversely, let G be a nano gb-closed set in $(V,\tau_{R'}(X))$, then $f^{-1}(G^c)$ is nano gb-open in $(U,\tau_R(X))$. Since $f^{-1}(G^c)=f^{-1}(G)^c$, f is nano gb-irresolute.

Theorem 3.6: If a map $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is nano gb-irresolute, then it is nano gb-continuous.

Proof: Let G be any nano open set in $(V,\tau_{R'}(X))$. Since every nano open set is nano gb-open, and f is nano gb-irresolute $f^{-1}(G)$ is nano gb-open in $(U,\tau_R(X))$. Therefore, f is nano gb-continuous.

Remark 3.7: The converse of the Theorem 3.6 need not be true as seen from the following example.

Example 3.8: Let U = {a, b, c, d} with U/R = {{a, c}, {b}, {d}} and X = {a, d}. Then the nano topology is defined as $\tau_R(X)$ = {U, ϕ, {d}, {a, c, d}, {a, c}}. Let V = {x, y, z, w} with V/R' = {{x}, {y, z}, {w}} and Y = {x, z}. Then $\tau_{R'}(Y)$ = {V, ϕ, {x}, {x, y, z}, {y, z}}.Define $f:U\to V$ as f(a) = x, f(b)= y, f(c) = w and f(d) = z. Then f is nano gb-continuous but not nano gb-irresolute because $f^{-1}(\{z,w\})$ = {c, d} which is not nano gb-closed in $(U,\tau_R(X))$.

Definition 3.9: A function $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is said to be strongly nano gb-continuous if the inverse image of every nano gb-open set in $(V,\tau_{R'}(X))$ is nano open in $(U,\tau_R(X))$.

Theorem 3.10: If $f:(U,\tau_R(X))\to(V,\tau_{R'}(Y))$ is strongly nano gb-continuous then it is continuous.

Proof: Let G be any nano open set in $(V,\tau_{R'}(X))$. Since every nano open set is nano gb-open, G is nano gb-open in $(V,\tau_{R'}(X))$.Then $f^{-1}(G)$ is nano open in $(U,\tau_R(X))$. Therefore, f is nano continuous.

Remark 3.11: The converse of the Theorem 3.10 need not be true as seen from the following example.

Example 3.12: Let U = {a, b, c, d} with U/R = {{a, d}, {b}, {c}} and X = {a, c}. Then the nano topology is defined as $\tau_R(X)$ = {U, ϕ, {c}, {a, c, d}, {a, d}}. Let V = {x, y, z, w} with V/R' = {{x}, {y}, {z}, {w}} and Y = {x, w}. Then $\tau_{R'}(Y)$ = {V, ϕ, {x, w}}. Define $f: U \to V$ as f(a) = x, f(b)= y, f(c) = z and f(d) = w. Then f is nano continuous but not strongly nano gb-continuous since for the nano gb-open set {x, z} in $(V, \tau_{R'}(X))$, $f^{-1}(\{x,z\})$ = {a, c} which is not nano open in $(U, \tau_R(X))$.

Definition 3.13: A function $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ is said to be strongly nano continuous if $f^{-1}(G)$ is nano clopen in $(U,\tau_R(X))$ for every subset G in $(V,\tau_{R'}(X))$.

Theorem 3.14: If $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ is strongly nano continuous then it is strongly nano gb-continuous.

Proof: Let G be any nano gb-open set in $(V,\tau_{R'}(X))$. Then $f^{-1}(G)$ is both nano open and nano closed in $(U,\tau_R(X))$. Hence f is strongly nano gb-continuous.

Remark 3.15: The converse of the Theorem 3.14 need not be true as seen from the following example.

Example 3.16: Let U = {x, y, z, w} with U/R = {{x, z}, {y}, {z}} and X = {x, z}. Then the nano topology is defined as $\tau_R(X)$ = {U, ϕ, {z}, {x, z, w}, {x, w}}. Let V = {a, b, c, d, e} with V/R' = {{a}, {b}, {c, d}, {e}} and Y = {a, b, d}. Then $\tau_{R'}(Y)$ = {V, ϕ, {a, b}, {a, b, c, d}, {c, d}}. Define $f: U \to V$ as f(x) = e, f(y) = e, f(z) = d and f(w) = e. Then f is strongly nano gb-continuous but not strongly nano continuous since for the subset {c, d} in $(V,\tau_{R'}(X))$, $f^{-1}(\{c,d\})$ = {z} which is not nano closed in $(U,\tau_R(X))$.

Theorem 3.17: Let $(U,\tau_R(X))$ be any nano topological space and $(V,\tau_{R'}(X))$ be a T^*_{Ngb} space and $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ be a map. Then the following are equivalent.

(i) f is nano gb-irresolute

(ii) f is nano gb-continuous

Proof: (i) $\to$ (ii) Let f be nano gb-irresolute. Let G be nano closed set in $(V,\tau_{R'}(X))$. Then, G is nano gb-closed in V. Since f is nano gb-irresolute $f^{-1}(G)$ is nano gb-closed in $(U,\tau_R(X))$. Thus f is nano gb-continuous.

(ii) $\to$ (i)Let F be a nano gb-closed set in $(V,\tau_{R'}(X))$. Since V is a T^*_{Ngb}-space F is nano closed in V. By assumption, $f^{-1}(F)$ is nano gb-closed in $(U,\tau_R(X))$. Therefore f is nano gb-irresolute.

Theorem 3.18: Let $(U,\tau_R(X))$ be any nano topological space and $(V,\tau_{R'}(X))$ be a T^*_{Ngb}-space and $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ be a map. Then the following are equivalent.

(i) f is strongly nano gb-continuous.

(ii) f is nano continuous.

Proof: (i) $\to$ (ii) Follows from Theorem 3.14

(ii) $\to$ (i) Let G be any nano gb-open set in $(V,\tau_{R'}(X))$. Since $(V,\tau_{R'}(X))$ is a T^*_{Ngb}-space, G is nano open in $(V,\tau_{R'}(X))$ and since f is nano continuous, $f^{-1}(G)$ is nano open in $(U,\tau_R(X))$. Therefore f is nano gb-continuous.

Theorem 3.19: Let $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ be a map and both $(U,\tau_R(X))$ and $(V,\tau_{R'}(X))$ are T^*_{Ngb}-spaces. Then the following are equivalent.

(i) f is strongly nano gb-continuous

(ii) f is nano continuous

(iii) f is nano gb-irresolute

(iv) f is nano gb-continuous.

Proof follows from Theorems 3.17 and 3.18.

Theorem 3.20: A map $f:(U,\tau_R(X)) \to (V,\tau_{R'}(Y))$ is strongly nano gb-continuous if and only if the inverse image of nano gb-closed set in $(V,\tau_{R'}(X))$ is nano closed in $(U,\tau_R(X))$.

Proof is similar to Theorem 3.5.

Theorem 3.21: If $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ and $g:\left(V,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ are strongly nano gb-continuous, then their composition $g\circ f:\left(U,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ is also strongly nano gb-continuous.

Proof: Let G be nano gb-open set in $\left(W,\tau_{R''}(Y)\right)$. Since g is strongly nano gb-continuous, $g^{-1}(G)$ is nano open in $\left(V,\tau_{R'}(X)\right)$. Since $g^{-1}(G)$ is nano open, it is nano gb-open in $\left(V,\tau_{R'}(X)\right)$. As f is also strongly nano gb-continuous, $f^{-1}(g^{-1}(G))=(g\circ f)^{-1}(G)$ is nano open in $\left(U,\tau_R(X)\right)$ and so $g\circ f$ is strongly nano gb-continuous.

Theorem 3.22: Let $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ and $g:\left(V,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ be any two functions, then their composition $g\circ f:\left(U,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ is

(i) strongly nano gb-continuous if g is strongly nano gb-continuous and f is nano continuous.

(ii) nano gb-irresolute if g is nano strongly nano gb-continuous and f is nano gb continuous (or f is nano gb-irresolute)

(iii) nano continuous if g is nano gb-continuous and f is strongly nano gb-continuous.

Proof: (i) Let G be a nano gb-open set in $\left(W,\tau_{R''}(Y)\right)$. Since g is strongly nano gb-continuous, $g^{-1}(G)$ is nano open in $\left(V,\tau_{R'}(X)\right)$. Since f is nano continuous, $f^{-1}(g^{-1}(G))=(g\circ f)^{-1}(G)$ is nano open in $\left(U,\tau_R(X)\right)$ and so $g\circ f$ is nano gb-continuous.

(ii)Let G be a nano gb-open set in $\left(W,\tau_{R''}(Y)\right)$.Since g is strongly nano gb-continuous $g^{-1}(G)$ is nano open in $\left(V,\tau_{R'}(X)\right)$. As f is nano continuous, $f^{-1}(g^{-1}(G))=(g\circ f)^{-1}(G)$ is nano gb-open in $\left(U,\tau_R(X)\right)$ and so $g\circ f$ is nano gb-irresolute.

(iii) Let G be a nano gb-open set in $\left(W,\tau_{R''}(Y)\right)$.Since g is nano gb-continuous $g^{-1}(G)$ is nano gb-open in $\left(V,\tau_{R'}(X)\right)$. As f is strongly nano gb-continuous, $f^{-1}(g^{-1}(G))=(g\circ f)^{-1}(G)$ is nano open in $\left(U,\tau_R(X)\right)$ and so $g\circ f$ is nano continuous.

Definition 3.23: A map $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is called perfectly nano gb-continuous if the inverse image of every nano gb-open set in $\left(V,\tau_{R'}(X)\right)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$.

Theorem 3.24: If $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is perfectly nano gb-continuous, then it is strongly nano gb-continuous.

Proof: Since $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is perfectly nano gb-continuous $f^{-1}(G)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$ for every nano gb-open set G in $\left(V,\tau_{R'}(X)\right)$. Therefore f is strongly nano gb-continuous.

Remark 3.25: The converse of the Theorem 3.24 need not be true as seen from the following example.

Example 3.15 shows that f is strongly nano gb-continuous but not perfectly nano gb-continuous. Since for the nano gb-open set {d} in $\left(V,\tau_{R'}(X)\right)$, $f^{-1}(\{d\})$ = {z} which is not nano closed in $\left(U,\tau_R(X)\right)$.

Theorem 3.26: If $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is strongly nano continuous, then it is perfectly nano gb-continuous.

Proof: Since $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is strongly nano continuous $f^{-1}(G)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$ for every nano gb-open set G in $\left(V,\tau_{R'}(X)\right)$. Therefore f is perfectly nano gb-continuous.

Theorem 3.27: A map $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ is perfectly nano gb-continuous if and only if the inverse image of every nano gb-closed set in $\left(V,\tau_{R'}(X)\right)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$.

Proof: Let G be nano gb-closed set in $\left(V,\tau_{R'}(X)\right)$. Since f is perfectly nano gb-continuous, then $f^{-1}(G^c)$ is both nano open and nano closed in $\left(V,\tau_{R'}(X)\right)$. Since $f^{-1}(G^c)=f^{-1}(G)^c$, $f^{-1}(G)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$. Conversely, let G be any nano gb-open set in $\left(V,\tau_{R'}(X)\right)$. Since $f^{-1}(G^c)=f^{-1}(G)^c$, $f^{-1}(G)$ is both nano open and nano closed in $\left(U,\tau_R(X)\right)$. Hence f is perfectly nano gb-continuous.

Theorem 3.28: If $f:\left(U,\tau_R(X)\right)\to\left(V,\tau_{R'}(Y)\right)$ and $g:\left(V,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ are perfectly nano gb-continuous, then their composition $g\circ f:\left(U,\tau_{R'}(X)\right)\to\left(W,\tau_{R''}(Y)\right)$ is also perfectly nano gb-continuous.

Proof: Let G be nano gb-open set in $\left(W, \tau_{R''}(Y)\right)$. Then, $g^{-1}(G)$ is both nano open and nano closed in $\left(V, \tau_{R'}(X)\right)$. Since any nano open set is nano gb-open and f is perfectly nano gb-continuous $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is both nano open and nano closed in $\left(U, \tau_R(X)\right)$. Hence $g \circ f$ is perfectly nano gb-continuous.

Theorem 3.29: Let $f : \left(U, \tau_R(X)\right) \to \left(V, \tau_{R'}(Y)\right)$ and $g : \left(V, \tau_{R'}(X)\right) \to \left(W, \tau_{R''}(Y)\right)$ be any two functions, then their composition $g \circ f : \left(U, \tau_{R'}(X)\right) \to \left(W, \tau_{R''}(Y)\right)$ is

(i) nano gb-continuous if g is strongly nano gb-continuous and f is nano gb-continuous.
(ii) nano gb-irresolute if g is perfectly nano gb-continuous and f is nano gb continuous (or f is nano gb-irresolute)
(iii) strongly nano gb-continuous if g is perfectly nano gb-continuous and f is nano continuous(or f is strongly nano continuous).
(iv) perfectly nano gb-continuous if g is strongly nano continuous and f is perfectly nano gb- continuous.

Proof: (i) Let G be a nano gb-open set in $\left(W, \tau_{R''}(Y)\right)$. Then, $g^{-1}(G)$ is both nano open and nano closed in $\left(V, \tau_{R'}(X)\right)$. Hence $f^{-1}(g^{-1}(G))$ is nano gb-open in $\left(U, \tau_R(X)\right)$. Thus, $g \circ f$ is nano gb-continuous.

(ii)Let G be a nano gb-open set in $\left(W, \tau_{R''}(Y)\right)$. Then, $g^{-1}(G)$ is nano open or nano closed in $\left(V, \tau_{R'}(X)\right)$. As f is nano gb-continuous, $f^{-1}(g^{-1}(G))$ is nano gb-closed or nano gb-open in $\left(U, \tau_R(X)\right)$. Thus, $g \circ f$ is nano gb-irresolute.

(iii) Let G be a nano gb-open set in $\left(W, \tau_{R''}(Y)\right)$. Then $g^{-1}(G)$ is both nano open and nano closed in $\left(V, \tau_{R'}(X)\right)$ and hence $f^{-1}(g^{-1}(G))$ is both nano open and nano closed in $\left(U, \tau_R(X)\right)$ and hence $g \circ f$ is strongly nano gb-continuous.

(v) Let G be a nano gb-open set in $\left(W, \tau_{R''}(Y)\right)$. Then $g^{-1}(G)$ is both nano open and nano closed in $\left(V, \tau_{R'}(X)\right)$ which is nano gb-open in $\left(V, \tau_{R'}(X)\right)$ then hence $f^{-1}(g^{-1}(G))$ is both nano open and nano closed in $\left(U, \tau_R(X)\right)$ and hence $g \circ f$ is perfectly nano gb-continuous.

References

[1] D. Andrijević - Semi preopen sets, Mat. Vesnik, 38(1986), no. 1, 24-32.
[2] D. Andrijević, On b-open sets, Mat. Vesnik 48 (1996), no. 1-2, 59-64.
[3] Ahmad Al-Omari and Mohd. Salmi Md. Noorani, On Generalized b-closed sets, Bull. Malays. Math. Sci. Soc. (2)32(1)(2009), 19-30.
[4] P. Bhattacharryya and B. K. Lahiri, semi generalized closed sets in topology, Indian J. Math. 29(1987), (1988), no.3, 375-382.
[5] Bhuvaneswari and Mythili Gnanapriya K, Nano generalized closed sets in nano topological spaces, International Journal of Scientific and Research Publications, (2014).
[6] Bhuvaneswari K, Ezhilarasi, On nano semi- generalized and generalized- semi closed sets in nano topological spaces, International Journal of Mathematics and Computer Applications Research, (2014), 117-124.
[7] E. Ekici and Caldas, Slightly γ -continuous functions, Bol. Soc. Parana. Mat. (3) 22 (2004), no. 2, 63-74.
[8] M. Ganster and M. Steiner, On b τ -closed sets, Appl. Gen. Topol. 8 (2007), no. 2, 243-247.
[9] N. Levine, generalized closed sets in topology, Rend.Circ. Mat. Palermo (2)19(1970), 89-96.
[10] N. Levine, semi open sets and semi continuity in topological spaces, Amer, Math. Monthly 70(1963), 36- 41.
[11] M. Lellis Thivagar and Carmel Richard, On nano forms of weakly open sets, International Journal of Mathematics and statistics Invention, (2013), 31-37.
[12] Lellis Thivagar. M and Carmel Richard "On Nano Continuity", Mathematical theory and modeling, (2013), no.7, 32-37.
[13] A. S. Mashhour, M. E. Abd El-Monsef and S. N. El-Deep, On pre continuous and weak pre- continuous mappings, Proc. Math. Phys. Soc. Egypt No. 53 (1982), 47-53 (1983).
[14] H. Maki, R. Devi and K. Balachandran, Associated Topologies of generalized α -closed sets and α - generalized closed sets, Mem. Fac. Sci. Kochi Univ. Ser. A Math. 15 (1994), 51-63.
[15] O. Njastad, On some classes of nearly open sets, Pacific J. Math. 15 (1965), 961-970.
[16] Thanga Nachiyar R, Bhuvaneswari K, "On nano generalized α -closed sets and nano α - generalized closed sets in nano topological spaces ", International Journal of Engineering Trends and Technology, (2014), no.6.
[17] Z. Pawlak (1982) "Rough Sets", International Journal of Information and Computer Sciences, 11(1982), 341-356.