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(i,j)-Quasi Semi Weakly g*-Closed Functions in Bitopological Spaces

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Abstract

The primary purpose of this paper is to introduce and study two new types of functions on bitopological spaces called (i,j)- quasi semi weakly g*-open and (i,j)- quasi semi weakly g*-closed.

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Key Words : Bitopological spaces, (i,j)- semi weakly g*-open , (i,j)- quasi semi weakly g* -closed, Pairwise open, Pairwise closed, Pairwise –semi weakly g* -closed, Pairwise semi weakly g**-closed, Pairwise continuous , Pairwise semi weakly g* -continuous , Pairwise semi weakly g*- irresolute, Pairwise normal, Pairwise semi weakly g*-normal, Pairwise semi weakly g**- normal.

1. Introduction

The Concept of a bitopological space (X,τ_1 ,τ_2) was first introduced by Kelly [1] , where X is a non-empty set and τ_1 ,τ_2 are topologies on X. The authors [3, 4] defined the notions of swg*-open sets and swg*-continuity.

Pervin [6] investigated connectedness in bitopological space. Khedr, El.Areefi and Noiri [2] defined pre-continuity and semi pre continuity in bitopological spaces.In this paper, we introduce and study the concepts of quasi SWG*- open and quasi-swg*-closed functions on bitopological spaces.

Throughout this paper, (X, τ_1, τ_2) or simply X denote a bitopological space. The intersection (resp.union) of all τ_i - closed sets containing A (resp. τ_i-open sets contained in A) is called the τ_i-closure (resp. τ_i-interior) of A, denoted by τ_i-cl (A) (resp. τ_i-int (A)).

2. Perliminaries

Definition 2.1: Let A be subset of a topological space (X,τ). It is called semi weakly g*-closed [3] denoted by swg*- closed set if gcl (A) $\subseteq$ U whenever A$\subseteq$U and U is semi-open.

Definition 2.2: Let X and Y be topological spaces. A map f: X$\rightarrow$Y is said to be semi weakly g*-continuous [4] (swg*-continuous), if the inverse image of every open set Y is swg*- open in X.

Definition 2.3: Let (i, j) $\in\{1, 2\}$ be fixed integers. In a bitopological space (X, τ_1, τ_2) a subset A$\subseteq$ X is said to be (i, j)-semi weakly g*- closed [5] (briefly (i,j)-swg*-closed), if j-gcl A$\subseteq$ U whenever A$\subseteq$ U and U$\in$i- semi-open.

Definition 2.4: A space (X,τ_1 ,τ_2) is said to be pairwise normal [7] , if for each τ_1-closed set A and τ_2-closed set B disjoint from A, there is a τ_1-open set U containing A and a τ_2-open set V containing B such that U $\cap$V= ϕ.

3. (i, j)-QUASI SEMI WEAKLY g*- OPEN AND QUASI SEMI WEAKLY g*- CLOSED FUNCTIONS

Definition 3.1: A function f : $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ is said to be (i,j) – quasi semi weakly g*-open if the image of every (i,j)- semi weakly g*-open set in X is σ_i – open in Y.

Remark 3.2: It is clear that every (i, j)-quasi –swg*-open function is both pairwise open and pairwise swg*-open. The converse is not true as seen from the following example.

Example 3.3 : Let X= {a,b,c}, τ_1={X,ϕ,{a,b}}, σ_1= {Y,ϕ,{a},{a,b}}, and τ_2= {X,ϕ,{b,c}}, σ_2 = {Y,ϕ,{b,c},{c}}. Clearly the function f: $(X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is pairwise open and pairwise swg*-open. However, f is not quasi –(i,j)-swg*-open because {a,b} is (2,1)-swg*-open in (X,τ_1 ,τ_2) , but not σ_2-open.

Theorem 3.4: Let f: $(X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is a function. Then the following are equivalent:

(i) f is (i,j) – quasi swg*- open;

(ii) For each subset U of X, f ((i,j) –g int (U)) $\subset \sigma_i$ – int (f(U));

(iii) For each x$\in$X and each (i,j) – swg*-neighbourhood U of x in X, there exists a σ_i- neighbourhood V of f(x) such that V $\subset$ f(U).

Proof :(i) $\Rightarrow$(ii): Let f be an (i, j) - quasi – swg* - open function. Since (i,j)- g int (U) is an (i,j)- swg*-open set contained in U, we obtain that f((i,j)- g int (U)) $\subset$f (U). As f ((i,j)- g int (U)) is σ_i – open, f ((i,j)-g int (U)) $\subset \sigma_i$ –int (f(U)).

(ii) $\Rightarrow$ (iii): Let x $\in$ X and U be an (i, j) –swg* - neighbourhood of x in X. Then there exist an (i,j) – swg*-open set V in X such that x $\in$V $\subset$ U . Thus by (ii) , we have f(V) = f((i,j)- g int (V)) $\subset \sigma_i$- int (f(V)), and hence , f(V) = σ_i- int (f(V)). Therefore it follows that f (V) is σ_i– open such that f(x) $\in$ f (V) $\subset$f (U).

(iii)$\Rightarrow$ (i): Let U be an (i, j) –swg* -open set in X. Then by (iii), for each y$\in$ f (U), there exists a σ_i – neighbourhood Vy of y such that $V_y \subset$ f (U). As V_y is a σ_i –neighbourhood of y, there exists a σ_i –open set W_y such that Y $\in W_y \subset V_y$. Thus f (U) = $\cup$ {W_y: Y $\in$ f (U)} is σ_i – open. Hence, f is (i, j)-quasi – swg*-open.

Theorem 3.5: A function f: $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ is (i,j) –quasi –swg*-open ,if and only if for any subset B of Y and for any (i,j) –swg*-closed set F in X such that $f^{-1}(B) \subset F$, there exists a σ_i-closed set G containing B such that $f^{-1}(G) \subset F$.

Proof: Suppose that f is (i, j) - quasi swg*-open. Let B$\subset$Y and F be an (i, j) - swg*- closed set in X such that f^{-1} (B) $\subset$ F. Now, put G= Y- f (X-F). It is clear that B $\subset$ G as f^{-1} (B) $\subset$ F, and that f^{-1} (G) $\subset$ F. Also G is σ_i – closed, since f is ((i, j)-quasi – swg* -open. Conversely , let U be an ((i,j)- swg* -open set in X, and put B=Y-f(U).Then X-U is an (i,j)-swg*-closed set in X such that f^{-1} (B) $\subset$ X-U. By hypothesis, there exists a σ_i closed set G such that B$\subset$G and f^{-1} (G) $\subset$ X-U. Hence, f (U) $\subset$ Y-G .On the other hand, since B$\subset$G, Y-G $\subset$ Y-B= f (U). Thus f (U) = Y-G is σ_i -open, and hence, f is a (i, j) - quasi – swg*- open.

Theorem 3.6: Let f: $(X, \tau_1, \tau_2) \to (Y, \sigma_1, \sigma_2)$ be a function. Then the following are equivalent:

(i) f is (i,j)-quasi swg*-open;
(ii) $f^{-1}(\sigma_i\text{- cl }(B)) \subset$ (i,j)-gcl $(f^{-1}(B))$ for every subset B of Y ;
(iii) (i,j)- g int $(f^{-1}(B)) \subset f^{-1}(\sigma_i\text{– int }(B))$ for every subset B of Y.

Proof: (i) ⇒(ii): Suppose that f is (i, j) - quasi swg*-open. Now for any subset B of Y, $f^{-1}(B) \subset$ (i, j) - gcl $(f^{-1}(B))$. Therefore by Theorem 3.5 , there exists a σ_i – closed set G such that $B \subset G$ and $f^{-1}(G) \subset$ (i,j)-gcl $(f^{-1}(B))$. Hence, $f^{-1}(\sigma_i - \text{cl }(B)) \subset f^{-1}(G) \subset$ (i,j) - gcl $(f^{-1}(B))$.

(ii) ⇒ (i): Let $B \subset Y$ and F be an (i, j)-swg*- closed set in X such that $f^{-1}(B) \subset F$. Put $G = \sigma_i - \text{cl }(B)$, then $B \subset G$, G is σ_i – closed, and $f^{-1}(G) \subset$ (i, j) - gcl $(f^{-1}(B)) \subset F$. Thus by theorem 3.5, f is (i, j) - quasi – swg*-open.

(ii) ⇔(iii): It is Clear, because $f^{-1}(\sigma_{i\text{-}}\text{ cl }(B)) \subset$ (i,j)-gcl $(f^{-1}(B))$ for every subset B of Y is equal to (i,j)-g int $(f^{-1}(B)) \subset f^{-1}(\sigma_i\text{– int }(B))$ for every subset B of Y.

Theorem 3.7: Let f: $(X,\tau_1,\tau_2) \to (Y,\sigma_1,\sigma_2)$ and g : $(Y,\sigma_1,\sigma_2) \to (Z,\eta_1,\eta_2)$ be two functions such that $g_o f : X \to Z$ is (i,j)-quasi swg* -open . If g is a pairwise continuous injection, then f is (i, j) - quasi-swg*-open.

Proof: Let U be an (i, j) - swg*-open set in X. Then $(g_o f(U))$ is η_i-open as $g_o f$ is (i, j)-quasi –swg*-open. Since g is a pairwise continuous injection, $f(U) = g^{-1}(g_o f(U))$ is σ_i-open. Hence, f is (i, j)-quasi –swg*-open.

Definition 3.8: A function f: $(X,\tau_1,\tau_2) \to (Y,\sigma_1,\sigma_2)$ is said to be (i,j)-quasi – swg* - closed if the image of each (i,j)-swg* -closed set in X is σ_i-closed in Y.

Remark 3.9: It is clear that every (i, j)-quasi- swg*-closed function is both pair wise closed and pairwise swg*-closed. The converse is not true as seen from the following example.

Example 3.10: Let X= {a,b,c}, τ_1={X,ϕ,{c}}, σ_1= {Y,ϕ,{b,c},{c}},and τ_2= {X,ϕ,{a}}, σ_2 = {Y,ϕ,{a},{a,b}}. Clearly the function f: $(X, \tau_1, \tau_2) \to (Y, \sigma_1, \sigma_2)$ is pairwise closed and pairwise swg*-closed. However, f is not quasi –(i,j)-swg*-closed because {c} is (2,1)-swg*-closed in (X,τ_1,τ_2) , but not σ_2-closed.

Theorem 3.11: A function f: $(X,\tau_1,\tau_2) \to (Y,\sigma_1,\sigma_2)$ is (i,j)-quasi swg*-closed if and only if σ_i -cl (f(A)) $\subset$ f ((i,j)-gcl (A)) for every subset A of X.

Proof: Suppose that f is (i,j)-quasi –swg* -closed, there exist σ_i –cl (f(A)) $\subset$ f ((i,j)-gcl (A)) for every subset A of X. Conversely , every σ_i- cl (f (A)) $\subset$ f ((i,j)-gcl (A)) is (i,j)- quasi swg*-closed.

Theorem 3.12: Let f: $(X, \tau_1, \tau_2) \to (Y, \sigma_1, \sigma_2)$ be a function. Then the following are equivalent:

(i) f is (i,j)-quasi swg*- closed ;
(ii) For any subset B of Y and for any (i,j)-swg* -open set G in X such that $f^{-1}(B) \subset G$, there exists a σ_i-open set U containing B such that $f^{-1}(U) \subset G$;
(iii) For each $y \in Y$ and for any (i,j)-swg*-open set G in X such that $f^{-1}(\{y\}) \subset G$, there exists a σ_i-open set U containing {y} such that $f^{-1}(U) \subset G$.

Proof:

(i)⇒ (ii): Suppose f is (i, j)-quasi –swg* closed set. Now there exist for any subset B of Y and for (i,j)-swg*-open set G in X such that $f^{-1}(B) \subset G$,there exist a σ_i- open set U containing B such that $f^{-1}(U) \subset G$.

(ii) ⇒ (iii) : For any subset B of Y and for any (i,j)-swg* -open set G in X such that $f^{-1}(B) \subset G$, there exists a σ_i-open set U containing B such that $f^{-1}(V) \subset G$, Also there exist for each $y \in Y$ and for any (i,j)- swg*-open set G in X such that $f^{-1}(\{y\}) \subset G$, there exists a σ_i-open set containing {y} such that $f^{-1}(U) \subset G$.

(iii)⇒(i): For each $y \in Y$ and for any (i,j)-swg*-open set G in X such that $f^{-1}((Y)) \subset G$, there exists a σ_i-open set U containing B such that $f^{-1}(U) \subset G$. Then f is (i,j)- quasi swg*-closed.

Definition 3.13: A function f: $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ is called pair wise swg**-closed if the image of every (i,j)-swg*-closed set in X is (i,j)-swg*-closed in Y.

Theorem 3.14: Let f: $(X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ be a function. Then the following as equivalent:

(i) f is pair wise swg**- closed;

(ii) For any subset B of Y and for any (i,j)-swg*-open set G in X such that $f^{-1}(B) \subset G$, there exists an (i,j)-swg*-open set U in Y such that $B \subset U$ and $f^{-1}(U) \subset G$;

(iii) For each $y \in Y$ and for any (i,j)-swg*-open set G in X such that $f^{-1}(\{Y\}) \subset G$, there exists an (i,j)-swg*-open set U in Y such that $y \in U$ and $f^{-1}(U) \subset G$;

(iv) (i,j)-gcl (f (A)) ⊂ f ((i,j)-gcl ((A)) for every subset A of X.

Proof:

(i) ⇒ (ii): Let f be an pair wise swg**-closed. By definition 3.13. A function f: $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ is called pair wise swg**-closed if the image of every (i,j)-swg*-closed set in X is (i,j)-swg*-closed in Y, there exists for any subset B of Y and for any(i,j)-swg* -open set G in X such that $f^{-1}(B) \subset G$, there exists an (i,j)-swg*-open set U in Y, such that $B \subset U$ and $f^{-1}(U) \subset G$.

(ii)⇒(iii): For any subset B of Y and for any (i,j)-swg* -open set G in X such that $f^{-1}(B) \subset G$, there exists an (i,j)- swg*open set U in Y such that $B \subset U$ and $f^{-1}(U) \subset G$. There exist for $y \in Y$ and for any (i,j)-swg* -open set G in X. Such that $f^{-1}(\{y\}) \subset G$, Also there exists an (i, j) - swg* -open set U in Y such that $y \in U$ and $f^{-1}(U) \subset G$.

(iii)⇒(iv) : Let each $y \in Y$ and for any (i,j)-swg*-open set G in X such that $f^{-1}(\{y\}) \subset G$, there exists an (i,j)-swg*-open set U in Y such that $y \in U$ and $f^{-1}(U) \subset G$. That implies (i, j)-gcl (f (A)) ⊂ f (i, j)-gcl (A)) for every subset A of X.

(iv) ⇒(i): Let (i, j)-gcl (f (A)) ⊂ f ((i.j) – gcl (A)) for every subset A of X. There exist a f is pair wise swg**-closed.

Theorem 3.15: Let f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ and g: $(Y,\sigma_1,\sigma_2) \rightarrow (Z,\eta_1,\eta_2)$ are two (i,j)-quasi –swg* -closed functions , then $g_o f : (X,\tau_1,\tau_2) \rightarrow (Z,\eta_1,\eta_2)$ is (i,j)-quasi swg*-closed.

Proof: If f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ and g: $(Y,\sigma_1,\sigma_2) \rightarrow (Z,\eta_1,\eta_2)$ are two (i,j)-quasi –swg* -closed. Let U be an (i,j)-swg*-closed in X. Then ($g_o f$ (U) is σ_i-closed as $g_o f$ is (i, j) - quasi – swg* -closed.

Theorem 3.16: Let f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ and g: $(Y,\sigma_1,\sigma_2) \rightarrow (Z,\eta_1,\eta_2)$ be any two functions . Then if f is pairwise swg*-closed and g is (i,j)-quasi –swg*-closed the $g_o f$ is pairwise closed.

Proof: If f is pairwise swg* -closed and g is (i, j)-quasi –swg*-closed then $g_o f$ is pair wise closed.

Theorem 3.17 : Let f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ and g: $(Y,\sigma_1,\sigma_2) \rightarrow (Z,\eta_1,\eta_2)$ be any two functions . Then if f is pairwise swg**-closed and g is (i,j) -quasi –swg*-closed then $g_o f$ is (i,j)-quasi –swg* -closed.

Proof: If f is pairwise swg**-closed and g is (i,j)-quasi –swg*-closed then $g_o f$ is (i, j)-quasi –swg*-closed.

Definition 3.18: A function f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ is called pairwise swg*-irresolute, if $f^{-1}(V)$ is (i,j)-swg*-open in (X,τ_1,τ_2) for every (i,j)-swg*-open set V in Y.

Definition 3.19: A function f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ is called pairwise swg*-continuous, if $f^{-1}(V)$ is (i,j)-swg* -open in (X,τ_1,τ_2) for every σ_i-open set V in Y.

Theorem 3.20:

Let f : $(X,\tau_1,\tau_2) \rightarrow (Y,\sigma_1,\sigma_2)$ and g: $(Y,\sigma_1,\sigma_2) \rightarrow (Z,\eta_1,\eta_2)$ be two functions such that $g_o f : X \rightarrow Z$ is (i,j)-quasi-swg*-closed . Then

(i) If f is a pairwise swg*-irresolute surjection, then g is (i, j)-quasi –swg*-closed.

(ii) If g is a pairwise –swg* -continuous injection, then f is pair wise swg**-closed.

Proof: (i) Suppose that F is (i, j)-swg*-closed set in Y. Then $f^{-1}(F)$ is (i, j)-swg*-closed in X as f is pair wise swg*-irresolute. Since $g_o f$ is (i, j) - quasi –swg*-closed and f is subjective $(g_o f\ (f^{-1}\ (F))) = g\ (F)$ is η_i-closed. Hence g is (i, j)-quasi-swg*-closed.

(ii)Suppose that F is an (i, j) –swg*-closed set in X. Since $g_o f$ is (i,j)-quasi swg*-closed, $(g_o f\ )\ (F)$ is η_i-closed, but g is a pairwise swg*-continuous injection, so $g^{-1}\ (g_o f\ (F)) = f(F)$ is (i,j)-swg*-closed in Y. Hence f is pairwise swg**-closed.

Theorem 3.21: Let g: $(Y, \sigma_1, \sigma_2) \rightarrow (Z, \sigma_1, \sigma_2)$ be a function. Then g is (i,j)-quasi –swg*-closed if and only if g(X) is σ_i-closed , and g(V) – g (X-V) is σ_i-open in g(X) whenever V is (i,j)-swg*-open in X.

Proof: Necessity: Let g is (i, j) - quasi swg*-closed. Then g(X) is σ_i- closed as X is (i,j)- swg*-closed and g(V) –g (X-V)= g(X)-g(X-V) is σ_i-open in g(X) when V is (i,j)-swg*-open in X.

Sufficiency : Suppose that g(X) is σ_i- closed and g(V) –g (X-V) is σ_i-open is g (X) when V is (i,j)-swg* -open in X , and let C be (i,j)-swg* - closed in X. Then g (C) = g(X)-(g (X-C) –g(C)) is σ_i- closed in g(X), and therefore, σ_i-closed. Hence, g is (i, j)-quasi –swg* -closed.

Corollary 3.22: Let g: $(X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ be a surjection. Then g is (i,j) -quasi – swg* -closed if and only if g(V) –g (X-V) is σ_I –open whenever V is (i,j)- swg*- open in X.

Definition 3.23: A Space (X,τ_1 ,τ_2) is said to be pair wise swg*- normal if for any disjoint subset $F_1 \in$ (1,2) SWG*C (X) and $F_2 \in$ (2,1)- SWG*C (X) , there exist disjoint subsets $U \in \tau_1$ and $V \in \tau_2$ such that $F_1 \subset U$ and $F_2 \subset V$.

Theorem 3.24: Let $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ be two spaces , where X is pairwise swg*-normal and let

Theorem 3.24: Let $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ be two spaces , where X is pairwise swg*-normal and let g: $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ be a pairwise swg*-continuous, (i,j)- quasi swg*-closed surjection . Then Y is pair wise normal.

Proof: Let X is pair wise –swg*-normal. Let K be σ_1-closed and M be σ_2-closed disjoint subsets of Y. Then $g^{-1}(K) \in$ (1, 2) –SWG*C(X), g^{-1} (M) $\in$ (2, 1) - SWG*C(X) and $g^{-1} (K) \cap g^{-1} (M) = \phi$. Since X is pair wise –swg* -normal , there exist disjoint sets $V \in \tau_1$ and $W \in \tau_2$ such that $g^{-1} (K) \subset V$ and $g^{-1} (M) \subset W$. Thus $K \subset g$ (V) – g(X-V) and $M \subset g$ (W) - g (X-W). It follows also from corollary 3.22 that g(V) – g (X-V) $\in \sigma_1$ and g(W) – g(X-W) $\in \sigma_2$, and clearly (g(V)-g (X-V)) $\cap$ (g (w) – g(X-W)) = ϕ because $V \cap W = \phi$. Hence, Y is pair wise normal.

Theorem 3.25: Let $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ be two spaces, where X is pairwise swg*-normal and let g: $(X,\tau_1 ,\tau_2) \rightarrow (Y,\sigma_1 ,\sigma_2)$ be a pairwise swg*-irresolute (i,j)-quasi swg*-closed surjection. Then Y is pair wise swg*-normal.

Proof: Let X is pairwise swg*-normal. Let K be σ_1 – swg*-closed and M be σ_2 – swg*- closed disjoint subsets of Y. Then $g^{-1}(K) \in$ (1, 2) –SWG*C(X), g^{-1} (M)$\in$ (2, 1)-SWG*C (X) and $g^{-1} (K) \cap g^{-1} (M) = \phi$. Since X is pairwise swg*-normal, there exists disjoint sets $V \in \tau_1$ and $W \in \tau_2$ such that $g^{-1}(K) \subset V$ and $g^{-1} (M) \subset W$.Thus $K \subset g(V) – g(X-V)$ and $M \subset g(W) –g(X-W)$. It follows from corollary 3.22 that g(V)- g(X-V) $\in \sigma_1$ and g(W) – g(X-W) $\in \sigma_2$, and clearly g(V) – g (X-V) $\cap$(g(W)-g (X-W) = ϕ because $V \cap W = \phi$. Hence Y is pairwise swg*-normal.

References

(1) J.C.Kelly, (1963), Bitopological spaces, proc. London math.soc.3, 71-89.

(2) F.H.Khedr, S.M.El-Areefi and T.Noiri, (1992), Pre-continuity and Semi pre-continuity in bitopological spaces, Ind.J.Pure Appl.math.23 (9), 625 – 633.

(3) C.Mukundhan and N.Nagaveni, (2011), A Weaker form of a generalized closed set Int.J.contemp.Math.Sciences., Vol –b, No.20, 949-961.
(4) C.Mukundhan and N.Nagaveni, (III may 2011), on semi weakly g*-continuous functions in topological spaces Int.J.of Math. Sciences & Engg. Appls. (IJMSEA) Vol.5.No. pp 361-370.
(5) C.Mukundhan and N.Nagaveni, (2012), (i, j) - semi weakly g*-closed sets in bitopological spaces, Advances in Applied Mathematical Analysis, Vol.7 No.1, pp-11-21.
(6) W.J.Pervin, (1967) Connectedness in bitopological spaces, Indag.math., 29,369 -372.
(7) I.L.Reily , (1972) On Bitopological separation properties , nanta math.,(2), (5), 14-25